



Medical Treatment Guidelines

Hand, Wrist and Forearm Injuries (including Carpal Tunnel Syndrome)

Effective May 2, 2022

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A. GENERAL GUIDELINE PRINCIPLES

The principles summarized in this section are key to the intended application of the New York State Medical Treatment Guidelines (MTG) and are applicable to all Workers' Compensation Medical Treatment Guidelines.

A.1 Medical Care

Medical care and treatment required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities with a focus on a return to work, while striving to restore the patient's health to its pre-injury status in so far as is feasible.

A.2 Rendering Of Medical Services

Any medical provider rendering services to a workers' compensation patient must utilize the Treatment Guidelines as provided for with respect to all work-related injuries and/or illnesses.

A.3 Positive Patient Response

Positive results are defined primarily as functional gains which can be objectively measured. Objective functional gains include, but are not limited to, positional tolerances, range of motion, strength, endurance, activities of daily living (ADL), cognition, psychological behavior, and efficiency/velocity measures which can be quantified. Subjective reports of pain and function may be considered and given relative weight when the pain has anatomic and physiologic correlation in proportion to the injury.

A.4 Re-Evaluate Treatment

If a given treatment or modality is not producing positive results within a well-defined timeframe, the provider should either modify or discontinue the treatment regime. The provider should evaluate the efficacy of the treatment or modality 2 to 3 weeks after the initial visit and 3 to 4 weeks thereafter. These timeframes may be slightly longer in the context of conditions that are inherently mental health issues, and shorter for other non-musculoskeletal medical conditions (e.g. pulmonary, dermatologic etc.). Recognition that treatment failure is at times attributable to an incorrect diagnosis a failure to respond should prompt the clinician to reconsider the diagnosis in the event of an unexpected poor response to an otherwise rational intervention.

A.5 Education

Education of the patient and family, as well as the employer, insurer, policy makers and the community should be a primary emphasis in the treatment of work-related injury or illness. Practitioners should develop and implement effective educational strategies and skills. An education-based paradigm should always start with communication providing reassuring information to the patient. No treatment plan is complete without addressing issues of individual and/or group patient education as a means of facilitating self-management of symptoms and prevention of future injury.

Time Frames

A.6 Acuity

Acute, Subacute and Chronic are generally defined as timeframes for disease stages:

- Acute – Less than one month
- Subacute - One to three month, and
- Chronic - greater than three months.

A.7 Initial Evaluation

Initial evaluation refers to the acute timeframe following an injury and is not used to define when a given physician first evaluates an injured worker (initial encounter) in an office or clinical setting.

A.8 Diagnostic Time Frames

Diagnostic time frames for conducting diagnostic testing commence on the date of injury. Clinical judgment may substantiate the need to accelerate or decelerate the time frames discussed in this document.

A.9 Treatment Time Frames

Treatment time frames for specific interventions commence once treatments have been initiated, not on the date of injury. It is recognized that treatment duration may be impacted by disease process and severity, patient compliance, as well as availability of services. Clinical judgment may substantiate the need to accelerate or decelerate the time frames discussed in this document.

A.10 Delayed Recovery

For those patients who fail to make expected progress 6-12 weeks after an injury and whose subjective symptoms do not correlate with objective signs and tests, reexamination in order to confirm the accuracy of the diagnosis and re-evaluation of the treatment program should be performed. When addressing a clinical issue that is not inherently a mental health issue, assessment for potential barriers to recovery (yellow flags/psychological issues) should be ongoing throughout the care of the patient. At 6-12 weeks, alternate treatment programs, including formal psychological or psychosocial evaluation should be considered. Clinicians must be vigilant for any pre-existing mental health issues or subsequent, consequential mental health issues that may be impacting recovery. For issues that are clearly and inherently mental health issues from the outset (i.e. when it is evident that there is an underlying, work-related, mental health disorder as part of the claim at issue), referral to a mental health provider can and should occur much sooner. Referrals to mental health providers for the evaluation and management of delayed recovery do not indicate or require the establishment of a psychiatric or psychological condition. The evaluation and management of delayed recovery does not require the establishment of a psychiatric or psychological claim.

Treatment Approaches

A.11 Active Interventions

Active interventions emphasizing patient responsibility, such as therapeutic exercise and/or functional treatment, are generally emphasized over passive modalities, especially as treatment progresses. Generally, passive and palliative interventions are viewed as a means to facilitate progress in an active rehabilitation program with concomitant attainment of objective functional gains.

A.12 Active Therapeutic Exercise Program

Active therapeutic exercise program goals should incorporate patient strength, endurance, flexibility, range of motion, sensory integration, coordination, cognition and behavior (when at issue) and education as clinically indicated. This includes functional application in vocational or community settings.

A.13 Diagnostic Imaging And Testing Procedures

Clinical information obtained by history taking and physical examination should be the basis for selection of imaging procedures and interpretation of results. All diagnostic procedures have characteristic specificities and sensitivities for various diagnoses. Usually, selection of one procedure over others depends upon various factors, which may include: relative diagnostic value; risk/benefit profile of the procedure; availability of technology; a patient's tolerance; and/or the treating practitioner's familiarity with the procedure.

When a diagnostic procedure, in conjunction with clinical information, provides sufficient information to establish an accurate diagnosis, a second diagnostic procedure is not required. However, a subsequent diagnostic procedure including a repeat of the original (same) procedure can be performed, when the specialty physician (e.g. physiatrist, sports medicine physician or other appropriate specialist) radiologist or surgeon documents that the initial study was of inadequate quality to make a diagnosis. Therefore, in such circumstances, a repeat or complementary diagnostic procedure is permissible under the MTG.

It is recognized that repeat imaging studies and other tests may be warranted by the clinical course and/or to follow the progress of treatment in some cases. It may be of value to repeat diagnostic procedures (e.g., imaging studies) during the course of care to reassess or stage the pathology when there is progression of symptoms or findings, prior to surgical interventions and/or therapeutic injections when clinically indicated, and post-operatively to follow the healing process. Regarding serial imaging, (including x-rays, but particularly CT scans), it must be recognized that repeat procedures result in an increase in cumulative radiation dose and associated risks.

A given diagnostic imaging procedure may provide the same or distinctive information as obtained by other procedures. Therefore, prudent choice of procedures(s) for a single diagnostic procedure, a complementary procedure in combination with other procedures(s), or a proper sequential order in multiple procedures will ensure maximum diagnostic accuracy, minimize the likelihood of adverse effect on patients, and promote efficiency by avoiding duplication or redundancy.

A.14 Surgical Interventions

Consideration of surgery should be within the context of expected functional outcome. The concept of "cure" with respect to surgical treatment by itself is generally a misnomer. All operative interventions must be based upon positive correlation of clinical findings, clinical course and imaging and other diagnostic tests. A comprehensive assimilation of these factors must lead to a specific diagnosis with positive identification of pathologic condition(s). For surgery to be performed to treat pain, there must be clear correlation between the pain symptoms and objective evidence of its cause. In all cases, shared decision making with the patient is advised. The patient should be given the opportunity to understand the pros and cons of surgery, potential for rehabilitation as an alternative where applicable, evidence-based outcomes, and specific surgical experience.

A.15 Pre-Authorization

All diagnostic imaging, testing procedures, non-surgical and surgical therapeutic procedures, and other therapeutics within the criteria of the Medical Treatment Guidelines and based on a correct application of the Medical Treatment Guidelines are considered authorized, with the exception of the procedures listed in section 324.3(1)(a) of Title 12 NYCRR. These are not included on the list of pre-authorized procedures. Providers who want to perform one of these procedures must request pre-authorization from the carrier before performing the procedure.

Second or subsequent procedures (the repeat performance of a surgical procedure due to failure of, or incomplete success from the same surgical procedure performed earlier, if the Medical Treatment Guidelines do not specifically address multiple procedures) also require pre-authorization.

A.16 Psychological/Psychiatric Evaluations

In select patients, mental health evaluations are essential to make, secure or confirm a diagnosis. Of course, the extent and duration of evaluations and/or interventions by mental health professionals may vary, particularly based on whether: the underlying clinical issue in the claim is inherently a mental health issue; or there is a mental health issue that is secondary or consequential to the medical injury or illness that is at issue in the claim in question; or there is a pre-existing, unrelated mental health issue that has been made worse by, or is impeding the recovery from (or both) the medical injury or illness that is at issue in the claim in question.

Tests of psychological function or psychometric testing, when indicated, can be a valuable component of the psychological evaluation in identifying associated psychological, personality and psychosocial issues. Although these instruments may suggest a diagnosis, neither screening nor psychometric tests are capable of making a diagnosis. The diagnosis should only be made after careful analysis of all available data, including from a thorough history and clinical interview.

A professional fluent in the primary language of the patient is strongly preferred. When such a provider is not available, services of a professional language interpreter must be provided.

Frequency: When assessing for a pre-existing, unrelated mental health issue that has been made worse by, or is impeding the recovery from (or both) a work-related, medical injury or

illness, then a one-time visit for initial psychiatric/psychological encounter should be sufficient, as care would normally be continued by the prior treating provider. If psychometric testing is indicated by findings in the initial encounter, time for such testing should not exceed an additional three hours of professional time. For conditions in which a mental health issue is a central part of the initial claim, or in which there is a mental health issue that is secondary or consequential to the work-related, medical injury or illness, that is part of the claim in question, then more extensive diagnostic and therapeutic interventions may be clinically indicated, and are discussed in detail in the Medical Treatment Guidelines for such mental health conditions.

A.17 Personality/Psychological/Psychosocial Intervention

Following psychosocial evaluation, when intervention is recommended, such intervention should be implemented as soon as possible. This can be used alone or in conjunction with other treatment modalities. For all psychological/psychiatric interventions, there must be an assessment and treatment plan with measurable behavioral goals, time frames and specific interventions planned.

- Time to produce effect: two to eight weeks.
- Optimum duration: six weeks to three months.
- Maximum duration: three to six months.
- Counseling is not intended to delay but rather to enhance functional recovery.

For PTSD Psychological Intervention:

- Optimum duration three to six months.
- Maximum duration: nine to twelve months.

For select patients, longer supervision and treatment may be required, and if further treatment is indicated, documentation of the nature of the psychological factors, as well as projecting a realistic functional prognosis, should be provided by the authorized treating practitioner every four weeks during the first six months of treatment. For treatment expected to last six to twelve months, such documentation should be provided every four to eight weeks. For long-term treatment beyond twelve months, such documentation should be provided every eight to twelve weeks. All parties should strive for ongoing and continuous communications, in order to facilitate seamless, continuous and uninterrupted treatment.

A.18 Functional Capacity Evaluation (FCE)

Functional capacity evaluation is a comprehensive or more restricted evaluation of the various aspects of function as they relate to the patient's ability to return to work. Areas such as endurance, lifting (dynamic and static), postural tolerance, specific range-of-motion, coordination and strength, worker habits, employability, as well as psychosocial, cognitive, and sensory perceptual aspects of competitive employment may be evaluated.

Components of this evaluation may include: (a) musculoskeletal screen; (b) cardiovascular profile/aerobic capacity; (c) coordination; (d) lift/carrying analysis; (e) job-specific activity tolerance; (f) maximum voluntary effort; (g) pain assessment/psychological screening; (h)

non-material and material handling activities; (i) cognitive and behavioral; (j) visual; and (k) sensory perceptual factors.

In most cases, the question of whether a patient can return to work can be answered without an FCE.

An FCE may be considered at time of MMI, following reasonable prior attempts to return to full duty throughout course of treatment, when the treating physician is unable to make a clear determination on work status on case closure. An FCE is not indicated early during a treatment regime for any reason including one to support a therapeutic plan.

When an FCE is being used to determine return to a specific job site, the treating physician is responsible for understanding and considering the job duties. FCEs cannot be used in isolation to determine work restrictions. The authorized treating physician must interpret the FCE in light of the individual patient's presentation and medical and personal perceptions. FCEs should not be used as the sole criteria to diagnose malingering.

A.19 Return To Work

For purposes of these guidelines, return to work is defined as any work or duty that the patient is able to perform safely. It may not be the patient's regular work. Ascertaining a return to work status is part of medical care, and should be included in the treatment and rehabilitation plan. It is normally addressed at every outpatient visit. A description of the patient's status and task limitations is part of any treatment plan and should provide the basis for restriction of work activities when warranted. Early return to work should be a prime goal in treating occupational injuries. The emphasis within these guidelines is to move patients along a continuum of care and return to work, since the prognosis of returning an injured worker to work drops progressively the longer the worker has been out of work.

A.20 Job Site Evaluation

The treating physician may communicate with the employer or employer's designee, either in person, by video conference, or by telephone, to obtain information regarding the individual or specific demands of the patient's pre-injury job. This may include a description of the exertional demands of the job, the need for repetitive activities, load lifting, static or awkward postures, environmental exposures, psychological stressors and other factors that would pose a barrier to re-entry, risk of re-injury or disrupt convalescence. When returning to work at the patient's previous job tasks or setting is not feasible, given the clinically determined restrictions on the patient's activities, inquiry should be made about modified duty work settings that align with, the patient's condition in view of proposed work activities/demands in modified duty jobs. It should be noted, that under certain circumstances, more than one job site evaluation may be indicated.

Ideally, the physician would gain the most information from an on-site inspection of the job settings and activities; but it is recognized that this may not be feasible in most cases. If job videos/CDs/DVDs are available from the employer, these can contribute valuable information, as can video conferences, conducted from the worksite and ideally workstation or work area.

Frequency: one or two contacts

- 1st contact: Patient is in a functional state where the patient can perform some work.
- 2nd contact: Patient has advanced to state where the patient is capable of enhanced functional demands in a work environment.

The physician shall document the conversation.

Other

A.21 Guideline Recommendations And Medical Evidence

The Workers' Compensation Board and its Medical Advisory Committee have not independently evaluated or vetted the scientific medical literature used in support of the guidelines, but have relied on the methodology used by the developers of various guidelines utilized and referenced in these Guidelines.

A.22 Experimental/Investigational Treatment

Medical treatment that is experimental/investigational and not approved for any purpose, application or indication by the FDA is not permitted under these Guidelines.

A.23 Injured Workers As Patients

In these Guidelines, injured workers are referred to as patients recognizing that in certain circumstances there is no doctor-patient relationship.

A.24 Scope Of Practice

These Guidelines do not address scope of practice or change the scope of practice.

Hand, Wrist and Forearm Injuries

Effective: May 02, 2022

B. Introduction to Hand, Wrist and Forearm Injuries

This guideline addresses common work-related hand, wrist and forearm injuries/conditions and includes recommendations for assessing and treating these disorders.

B.1 History Taking and Physical Exam

B.1.a History Taking and Physical Exam

History taking and physical examination establish the foundation/basis for and dictate subsequent stages of diagnostic and therapeutic procedures. When findings of clinical evaluations and those of other diagnostic procedures are not consistent with each other, the objective clinical findings should have preference. The medical records should reasonably document the following:

B.1.b History Of Present Injury (HPI)

- Age, hand dominance, gender.
- Mechanism of injury: includes details of symptom onset (date of onset), progression, triggering event (if present) versus gradual onset. Activity at or before onset of symptoms.
- Prior occupational and non-occupational injuries to the same area including specific prior treatment.
- Location of symptoms.
- Nature of symptoms: pain, numbness, tingling, weakness, swelling, stiffness, limited movement, temperature change, moisture change, color change.
- Exacerbating and alleviating factors for symptoms. Identify the specific physical factors that aggravate or alleviate the problem.
- Time of day symptoms are best and worst e.g., upon awakening, after work.
- If symptoms improve when away from work (weekends, vacations).
- For traumatic injuries: Note if the area was swollen at any time and if so how quickly the swelling occurred (immediately or delayed). Hand/finger deformity.
- Use of comprehensive pain diagrams to better localize pain symptoms.
- Sleep disturbances.
- Other associated signs and symptoms noted by the patient.
- Ability to perform work activities and activities of daily living (ADL's). Assess the overall degree of restriction or combination of restrictions.

- Discussion of any symptoms present in the uninjured extremity.
- Relationship to work: This includes a statement of the probability that the illness or injury is work-related.
- Treatments used for current symptoms: Medications? Splints? Ice/heat? Rest? Surgery? Other? Have any treatment(s) been helpful? What treatments were not helpful?

B.1.c Past History

Past medical history includes, but is not limited to, neoplasm, gout, arthritis, and diabetes overweight/obesity, hypothyroidism, other endocrinopathy, pregnancy, osteoarthritis, rheumatoid arthritis, other arthritides, renal disease, systemic lupus erythematosus, spondyloarthropathy;

- Review of systems includes, but is not limited to, symptoms of rheumatologic, neurologic, endocrine, neoplastic, and other systemic diseases;
- Smoking history;
- Vocational and recreational pursuits;
- Previous testing, imaging or diagnostic studies or treatment, including the results and outcomes;
- Past surgical history,
- Psychosocial history.

B.1.d Physical Examination

Examination should include the joint above and below the affected area, including the opposite side for comparison. Physical examination should include accepted tests and exam techniques applicable to the joint or area being examined, including:

B.1.d.i Visual inspection - Examine both hands, wrists and forearms and look for and note asymmetries and for deformities suggestive of degeneration, malformation, fracture, or dislocations. Observe for signs of serious injuries, e.g., degloving injuries, lacerations, puncture wounds, open wounds and crush injuries

The neurologic and vascular status of the hand, wrist, forearm, and upper limb should include peripheral pulses, motor function, reflexes, and sensory status. It should also describe any dystrophic changes or variation in skin color or turgor. Examining the neck and cervical nerve root function is also recommended for most patients.

B.1.d.ii Palpation

B.1.d.iii Range of motion/quality of motion (active and passive); The range of motion (ROM) of the hand, wrist and forearm should be determined both actively and passively. Compare mobility of the affected and unaffected side.

B.1.d.iv Strength (weakness / atrophy)

B.1.d.v Joint integrity / stability - Stress the ligaments to assess the stability and compare to contralateral unaffected side

B.1.d.vi Examination for deformity, displacement, swelling

B.1.d.vii Assess neurologic (motor, sensory and reflexes) and vascular status (integrity of distal circulation, peripheral pulses, skin temperature) of the foot and ankle, as clinically indicated. Examining the neck and cervical nerve root function is also recommended for most patients.

Observe for signs of serious injuries, e.g., degloving injuries, lacerations, puncture wounds open wounds and crush injuries.

B.1.e Red Flags

Certain findings, “red flags,” raise suspicion of potentially serious and urgent medical conditions. Assessment (history and physical examination) should include evaluation for red flags that require urgent/emergent assessment and treatment as clinically indicated. The Hand Wrist and Forearm MTG incorporate changes in clinical management as triggered by “red flags”.

See table 4 and each individual condition for condition specific physical examination guidelines.

B.1.f Assessing Red Flags

Potentially serious conditions for the hand, wrist, and forearm are listed in Table 3. Early consultation by a hand or upper limb specialist, rheumatologist, or other relevant specialist is recommended depending on the provider’s training and experience in dealing with the particular disorder.

Table 3. Red Flags for Potentially Serious Hand, Wrist, or Forearm Conditions

Disorder	Medical History	Physical Examination
Fracture	History of significant trauma History of deformities with or without spontaneous reduction or self-reduction Focal, severe non-radiating pain combined with history of trauma Inability to use the joint	Significant swelling Deformity with displaced, rotated or spiral fractures Point tenderness Swelling, hematoma Ecchymosis Compartment syndrome
Dislocation	History of significant trauma History of deformities with or without spontaneous or self-reduction Inability to use the joint	Deformity present Tenderness and instability with history of deformity with reduction Hemarthrosis Compartment syndrome
Infection	History of systemic symptoms: fever, chills/rigor History of immunosuppression (e.g., transplant, chemotherapy, HIV) Diabetes mellitus Portal of infection (e.g., laceration, distant infection)	Tenderness with motion Systemic signs of sepsis Local heat, swelling, erythema Drainage of a sinus tract Painful, red, swollen area(s)
Tumor	History of rapidly growing, painful, firm or hard mass of hand or wrist not consistent with ganglion History of immunosuppression (e.g., transplant, chemotherapy, HIV) History of cancer	Mass of hand, wrist, or forearm, not consistent with ganglion or other benign lesion
Joint Inflammation	History of inflammatory arthropathy or crystal arthritis Clinical history consistent with inflammatory or crystal arthropathies	Swelling and deformity Mostly symmetrical joint involvement for more common inflammatory arthropathies (e.g., rheumatoid arthritis) Erythematous, swollen, warm usually solitary joint for acute crystal arthropathy

		Painful swollen joints, usually without systemic symptoms
Rapidly Progressive Neurologic Compromise	Rapidly progressive numbness, paresthesias, or weakness in radial, ulnar, or median nerve distribution Inciting traumatic event or history to produce acute neurological compromise Progressive weakness Stroke, cervical spine disorders or other central nervous system compromise	Sensory deficit in ulnar, median, or radial distribution Loss of finger or grip strength when picking up objects Atrophy Compartment syndrome
Vascular Compromise	History of vascular disease History of diabetes mellitus Compartment syndrome Inflammatory arthropathies with vasculitis	Decreased pulses Decreased capillary filling Cold, cool, or pale hand Compartment syndrome
Severe Carpal Tunnel Syndrome	Continuous median distribution tingling and numbness after acute trauma, especially fracture Severe flexor compartment pain after repeated, unaccustomed, forceful use with continual median distribution tingling and numbness	Reduced median distribution sensation Muscle atrophy (late) and severe weakness of thenar muscles
Compartment Syndrome	Trauma, fracture, penetrating fracture, animal bites or stings, high pressure injection, vascular injury Cast, bandages, splints Thermal burns *Compartment syndrome is an emergency requiring emergent surgical evaluation and treatment	Serial evaluation as indicated for Painful tense muscle compartment, pain out of proportion to the injury Pain with passive stretch of muscles in the effected compartment Muscle weakness, palor of the extremity, decreased sensation Increased (measured) compartment pressure

B.1.g Diagnostic Criteria

The criteria presented in the Diagnostic Criteria for Hand, Wrist, or Forearm Disorders table (Table 4) list the probable diagnosis or injury, potential mechanism(s) of illness or injury, symptoms, signs, and appropriate tests and results to consider in assessment and treatment.

Table 4. Diagnostic Criteria for Hand, Wrist, or Forearm Disorders

Probable Diagnosis or Injury	Mechanism of Injury (includes only physical factors; in some cases, there are other factors)	History	Examination	Tests and Results
Carpal Tunnel Syndrome	High force and repetition, combinations of physical factors Vibration (Associated factors include cold temperatures and glove use. Posture is unclear factor, thought to be a relatively weak factor)	Hand dominance, numbness/tingling in thumb, index, middle, radial half of ring finger, especially at night or with activity Volar hand pain radiating into forearm may be present. Aggravating and alleviating factors (occupational and nonoccupational) Difficulty picking up small objects	Atrophy or decreased strength of abductor pollicis brevis, opponens (advanced cases) Decreased sensation (to light touch, pinprick two - point discrimination) in median nerve distribution (including monofilaments). Moisture, temperature or color change.	Electrodiagnostic studies

Triangular Fibrocartilage Complex (TFCC) Tears	Acute discrete traumatic events and/or as degenerative cartilaginous changes	Should include ulnar wrist joint pain and a catching snapping or popping sensation in the wrist with movement. The physical exam should reproduce these symptoms	Ulnar deviation with axial loading tends to increase pain. A “click” or “clunk” in the ulnar wrist joint may be reproduced with forearm rotation (supination/pronation).	X-rays
Crush Injuries and Compartment Syndrome	Crush injuries have clear mechanisms of injury on history. However, there are many causes of compartment syndrome	Crush: specific acute injury Compartment Syndrome: trauma, excessive traction from fractures, tight casts, bleeding disorders, burns, snakebites, intraarterial injections, infusions, and high-pressure injection injuries. *Compartment syndrome is an emergency requiring emergent surgical evaluation and treatment	Mild abnormalities with mild injuries (e.g., contusions) to severe with fractures, limited range(s) of motion and neurovascular compromise. Those with vascular compromise may have a cool extremity compared with the unaffected limb Progressive pain out of proportion to the injury; signs include tense swollen compartments and pain with passive stretching of muscles within the affected <i>compartment</i> .	X-Ray MRI/CT
Kienböck Disease	There are multiple disorders that are thought to predispose to Kienböck disease.	Complaints of increasing (non- radiating) wrist pain, pain with movement, pain with use, and limited range of motion.	The physical examination may be normal early, but generally the patient has mild to moderate dorsal wrist tenderness while also having asymmetric, limited range of motion. Tenderness and limited range of motion tend to progress.	X-Ray, CT, MRI Screening for systemic disorders that may predispose to Kienböck disease including: diabetes, glucose intolerance, alcoholism, and rheumatological studies
Wrist Sprains	Typically occur with acute traumatic events	Occupational slips, trips, and falls with forceful loading of the wrist joint in full extension	May include wrist capsule tenderness. Deformity or scaphoid tubercle tenderness suggests (scaphoid) fracture	X-rays CT MR Arthrography
Mallet Finger	Involves rupture of the extensor mechanism of a digit at the distal upper extremity joint with or without fracture of the distal phalangeal segment. The mechanism of injury most typically involves forcefully striking the tip of the extended digit on an object	Striking tip of extended digit on an object. Fall	The patient is unable to extend the distal phalangeal segment. Swelling often signifies a fracture fragment, while most are extensor tendon ruptures and have no significant swelling.	X-ray occasionally may show fracture, but usually normal. May not have fracture if extensor mechanism ruptured without fracturing bone

Mallet Finger (Continued)	including balls, or from falls. Forceful flexion of DIP joint while digit is extended. Ball striking tip of digit or digit extended during fall. Some rupture spontaneously, usually over a Heberden's node from osteoarthritis.			
Ligament Sprain	Acute excess loading, generally from falling onto an extremity. Increased pain with motion.	Focal pain in ligament	Tenderness over ligament(s) Pain or weakness on strength testing of the affected ligament(s)	X-rays (normal)
Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)	Typically, idiopathic or as a complication of medical conditions (especially diabetes mellitus and rheumatoid arthritis) May also occur as a complication of repeated forceful use of a digit, or unaccustomed use		Tenderness localized over the A1 pulley A palpable tendon nodule may be present Finger stuck in a bent position Clicking, snapping, locking with range of motion	None
Extensor Compartment Tenosynovitis Including de Quervain's Stenosing Tenosynovitis and	High force and repetition with forceful wrist and thumb motion Direct pressure (unusual) Blunt trauma (rare)	Patients present with wrist pain that is augmented by movement and generally non-radiating, although occasionally pain may spread along the course of the affected tendon sheath	Focal tenderness over extensor compartment Thick tendon sheath Pain upon passive abduction Finkelstein's maneuver is the classic provocative maneuver and is nearly always present	None
Ulnar Nerve Entrapment at the Wrist (including Guyon's Canal Syndrome) and Hypothenar Hammer Syndrome	Repeated striking of the heel of the hand/hypothenar region on a tool or object	First presents with symptoms of paresthesias followed by late symptoms of weakness. usually not associated with pain, in contrast with carpal tunnel syndrome that appears to more often involve pain. Patients with traumatic causes of ulnar neuropathy tend to have motor symptoms, whereas those with idiopathic or non-trauma related causes usually manifest sensory symptoms	Dependent on the location of the lesion, motor, sensory, or mixed motor-sensory findings are detectable. Muscle atrophy and point tenderness may be present. Sensory loss is typically most prominent at the palmar tip of the 5th finger	Electrodiagnostic studies
Radial Nerve Entrapment	Has been attributed to wearing a tight wrist or forearm band, anomalous brachioradialis	The medical history should search for sensory symptoms including paresthesias with location of the paresthesias in a typical	Should include evaluation of sensory and motor components (including wrist extensor weakness as well as	Electrodiagnostic studies

	tendon, repeated wrist flexion and ulnar deviation, external compression and trauma, or from mass or bony lesion	radial nerve distribution on the dorsal hand	wrist drop) to localize the entrapment Compare to unaffected limb	
Non-Specific Hand/Wrist/Forearm Pain	Occurs in the absence of discrete trauma. Instead, it frequently occurs in settings of high physical job demands or ill-defined exposures.	Varied and non-specific	Evaluate strength/weakness, pain and changes in sensation	Rheumatological Studies Arthrocentesis for Joint Effusions Electrodiagnostic Studies X-Rays
Scaphoid Fracture	Fall on the outstretched hand Axial loading with a closed fist	Fall Auto accident (when gripping steering wheel) Using heel of wrist as a hammer	Scaphoid tenderness Snuffbox tenderness	X-Rays
Distal Phalanx Fractures (tuft fracture/mallet fracture) and Subungual Hematoma	Tuft fracture usually due to crush injury of the fingertip. Often accompanied with nail bed laceration and subungual hematoma. Mallet fracture is fracture-dislocation injury of the distal phalanx involving loss of continuity of the extensor tendon over the distal interphalangeal joint	Acute injury	Evaluate neurovascular status, swelling and wounds Evaluate passive range of motion and joint stability through dorsal, volar and lateral stressing Evaluate (and describe) for subungual hematoma	X-Rays Trephination
Middle and Proximal Phalangeal and Metacarpal Fractures	Trauma/Direct blow to the bone	Acute injury	Pin prick nerve evaluation, range of motion, pain, swelling, deformity	X-Rays
Distal Forearm Fractures	Falling on outstretched hand		Evaluate for significant pain, swelling, ecchymosis, crepitus, deformity, vascular, neurological, ligament and tendon injuries	X-Ray
Ganglion Cyst	Unknown	Non-contributory	Wrist ganglia are usually well demarcated, firmly tethered, have a consistency similar to a rubber ball, and are translucent. Lack of translucency should raise suspicion of other tumor type	None
Hand-Arm Vibration Syndrome	Repeated, prolonged use of low-frequency, high-amplitude vibrating tool,	Use of vibrating tools local finger blanching; sensory and motor disturbances such as	Blanching of fingers/skin changes, worse with cold provocation. Decreased grip strength, tenderness, sensory and	None

	especially in cold environments	numbness, loss of finger coordination and dexterity	motor disturbances such as numbness, loss of finger coordination and dexterity, inability to perform intricate tasks; and musculoskeletal disturbances such as swelling of the fingers, bone cysts, and vacuoles.	
Laceration Management	Acute Injury/Trauma	Non-specific	The wound should be evaluated for damage to underlying structures including joint involvement, vessels, tendons, bone and nerves. Close inspection should be made for foreign bodies.	X-Ray Antibiotics
Human and Animal Bites and Associated Lacerations	Acute Injury/Trauma	Non-specific Should note exposure to saliva in animal bites.	Based upon presentation	
Hand/Finger Osteoarthritis	Genetic factors Potentially discreet trauma	Non-specific	Evaluate for joint enlargement and range of motion	X-Ray
Dupuytren's Disease	Age/Genetics	Non-specific	Thickening of the skin at the palm (cord). Contracture of finger(s)	

B.1.h Rehabilitation Principles

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C. Conditions

This Guideline addresses the following hand, wrist, and forearm disorders which may present to the health care provider.

- C.1 Carpal Tunnel Syndrome
- C.2 Triangular Fibrocartilage Complex (TFCC) Tears
- C.3 Crush Injuries and Compartment Syndrome
- C.4 Kienböck Disease
- C.5 Wrist Sprains
- C.6 Mallet Finger
- C.7 Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)
- C.8 Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)
- C.9 Ulnar Nerve Entrapment at the Wrist (Including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome)
- C.10 Radial Nerve Entrapment
- C.11 Non-Specific Hand/Wrist/Forearm Pain
- C.12 Scaphoid Fracture
- C.13 Distal Phalanx Fractures and Subungual Hematoma
- C.14 Middle and Proximal Phalangeal and Metacarpal Fractures
- C.15 Distal Forearm Fractures
- C.16 Ganglion Cyst
- C.17 Hand Arm Vibration Syndrome
- C.18 Laceration Management
- C.19 Human and Animal Bites and Associated Lacerations
- C.20 Hand/Finger Osteoarthritis
- C.21 Dupuytren's Disease

C.1 Carpal Tunnel Syndrome (CTS)

CTS is the most common and widely known of the entrapment neuropathies in which the body's peripheral nerves are compressed or traumatized. CTS occurs when symptoms occur that are attributable to abnormal median nerve compression within the carpal tunnel. The median nerve supplies sensations to the palmar aspect of the thumb, index, middle and radial half of the ring finger, as well as the dorsal segment of each of those four digits from the DIP distally. Tingling and numbness are essential symptoms. Pain is not an essential symptom and it may indicate other conditions, but if present, may also radiate proximally. Often, the condition arises without apparent cause.

CTS may result from numerous conditions, including inflammatory or non-inflammatory arthropathies, recent or remote wrist trauma or fractures, diabetes mellitus, obesity, hypothyroidism, pregnancy, and genetic factors. In the unusual instance that CTS is acutely, traumatically induced, e.g. a patient has both CTS and concomitant trauma (fracture or dislocation), the treatment may require prompt carpal tunnel release. Patients who have open injuries, unstable fractures, wrist fractures that results in acute CTS require immediate referral to a surgeon since improvement may only be obtained through surgery.

C.1.a Medical History

A diagnosis of CTS requires symptoms suggestive of median nerve entrapment at the wrist supported by physical examination findings. Prior to surgery, confirmation of the diagnosis by electrodiagnostic studies (EDX) is required. Typical symptoms of CTS may include numbness, tingling, or pain in the volar aspects of one or both hands, especially noted after work or at night. Nocturnal symptoms are prominent in a majority of patients. Patients frequently awaken at night or early morning and shake their hands to relieve these symptoms. The location of these symptoms may be reported as involving the entire hand or localized to the palmar surfaces of the thumb and first two or three fingers. A hand pain diagram may be useful in localizing sensory symptoms of CTS. Weakness of the hands or dropping objects are more ominous signs that may suggest muscle damage. Presence of such symptoms in the clinical context of a possible CTS diagnosis requires prompt consideration to EDX and surgical treatment.

Medical conditions associated with CTS: The following are examples of medical conditions which have been commonly seen in association with CTS conditions. These require treatment and may impact the recovery of the work-related injury.

- a. Arthropathies including connective tissue disorders, rheumatoid arthritis, systemic lupus erythematosus, gout, osteoarthritis and spondyloarthropathy;
- b. Diabetes mellitus, including family history or gestational diabetes;
- c. Hypothyroidism, especially in older females;
- d. Obesity;
- e. Pregnancy.

C.1.b Physical Exam

No single physical finding is diagnostic of CTS. Final diagnosis is dependent on a correlation of symptoms, physical exam findings, and EDX testing where appropriate, as any of these alone can be false positive or false negative.

The evaluation of any patient with suspected CTS should begin at the neck and upper back and then proceed down to the fingers and include the contralateral region. It should include evaluation of vascular and neurologic status, and describe any dystrophic changes or variation in skin color or turgor. Additional physical exam components may be necessary based on past medical history.

A neurological examination typically includes bilateral assessments of light touch sensation, pinprick, two-point sensation as applicable, motor strength, and reflexes. Similar assessments of the upper extremities, including a vascular assessment, may be performed. Special care to evaluate for polyneuropathic processes such as diabetic neuropathy is recommended.

The clinical diagnosis should be suspected whenever the patient has: 1) a history of paresthesia in one or more of the following digits: thumb, index, and middle finger; and 2) at least one of the physical exam signs listed below.

Provocative tests must recreate symptoms in the median nerve distribution.

- Phalen's sign/reverse Phalen's sign.
- Tinel's sign over the carpal tunnel.
- Compression test.
- Weakness of the abductor pollicis brevis (see discussion EDX studies).
- Thenar atrophy may be present, usually late in the course (see discussion of EDX studies).
- Sensory loss to pinprick, light touch, two-point discrimination or Semmes Weinstein monofilament test in a median nerve distribution.

The performance of clinical exam tests for CTS may include the following .

- Monofilament test – A test involving nylon monofilaments that collapse at specific amounts of force when pushed perpendicularly against the palm or fingers. A positive test results when a filament of greater than normal size is required in order for its application to be perceived by the patient.
- Vibration Testing – Diminished ability to perceive vibratory sensations using a standard vibrating tuning fork comparing the distal interphalangeal joint of the index finger to ipsilateral fifth finger.
- Weak thumb abduction strength – Weakness of resisted abduction (i.e., palm horizontal, thumb lifted as vertically as possible, then patient resists examiner pushing the thumb down towards the index finger).
- Hoffmann-Tinel's Sign ("Tinel's") – Up to 6 taps of a reflex hammer or tip of examiner's finger to the soft tissue overlying the carpal tunnel. A positive test occurs when the taps cause paresthesias or shooting pain in the median nerve distribution.

- Phalen Sign – As originally described, flexion of the wrist by having the examiner passively flex the wrists of the patient for up to 60 seconds. Clinically, this is more commonly performed by having the patient press the dorsal aspect of both hands together with approximately 90° of flexion for 60 seconds. It is unclear if these two means of performing this sign result in different sensitivities and specificities. A positive test produces paresthesias in the distribution of the affected median nerve.
- Carpal Compression Test – The examiner holds the supinated wrist in both hands, flexes the wrist 45° and applies direct, even pressure over the transverse carpal ligament with both thumbs for up to 30 seconds. A positive test is indicated by tingling or paresthesia into the thumb, index finger, and middle and lateral half of ring finger within 30 seconds.

C.1.c Diagnostic Studies

C.1.c.i Electrodiagnostic Studies

In those cases where EDX studies are indicated, they should be conducted in accordance with the CTS practice parameters of the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM).

It is recommended and preferred that EDX in the out-patient setting be performed and interpreted by physicians board-certified in Neurology or Physical Medicine and Rehabilitation.

The EDX study is to include median motor and median sensory nerve conduction velocity results (NCV). If abnormal, then comparison to ipsilateral ulnar motor/sensory and contralateral median motor/sensory should be made. Needle electromyography (EMG) of a sample of muscles innervated by the C5 to T1 spinal roots, including paraspinal muscles and a thenar muscle innervated by the median nerve of the symptomatic limb, is required. EDX findings in CTS reflect slowing of median motor distal latency and sensory conduction (velocity) across the carpal tunnel region due to demyelination or axonopathy (axonal loss). Axonal loss, when present, is demonstrated by EMG abnormality in median-nerve- supplied thenar muscles.

NCS and EMG may be normal particularly in some mild cases of CTS. If EDS are negative, tests may be repeated later in the course of treatment if symptoms persist. It is also important to recognize that electrodiagnostic studies are abnormal in a large proportion of patients who are without symptoms and thus without CTS. Thus, EDS testing in a patient with a low pre-test probability of CTS may result in inappropriate diagnosis of CTS. EDS has not been useful in diagnosing clear-cut CTS cases.

Frequency of NCV/EMG Studies/Maximum Number of Studies

- 1) Indications for initial testing:
 - a. Patients with clinically significant CTS who do not improve symptomatically or functionally with conservative measures for CTS over a 3 to 4 week period.

- b. Patients in whom the diagnosis is in question and who are symptomatic for at least 3 weeks.
 - c. To rule out other nerve entrapments, or alternative radiculopathy.
 - d. Patients for whom surgery is contemplated in accordance with Section F.1.
- 2) A repeat study may be performed:
- a. At 3 months or longer when the initial studies were normal and CTS is still suspected.
 - b. Postoperative 8 to 12 weeks for persistent or recurrent symptoms following carpal tunnel release, unless an earlier evaluation is required by the surgeon.

In patients with CTS where electrodiagnostic confirmation would alter treatment plans, the following EDS studies are recommended:

- 1) To ensure accurate testing, warm the hands if they are <30°C. If possible, it is best to keep the temperatures above 32°C as measured at the hand or fingers.
- 2) Perform a median sensory NCS across the wrist with a conduction distance of 13 to 14cm. If the result is abnormal, compare the result of the median sensory NCS to the result of a sensory NCS of one other adjacent sensory nerve in the symptomatic limb.
- 3) If the initial median sensory NCS across the wrist has a conduction distance greater than 8cm and the result is normal, one of the following additional studies is recommended:
 - a. Comparison of median-sensory- or mixed-nerve conduction across the wrist over a short (7 to 8cm) conduction distance to the ulnar sensory-nerve conduction across the wrist over the identical 7 to 8cm conduction distance, or
 - b. Comparison of median sensory across the wrist with ipsilateral radial or ulnar sensory conduction across the wrist, or
 - c. Comparison of median sensory or mixed nerve conduction through the carpal tunnel to sensory or mixed NCS of proximal or distal segments of the ipsilateral median nerve.
- 4) Motor conduction study of the median nerve recording from the thenar muscle and of one other ipsilateral nerve with distal latency.
- 5) Optional comparisons may include ipsilateral median-ulnar motor nerve distal latencies and median-ulnar motor conduction differences.
- 6) If abnormal in the index limb, then measuring the contralateral limb is helpful for both comparison and for diagnosis of systemic disorders.

C.1.c.i.a Electrodiagnostic Studies

Not Recommended - for initial evaluation of most patients with a clear diagnosis of CTS (confirming history and correlating clinical signs) as it will not alter the treatment plan.

Recommended - to assist in securing a firm diagnosis for those patients without a clear diagnosis of CTS *and to identify the presence or absence of axonopathies.*

Recommended - to definitively evaluate and objectively secure a diagnosis of CTS prior to surgical release.

Rationale – to assist in the diagnosis, prognosis and management of CTS.

Frequency – A repeat study at three months may be indicated if the first study was not diagnostic and CTS is still suspected. EDS is also indicated at 8-12 weeks post-operatively in cases where results are inadequate and/or symptoms have recurred.

Not Recommended - prior to glucocorticosteroid injection as a good history and clinical suspicion is believed to be sufficient to warrant the intervention which would not likely be altered by EDS.

Not Recommended - use of hand-held automated devices or portable automatic devices are not recommended and not acceptable to confirm a clinical diagnosis of CTS.

Not Recommended - surface EMG not recommended in the diagnostic evaluation of CTS.

C.1.c.i.b Ultrasound (Diagnostic)

Not Recommended - for diagnosing CTS.

Recommended in very select cases where a space occupying lesion is suspected and MRI is contraindicated.

C.1.c.i.c Magnetic Resonance Imaging

Not Recommended - for the evaluation and diagnosis of CTS

Recommended- in very select cases where a space occupying lesion is suspected.

C.1.d Initial Treatment

Initial treatment of CTS should begin with conservative measures including:

- Medications such as over-the-counter nonsteroidal anti-inflammatory drugs (NSAIDs), or other analgesics for symptomatic relief.
- Wrist splint at night.
- Restriction of activities such as forceful gripping, awkward wrist posture, and repetitive wrist motion.

C.1.d.i Wrist Splinting

Splinting is generally effective for milder cases of CTS and can lead to more improvement in symptoms and hand function than watchful waiting alone. Splints may be effective when worn during sleep hours or during portions of the day, depending on work activities. Splints should be loose and soft enough to maintain comfort while supporting the wrist in a relatively neutral position. This can be accomplished by using a soft or rigid splint with a metal or plastic support. Off-the-shelf splints are usually sufficient, although custom thermoplastic splints may provide a better fit for certain patients. Providers should be aware that over-usage is counterproductive and should counsel patients to avoid over-usage.

Recommended – nocturnal wrist splinting for treatment of acute, subacute, or chronic CTS.

Recommended- intermittent day time splinting for select patients depending on job activities.

Indications – Symptoms consistent with carpal tunnel syndrome.

Frequency/Dose – Wrist splints are recommended to be worn while sleeping for 4 to 6 weeks. Depending on job activities, intermittent daytime splinting can also be helpful. The time to produce effect is 1 to 4 weeks.

Discontinuation – Splints should be reevaluated and re-adjusted as indicated if no response within 2 weeks of starting treatment, particularly to assure that the patient is wearing them properly as well as to assess fit. If symptoms persist or if there is no improvement, splints should be discontinued and glucocorticosteroid injection and/or electrodiagnostic testing may be considered.

C.1.d.ii Patient Education

Instruction in self-management techniques, including sleeping postures that avoid excessive wrist flexion; ergonomics; and a home therapy program.

C.1.d.iii Continuation of Activities

Continuation of normal daily activities is an accepted and well-established initial recommendation for CTS with or without neurologic symptoms. Complete work cessation should be avoided if possible.

C.1.d.iv Work Activities

All patients should be encouraged to return to work as soon as possible. This process may be best facilitated with modified duty, particularly when the job demands exceed the patient's capabilities due to the workplace injury. It is recommended that work be restricted to those tasks that do not involve high-force combined with repeated hand gripping or pinching or the use of high acceleration vibrating hand-held tools. Recommendations

for ergonomic assessments to evaluate or reduce exposure may be of value for treatment and future intervention/prevention.

Evidence for Work Restrictions

C.1.e Diagnosis

To establish a diagnosis of work-related carpal tunnel syndrome, all of the following are required:

1. Exposure: Workplace activities that contribute to or cause CTS, and
2. Outcome: CTS that meets the diagnostic CTS criteria as defined in this guideline.
3. Relationship to work: This includes a statement of the probability that the illness or injury is work-related. The presence of concurrent disease does not eliminate the possibility of work-relatedness of any specific case.

Work-related CTS is most often associated with activities requiring extensive, forceful, repeated or prolonged use of the hands and wrists, particularly if these potential risk factors are present in combination (e.g., force and repetition or force and posture). Usually, one or more of the following work conditions occurs on a regular basis to support work-relatedness:

1. Forceful use, particularly if repeated.
2. Repetitive hand use combined with some element of force, especially for prolonged periods.
3. Constant firm gripping of objects.
4. Moving or using the hand and wrist against resistance or with force.

C.1.f Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.1.f.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic CTS

Recommended - for treatment of acute, subacute, or chronic CTS

Indications – For acute, subacute, or chronic CTS, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects that necessitate discontinuation.

C.1.f.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.1.f.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.1.f.iv Acetaminophen for Treatment of CTS Pain

Recommended - for treatment of CTS pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with CTS pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for CTS

C.1.f.v Systemic Glucocorticosteroids

Recommended – in select patients for the treatment of Acute, Subacute or Chronic CTS among patients who decline carpal tunnel injection

Indication – CTS unresponsive to splinting. Most patients should be injected rather than given oral steroids. However, for patients declining injection, oral glucocorticosteroids may be warranted.

Frequency/Dose. It is recommended that one course (10 to 14 days) of oral glucocorticosteroid be prescribed rather than repeated courses. Prescriptions of low rather than high doses are recommended to minimize potential for adverse effects.

Evidence for the Use of Oral Glucocorticosteroids

C.1.f.vi Diuretics

Diuretics have been used to treat CTS, in part due to observations of swelling in some patients.

Not Recommended - for treatment of acute, subacute, or chronic CTS in the absence of fluid retention states.

Evidence for the Use of Diuretics for CTS

C.1.f.vii Opioids

Not Recommended – for acute, subacute, or chronic CTS

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.1.f.viii Vitamins (including pyridoxine)

Not Recommended – for routine treatment of acute, subacute or chronic CTS in patients without vitamin deficiencies.

Evidence for the Use of Pyridoxine for CTS

C.1.f.ix Lidocaine Patches

Recommended in select patients for treatment of acute, subacute, or chronic CTS with pain when other treatable causes of the pain have been eliminated and after more efficacious treatment strategies, such as splinting and glucocorticosteroid injection(s), have been attempted and failed.

Indications for Discontinuation – Resolution, intolerance, adverse effects, lack of benefits, or failure to progress over a trial of at least two weeks.

Evidence for the Use of Topical Lidocaine Patches for CTS

C.1.f.x Gabapentin

Not Recommended – to treat carpal tunnel syndrome.

Evidence for the Use of Gabapentin for CTS

C.1.g Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.1.g.i Therapy - Active

C.1.g.i.a Therapeutic Exercise

Various exercise regimens have been utilized to treat patients with CTS.

Recommended - for treatment of chronic CTS in the presence of functional deficits

Recommended - for rehabilitation of post-operative CTS in patients with stiffness and significant deficits

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

Evidence for the Use of Exercise for CTS

C.1.g.i.b Yoga

Not Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Yoga for CTS

C.1.g.i.c Biofeedback

Not Recommended – for the treatment of acute, subacute or chronic CTS.

C.1.g.ii Therapy - Passive

Cryotherapy / Heat

C.1.g.ii.a Ice / Self-Applied Ice

Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Ice

C.1.g.ii.b Heat / Self-Applied Heat

Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Heat

C.1.g.ii.c Diathermy

Not Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Diathermy

C.1.g.iii Manipulation and Mobilization

Not Recommended - for treatment of acute, subacute, or chronic CTS.

C.1.g.iv Manipulation of the Spine for Acute, Subacute, or Chronic CTS

Not Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Manipulation and Mobilization for CTS

C.1.g.v Acupuncture

Not Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Acupuncture

C.1.g.vi Devices

C.1.g.vi.a Magnets

Not Recommended - for management of pain from acute, subacute, or chronic CTS.

C.1.g.vi.b Pulsed Magnetic Field Therapy

Not Recommended - for management of pain from acute, subacute, or chronic CTS.

Evidence for the Use of Magnets for CTS

C.1.g.vii Low Level Laser therapy (LLLT)

Not Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Low-Level Laser Therapy for CTS

C.1.g.viii Massage and Soft Tissue Massage

Not Recommended - for most patients for treatment of acute, subacute, or chronic CTS.

Recommended - for treatment of select patients with acute, subacute, or chronic CTS who have significant myofascial pain.

Indications – Symptoms of carpal tunnel syndrome combined with forearm myofascial pain sufficient for the patient to require treatment. Generally, the patient should have failed other treatments including splints and glucocorticosteroid injection.

Frequency/Dose – Three to four visits. Objective evidence of improvement should be documented. Additional 3 or 4 treatments should be based on incremental improvement in objective measures.

Discontinuation – Resolution, failure to objectively improve, or intolerance.

Evidence for the Use of Massage

C.1.g.ix Therapeutic Touch

Not Recommended - for treatment of acute, subacute, or chronic CTS

Evidence for the Use of Therapeutic Touch for CTS

C.1.g.x Ultrasound

Not Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Ultrasound for CTS

C.1.g.xi Phonophoresis

Recommended - for treatment of acute, subacute, or chronic CTS.

Indications – CTS that is sufficiently symptomatic to warrant treatment. Patients should generally be given splints and/or a glucocorticosteroid injection prior to considering phonophoresis as a splint or injection are believed to be more effective.

Frequency – 5-15 sessions per week for 4-8 weeks.

Discontinuation – Resolution, failure to objectively improve or intolerance.

Evidence for the Use of Phonophoresis

C.1.g.xii Iontophoresis

Not Recommended – for use for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Iontophoresis for CTS

C.1.g.xiii Injection Therapy

C.1.g.xiii.a Carpal Tunnel Steroid Injections

Recommended - for the treatment of subacute or chronic CTS with mild EMG findings

Recommended- in select patients with moderate to severe EMG findings for temporary relief while awaiting surgery.

Indications – CTS unresponsive to nocturnal wrist splinting, generally with symptoms lasting at least three weeks.

Frequency/Duration – An initial injection with documented improvement, even short-term is believed to have considerable prognostic significance. If the initial steroid

injection provides three to four weeks of partial relief or complete symptom relief but with recurrence of symptoms, a second injection may be indicated. If the second injection provides three to four weeks of partial or complete relief surgical release may be indicated.

Failure to respond, particularly if the median nerve was successfully anesthetized by the injection, should result in a careful re-assessment of the accuracy of the diagnosis of CTS.

Patients who respond to carpal tunnel injections, and develop recurrent symptoms are believed to be candidates for surgical release. If following the first injection, symptomatic relief is followed by recurrent symptoms, the decision to perform a second injection must be weighed against alternative treatments such as surgery.

Surgical release may give more definitive relief of symptoms.

C.1.g.xiii.b Carpal Tunnel Steroid Injections for Treatment of Acute, Traumatic CTS without Fracture

Recommended for treatment of acute CTS (without fractures) unresponsive to conservative management with symptoms lasting at least 3 weeks.

Acute CTS with fractures should be referred for potential emergent surgical release.

C.1.g.xiii.c Carpal Tunnel Steroid Injections for Treatment of Non Traumatic CTS Due to Acute, Repetitive Overload Injury

Recommended- for treatment of non traumatic CTS due to acute, repetitive overload injury. In patients who decline injection oral steroids may be an alternative (see **C.1.f.ii Systemic Oral Steroids**)

Evidence for the Use of Glucocorticosteroids (Oral and Injection) for CTS

C.1.g.xiii.d Intramuscular Injections

Not Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Intramuscular Injections for CTS

C.1.g.xiii.e Insulin

Not Recommended - for treatment of acute, subacute, or chronic CTS.

Evidence for the Use of Insulin Injections for CTS

C.1.g.xiii.f Botulinum Injections

Not Recommended – for treatment of acute, subacute or chronic CTS.

Evidence for the Use of Botulinum Injections for CTS

C.1.h Surgery

Surgical consultation may be indicated for CTS patients who:

- Have red flags of a serious nature;
- Fail to respond to non-surgical management including worksite modifications; or
- Have clear clinical and special study evidence of a lesion that has been shown to benefit, in both the short and long term, from surgical intervention.

Surgical considerations depend on the confirmed diagnosis of the presenting hand or wrist complaint. If surgery is a consideration, counseling regarding likely outcomes, risks, and benefits, and especially expectations is important. The single most important factor in predicting symptomatic improvement following carpal tunnel release is the severity of preoperative neuropathy.

If there is no clear indication for surgery, the patient should be referred for conservative management.

Surgery should be considered as initial therapy in the presence of

1. “Acute Carpal Tunnel Syndrome”

In patients who have open injuries, unstable fractures, wrist fractures that result in acute CTS require immediate referral to a surgeon since improvement may only be obtained through surgery, or

2. Thenar atrophy due to median nerve compression, or

3. In the presence of electrodiagnostic evidence of moderate to severe compressive neuropathy of the median nerve. EMG findings showing evidence of acute or chronic motor denervation suggest the possibility that irreversible damage may be occurring.

For cases with positive EDX findings and with a motor latency less than 5.0 ms, non-surgical treatment may be beneficial in some cases; therefore, conservative management, including job alterations, should be tried over four to six weeks before surgery is considered.

C.1.h.i Surgical Release

Recommended - for patients with sub-acute or chronic CTS and moderate to severe EMG findings.

Recommended - for patients with subacute or chronic CTS with mild EMG findings who / have recurrent symptoms after partial or complete relief of symptoms (3-4 weeks) with glucocorticosteroid injections.

Rationale/Indications – Failure of non-operative treatment to include two glucocorticosteroid injections. If the initial steroid injection provides 3 to 4 weeks of partial relief or complete symptom relief but with recurrence of symptoms, a second injection may be indicated. If the second injection provides 3 to 4 weeks of partial or complete relief surgical release may be indicated.

Patients who initially respond to corticosteroid injections, and develop recurrent symptoms are believed to be candidates for surgical release. If following the first injection, symptomatic relief is followed by recurrent symptoms, the decision to perform a second injection must be weighed against alternative treatments such as surgery.

Surgical release may give more definitive relief of symptoms.

Recommended - patients who have emergent or urgent indications (e.g., acute compression due to fracture, arthritides, or compartment syndrome with unrelenting symptoms of nerve impairment)

Rationale/Indications - Patients should have an electrodiagnostic study (EDS) consistent with CTS (see Electrodiagnostic Studies). Mild CTS with normal EDS exists, but a clinical impression of moderate or severe CTS with normal EDS is very rare and generally indicates a mistaken diagnosis. Positive EDS in asymptomatic individuals is very common, is not CTS, and suggests the need to carefully select patients for EDS and properly interpret the results.

Re-operation is potentially indicated if there is: (i) recurrence of symptoms after surgical release, (ii) electrodiagnostic findings are supportive at 8-12 weeks after surgical release, (iii) re-exposure to work factors are not explanatory and remediable; those not improving after an initial surgery should undergo a thorough diagnostic workup.

C.1.h.ii Open or Edoscopic Release

Recommended – for treatment of subacute or chronic CTS. The procedure utilized is based upon the surgeon’s evaluation and discretion.

C.1.h.iii Antibiotics for Patients Undergoing Carpal Tunnel Release

Not Recommended – for routine use.

C.1.h.iv Antibiotics For Post Operative Infection

Recommended - as clinically indicated.

Evidence for the Use of Carpal Tunnel Surgical Release

C.1.i Other Adjunctive Procedures or Techniques for Subacute or Chronic CTS

C.1.i.a Epineurotomy

Not Recommended

- C.1.i.b **Internal Neurolysis**
Not Recommended
- C.1.i.c **Flexor retinacular lengthening**
Not Recommended
- C.1.i.d **Ulnar Bursal Preservation**
Not Recommended
- C.1.i.e **Altering the Location of the Incision to “Superficial Nerve-Sparing Incision”**
Not Recommended
- C.1.i.f **Ulnar Incisional Approach**
Not Recommended
- C.1.i.g **Flexor Tenosynovectomy**
Not Recommended
- C.1.i.h **Biopsy of Abnormal Tenosynovium**
Not Recommended - for treatment of subacute or chronic CTS.

C.2 Triangular Fibrocartilage Complex (TFCC) Tears

Triangular fibrocartilage complex (TFCC) tears are frequent wrist injuries involving the cartilaginous meniscus between the radius and ulna with symptoms often described as occurring on the ulnar side of the wrist joint.

C.2.a Physical Exam

The exam may reveal dorso-ulnar wrist joint tenderness that is not focally tender over an extensor compartment. Swelling is generally not present, although it may be present with an acute, large tear. The examiner should generally attempt to reproduce catching or snapping in the ulnar wrist joint.

C.2.b Medical History

Patients commonly complain of non-radiating ulnar sided pain and clicking. It is important to correlate the symptoms with the physical examination and mechanism of injury since MRI studies suggest TFCC tears are both prevalent while also apparently frequently asymptomatic. Ulnar deviation with axial loading tends to increase pain. A

“click” or “clunk” in the ulnar wrist joint may be reproduced with forearm rotation (supination/pronation). Occupational cases will tend toward symptomatic onset after a discrete traumatic event such as a slip and fall.

The history should include ulnar wrist joint pain and a catching, snapping or popping sensation in the wrist with movement. The physical examination should reproduce these symptoms.

C.2.c Initial Assessment

A primary focus of the patient history is ascertaining whether the TFCC is significantly torn, and if so, whether it is sufficiently symptomatic to require intervention(s). Following the patient’s symptoms for healing without immediate surgical intervention is generally the most common approach. Some do not heal, continue to be symptomatic and do well with surgical repair or removal.

C.2.d Diagnostic Studies

C.2.d.i X-rays

Recommended - to diagnose triangular fibrocartilage complex (TFCC) tears.

Indications – Suspected TFCC tear and/or to rule out other sources of wrist pain.

Frequency/Duration – Obtaining x-rays once is generally sufficient.

C.2.d.ii MRI

Recommended - to diagnose Triangular Fibrocartilage Complex (TFCC) Tears

C.2.d.iii Arthroscopy

Recommended - In select patients with continued wrist pain unresponsive to conservative management and the MRI does not reveal etiology.

Diagnostic arthroscopy can be performed as a diagnostic procedure or as combined with surgical repair.

C.2.e Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.2.e.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic TFCC Tears

Recommended - for treatment of acute, subacute, or chronic TFCC tears.

Indications – For acute, subacute, or chronic TFCC tears., NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.2.e.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.2.e.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.2.e.iv Acetaminophen for Treatment of TFCC Tears Pain

Recommended - for treatment of TFCC tears pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with TFCC tears pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.2.e.v Opioids

Not Recommended – for acute, subacute, or chronic TFCC tears.

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.2.f Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.2.f.i Therapy: Active

C.2.f.i.a Therapeutic Exercise

Recommended- for select patients

Recommended – Recovery/Post-Operative Phase

Rationale for Recommendation - Exercise is generally not indicated acutely; however, exercise may be needed in the recovery or post-operative phases. Functional goals should include increased grip strength, key pinch strength, range of motion, advancing work abilities.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.2.f.ii Therapy: Passive

C.2.f.ii.a RICE (Rest, Ice, Compression, Elevation)

Recommended – relative rest for treatment of acute, subacute, or chronic triangular fibrocartilage complex (TFCC) tears.

Rationale for Recommendation -relative rest may preclude the need for surgical intervention. Ice and heat may help particularly with more acute symptoms. These treatments may help with symptomatic relief.

C.2.f.ii.b Cryotherapy / Heat

Recommended - Self-application of ice for treatment of acute, subacute, or chronic triangular fibrocartilage complex (TFCC) tears.

C.2.f.ii.c Self-Application of Heat

Recommended - for treatment of acute, subacute, or chronic triangular fibrocartilage complex (TFCC) tears.

C.2.f.iii Immobilization

Recommended - Splinting for treatment of moderate or severe, acute or subacute triangular fibrocartilage complex (TFCC) tears, particularly to reduce forearm rotation.

Rationale for Recommendations - Wrist splints may help avoiding aggravating activities or actions that provoke symptoms and therefore, may be more appropriate for acute or moderate to severe injuries.

Evidence for the Use of Initial Care

C.2.g Surgery

C.2.g.i Surgical Repair (Arthroscopic or Open Surgical Repair)

Recommended - for select patients with instability, concomitant fractures, or symptoms that persist without trending towards resolution despite non-operative treatment and the passage of approximately 3 to 6 weeks.

Rationale for Recommendation - Arthroscopic repair is most typically used although open repairs may be performed.

C.2.g.ii Ulna Shortening and Wafer Procedures for Chronic Triangular Fibrocartilage Complex (TFCC) Tears

Recommended - for select cases of chronic tears for which non-surgical treatment is unsuccessful and there is a demonstrable ulna positive variance.

Rationale for Recommendation in select cases with ulna positive variance and without resolution of considerable or incapacitating symptoms or lacking trending towards resolution, this procedure is recommended.

Evidence for the Use of Surgery

C.3 Crush Injuries and Compartment Syndrome

Crush injuries which include compartment syndrome are usually surgical emergencies. Mild cases of crush injuries, such as contusions may be treated similar to non-specific hand, wrist, forearm pain with particular emphasis on RICE (rest, ice, compression, elevation).

C.3.a Physical Exam

The physical examination ranges from mild abnormalities with mild injuries (e.g., contusions) to severe with fractures, limited range(s) of motion and neurovascular compromise

C.3.b Medical History

Compartment syndrome is an emergency requiring urgent evaluation. Those with vascular compromise may have a cool extremity compared with the unaffected limb. Crush injuries have clear mechanisms of injury on history. However, there are many causes of compartment syndrome including trauma, excessive traction from fractures, tight casts, bleeding disorders, burns, snakebites, intraarterial injections, infusions, and high-pressure injection injuries.

C.3.c Initial Assessment

Patients with more severe injuries present with severe pain and may have vascular compromise. Compartment syndrome is an emergency. The initial assessment should focus on the degree of injury severity and if the injury requires emergent surgical evaluation and treatment. Milder injuries may be managed non-operatively; however, the threshold for surgical consultation should be low. Those with milder injuries should be monitored for neurovascular compromise.

C.3.d Diagnostic Studies

C.3.d.i X-Rays

Recommended - for evaluating patients with crush injuries or compartment syndrome.

Rationale for Recommendation -X-rays are essential for evaluating the extent of injuries and identification of fractures.

Evidence for the Use of X-rays

C.3.d.ii MRI/CT

Recommended - for select patients with crush injuries or compartment syndrome.

Rationale for Recommendation - Initial evaluation of crush injuries or compartment syndrome generally does not require MRI or CT. However, some patients require MRI or CT for evaluation of symptoms and extent of injury and are recommended in select cases.

C.3.e Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.3.e.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Crush Injuries and Compartment Syndrome

Recommended - for treatment of acute, subacute, or chronic crush injuries and compartment syndrome

Indications – For acute, subacute, or chronic chronic crush injuries and compartment syndrome, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.3.e.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.3.e.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.3.e.iv Acetaminophen for Treatment of Crush injuries and Compartment Syndrome Pain

Recommended - for treatment of crush injuries and compartment syndrome pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with crush injuries and compartment syndrome pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.3.e.v Opioids - for Pain from Acute, Subacute, Chronic or Post-Operative Crush injuries

Recommended - Limited use of opioids (not to exceed seven days) for the treatment of select patients presenting with severe pain related to acute, subacute or chronic crush injuries. Limited use of opioids for a few days (not to exceed seven days) is also recommended for select patients who have undergone recent surgical intervention.

Frequency/Dose/Duration: Frequency and dose per manufacturer's recommendations; may be taken scheduled or as needed; generally taken for short courses of a few days, with subsequent weaning to nocturnal use if needed, then discontinuation. Total length of treatment usually ranges from a few days to one week. Generally should be utilized to supplement pain relief in addition to an NSAID or acetaminophen to reduce total need for opioid and the consequent adverse effects.

Indications for Discontinuation: Sufficient pain management with other methods such as NSAIDs, resolution of pain, intolerance, adverse effects, lack of benefits, or failure to progress over a couple weeks.

C.3.f Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.3.f.i Therapy: Active

C.3.f.i.a Therapeutic Exercise

Recommended - for the treatment of acute, subacute, chronic, or post-operative crush injuries

Rationale for Recommendation - Exercise is generally not indicated acutely; however, exercise may be needed in the recovery or post-operative phases. Functional goals should include increased grip strength, key pinch strength, range of motion, advancing work abilities.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.3.f.ii Therapy: Passive

C.3.f.ii.a Elevation and Relative Rest

Recommended - for treatment of acute crush injuries without compartment syndrome.

C.3.f.ii.b Self-Application of Ice

Recommended - for treatment of acute crush injuries without compartment syndrome.

C.3.f.iii Immobilization

C.3.f.iii.a Splinting

Recommended - after initial treatment for moderate or severe acute and subacute crush injuries when compartment syndrome has been ruled out.

Rationale for Recommendations . The type of splint required depends on the type of injury and subsequent debility. Splints are recommended particularly for patients with moderate to severe injuries when compartment syndrome has been ruled out.

Evidence for the Use of Initial Care

C.3.g Surgery

C.3.g.i Surgery

Recommended - for treatment of acute or subacute crush injuries or compartment syndrome depending on the nature of the injury. This frequently includes emergency fasciotomy for release of tension from compartment syndromes as well as other surgical procedures to address fractures and other remediable defects.

Rationale for Recommendation - Fasciotomies are particularly essential for treatment of significant neurovascular compromise from compartment syndrome and is a surgical emergency. Other procedures may be required based on remediable defects such as fractures, ligament tears, or other injuries.

Evidence for the Use of Surgery

C.4 Kienböck Disease

Kienböck disease involves changes in the lunate that eventually lead to collapse of the lunate bone, which results in progressive pain and disability. Patients with Kienböck disease often develop chronic pain

C.4.a Diagnostic Studies

C.4.a.i X-Rays

Recommended - to diagnose Kienböck disease.

Rationale for Recommendation , x-rays are used to confirm the diagnosis and should generally be taken of both hands.

Evidence for the Use of X-rays

C.4.a.ii CT

Recommended - to diagnose Kienböck disease when xrays are negative or unclear and MRI is contraindicated.

Rationale for Recommendation - CT is used to assist with diagnosis and management in select patients, where xrays are negative or unclear and MRI is contraindicated.

Evidence for the Use of CT

C.4.a.iii MRI

Recommended - to diagnose Kienböck disease when xrays are negative or unclear.

Rationale for Recommendation- MRIs are used to assist with diagnosis and management, thus they are recommended.

Evidence for the Use of MRI

C.4.a.iv Screening for Systemic Disorders

Recommended - for patients with Kienböck disease.

Rationale for Recommendation - There are multiple disorders that are thought to predispose to Kienböck disease. The threshold for evaluations of systemic metabolic issues (e.g., diabetes, glucose intolerance), alcoholism, and rheumatological studies should be low, particularly as potentially modifiable risks may theoretically slow the rate of progression.

Evidence for the Use of Screening

C.4.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.4.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Kienböck disease

Recommended - for treatment of acute, subacute, or chronic Kienböck disease

Indications – For acute, subacute, or chronic Kienböck disease, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.4.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.4.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.4.b.iv Acetaminophen for Treatment of Kienböck disease Pain

Recommended - for treatment of Kienböck disease pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with Kienböck disease pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.4.b.v Topical Medications

Recommended – In select patients for treatment of pain associated with acute, subacute, or chronic Kienböck disease. including topical creams, ointments, and lidocaine patches

Rationale for Recommendation - TOPICAL DRUG DELIVERY (e.g., capsaicin, topical lidocaine, topical NSAIDs and topical salicylates and nonsalicylates) may be an acceptable form of treatment in selected patients. A topical agent should be prescribed with strict instructions for application and maximum number of applications per day to obtain the desired benefit and avoid potential toxicity. For most patients, the effects of long-term use are unknown and thus may be better used episodically. These agents may be used in those patients who prefer topical treatments over oral medications. Localized skin reactions may occur, depending on the medication agent used. Prescribers should consider that topical medication can result in toxic blood levels.

Capsaicin offers a safe and effective alternative to systemic NSAIDs, although its use is limited by local stinging or burning sensation that typically disappears with regular use. Patients should be advised to apply the cream on the affected area with a plastic glove or cotton applicator to avoid inadvertent contact with eyes and mucous membranes. Long-term use of capsaicin is not recommended.

Topical Lidocaine is only indicated when there is documentation of a diagnosis of neuropathic pain. In this instance, a trial for a period of not

greater than four weeks can be considered, with the need for documentation of functional gains as criteria for additional use.

Topical NSAIDs (e.g. diclofenac gel) may achieve tissue levels that are potentially therapeutic. Overall the low level of systemic absorption can be advantageous, allowing the topical use of these medications when systemic administration is relatively contraindicated (such as patients with hypertension, cardiac failure, peptic ulcer disease or renal insufficiency).

Topical Salicylates or Nonsalicylates (e.g. methyl salicylate) overall do not appear to be more effective than topical NSAIDs. May be used for a short-term course especially in patients with chronic conditions in whom systemic medication is relatively contraindicated or as an adjuvant to systemic medication

Evidence for the Use of Topical Medications

C.4.b.vi Opioids

Not Recommended – for acute, subacute, or chronic Kienböck disease.

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.4.c Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.4.c.i Therapy: Active

C.4.c.i.a Therapeutic Exercise – Acute Phase

Not Recommended – during acute presentations of Kienböck disease

C.4.c.i.b Therapeutic Exercise – Post-Operative/Recovery

Recommended – for patients post-operatively.

Rationale for Recommendation - Exercise is generally not indicated acutely; however, exercise may be needed in the recovery or post-operative phases. Functional goals should include increased grip strength, key pinch strength, range of motion, advancing work abilities.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.4.c.ii Therapy: Passive

C.4.c.i Self-Application of Ice

Recommended - for treatment of acute, subacute, or chronic Kienböck disease.

C.4.c.ii Self-application of Heat

Recommended - for treatment of acute, subacute, or chronic Kienböck disease.

C.4.c.iii Splints

Recommended - for treatment of select patients with acute, subacute, or chronic Kienböck disease.

Rationale for Recommendations - A trial may be helpful to assess whether splinting provides symptomatic relief. However there are concerns over long term use regarding the potential for accelerated debility disuse and weakness of the wrist.

Evidence for the Use of Initial Care

Evidence for the Use of Exercise

C.4.d Surgical Treatment

Recommended - as an option for patients with moderate to marked impairment if not improved eight weeks post-injury or after six weeks of non-operative treatment due to Kienböck disease. The choice of surgery is dependent upon staging of disease and discretion of the surgeon.

Evidence for the Use of Surgery

C.5 Wrist Sprains

Wrist sprains (which are partially or totally disrupted ligaments) typically occur with acute traumatic events and commonly result from slips, trips and falls. Wrist sprain is often a diagnosis of exclusion among patients with pain in the setting of trauma in the absence of a fracture. Sprains may also occur in conjunction with fracture.

C.5.a Diagnostic Studies

C.5.a.i X-Rays

Recommended - to determine whether a fracture is present, particularly for patients with scaphoid pain or scaphoid tubercle tenderness.

Evidence for the Use of X-rays

C.5.a.ii CT Scan

Recommended - to determine whether a fracture is present, particularly for patients with scaphoid pain or scaphoid tubercle tenderness with negative x-rays.

Evidence for the Use of CT Scans

C.5.a.iii MR Arthrography

Recommended - for patients without improvement in wrist sprains after approximately 6 weeks of treatment.

Rationale for Recommendations - MR arthrograms are especially helpful to identify ligamentous issues such as scapholunate, lunotriquetral, and TFCC tears that may be diagnosed as simple sprains. Thus, MR arthrography is recommended after approximately 6 weeks of clinical management without patient improvement.

Evidence for the Use of MR Arthrography

C.5.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.5.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Wrist Sprain

Recommended - for treatment of acute, subacute, or chronic wrist sprain

Indications – For acute, subacute, or chronic wrist sprain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.5.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.5.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.5.b.iv Acetaminophen for Treatment of Wrist Sprain Pain

Recommended - for treatment of wrist sprain pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with wrist sprain pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.5.b.v Opioids

Recommended - for the treatment of select patients with pain from severe wrist sprains.

Indications – Select patients with severe pain from severe wrist sprains with insufficient control from other means, including acetaminophen and NSAIDs or with contraindications for NSAIDs. Considerable cautions are recommended concerning opioids and minimum numbers of doses should be prescribed as duration of treatment for wrist sprains is usually limited.

Frequency/Dose – As needed dosing. Among the few patients requiring opioids, most require at most a few days to not more than seven days of

treatment and then generally have insufficient pain for further treatment with opioids.

Indications for Discontinuation – Resolution of pain sufficiently to not require opioids, consumption that does not follow prescription instructions, adverse effects.

Rationale for Recommendation - Most patients do not require opioids. Some patients, particularly with more severe sprains may require opioids. They are recommended for limited duration (not more than seven days) use in select patients with wrist sprains.

C.5.c Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.5.c.i Therapy - Active

C.5.c.i.a Therapeutic Exercise - for treatment of moderate or severe acute or subacute wrist sprains.

Recommended - for the treatment of moderate or severe acute or subacute wrist sprains.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part

of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.5.c.ii Therapy - Passive

C.5.c.ii.a Relative Rest

Recommended - for treatment of acute wrist sprains.

C.5.c.ii.b Ice – Self-application

Recommended - for treatment of acute wrist sprain.

C.5.c.ii.c Heat – Self-appliation

Recommended - for treatment of acute wrist sprain.

C.2.c.ii.d Mobilization / Immobilization

Recommended - Splinting for treatment of moderate or severe acute or subacute wrist sprains.

Evidence for Initial Care

Evidence for the Use of Exercise

C.5.d Surgery

Not recommended - for treatment of acute or subacute wrist sprain in the absence of a remediable defect.

Evidence for the Use of Surgery

C.6 Mallet Finger

Mallet finger is a common occupational injury, although it may occur with minimal apparent trauma. The injury involves rupture of the extensor mechanism of a digit at the distal upper extremity joint with or without fracture of the distal phalangeal segment

Mallet finger is readily diagnosed based on the presentation of inability to extend the distal interphalangeal joint, generally in the context of trauma or distal interphalangeal joint arthrosis.

C.6.a Diagnostc Studies

C.6.a.i X-Rays

Recommended - in most cases of mallet finger to determine if a fracture is present.

Evidence for the Use of X-rays

C.6.a.ii Ultrasound

Not recommended - to diagnose mallet finger.

C.6.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.6.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Mallet finger

Recommended - for treatment of acute, subacute, or chronic mallet finger

Indications – For acute, subacute, or chronic mallet finger, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.6.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.6.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.6.b.iv Acetaminophen for Treatment of Mallet Finger Pain

Recommended - for treatment of mallet finger pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with mallet finger pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.6.b.v Opioids for Treatment of Acute, Subacute, or Chronic Mallet Finger Pain

Not Recommended - for treatment of acute, subacute, or chronic mallet finger pain.

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

Evidence for the Use of Medications

C.6.c Rehabilitation

C.6.c.i Therapy: Active

C.6.c.i.a Therapeutic Exercise

Not Recommended – acutely and most patients with mallet finger do not require participation in an exercise program.

Evidence for the Use of Exercise

Recommended- In select patients with residual deficits, particularly post-operatively.

Frequency/Dose/Duration – Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.6.c.ii Therapy: Passive

C.6.c.ii.a Splints - Extension Splinting With the Joint in a Neutral Position

Recommended - for treatment of acute or subacute mallet finger.

Indications – Acute or subacute mallet finger.

Frequency/Duration – Splinting for six to eight weeks, possible nocturnal use for an additional two to four weeks.

Splints must hold the finger in continuous, full extension for a minimum duration of six weeks. Some protocols involve eight

weeks, while some involve nocturnal use for an additional two to four weeks.

Evidence for the Use of Splints

C.6.c.ii.b Instructions for Splint Wear

Recommended - that careful instructions on splint wear be provided to patients.

Evidence for the Use of Splint Wear

C.6.d Surgery

Not Recommended - In general

Recommended – in select patients with displaced fractures when the DIP joint is subluxed.

C.7 Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)

Flexor tendon entrapment of the digits is a disorder characterized by snapping or locking of the thumb or fingers (with or without pain). Most cases are secondary to thickening of the digit's A1 pulley, but other pathogeneses are possible.

C.7.a Diagnostic Studies

There are no special tests that are typically performed. X-rays are usually not helpful. The threshold for testing for confounding conditions such as diabetes mellitus, hypothyroidism and connective tissue disorders should be low particularly to prevent other morbidity.

Evidence for the Use of Diagnostic Studies

C.7.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.7.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Flexor tendon entrapment

Recommended - for treatment of acute, subacute, or chronic flexor tendon entrapment

Indications – For acute, subacute, or chronic flexor tendon entrapment, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.7.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.7.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.7.b.iv Acetaminophen for Treatment of Flexor Tendon Entrapment Pain

Recommended - for treatment of flexor tendon entrapment pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with flexor tendon entrapment pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.7.b.v Opioids

Not Recommended – for acute, subacute, or chronic flexor tendon entrapment.

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.7.c Treatments

C.7.c.i Injection Therapy

C.7.c.i.a Glucocorticosteroid Injections

Recommended - for treatment of acute, subacute, or chronic flexor tendon entrapment.

Indications – Triggering digit or symptoms of pain over the A-1 pulley thought to be consistent with stenosing tenosynovitis. Injection may be the most appropriate initial intervention.

Frequency/Duration – A single injection and results evaluated to document improvement.

Not Recommended – Ultrasound guidance for glucocorticosteroid injections acute, subacute, or chronic flexor tendon entrapment.

C.7.c.i.b Splint

Recommended - for treatment of select cases (i.e., patients who decline injection) of acute, subacute, or chronic flexor tendon entrapment.

Evidence for the Use of Splints

C.7.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.7.d.i Therapy: Active

C.7.d.i.a Therapeutic Exercise

Not Recommended – for acute cases and for most patients with flexor tendon entrapment.

C.7.d.i.b Therapeutic Exercise – Patients with Residual Deficits

Recommended – particularly post-operatively,

Frequency/Dose/Duration – Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

Evidence for the Use of Exercise for Trigger Digit

Evidence for the Use of Glucocorticosteroid Injections for Flexor Tendon Entrapment

C.7.e Surgery

Recommended - for persistent or chronic flexor tendon entrapment (Trigger Finger) in patients who have been partially or temporarily responsive to two glucocorticosteroid injections. Those without any response should be evaluated carefully for possible alternate conditions. If there is no therapeutic response to two glucocorticosteroid injections in the presence of an obvious trigger finger, surgery may be appropriate

Evidence for Surgery for Flexor Tendon Entrapment

C.8 Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)

De Quervain's stenosing tenosynovitis may be occupational when jobs require repeated forceful gripping or sustained wrist extension. However, most cases are not likely occupational. De Quervain's is the most common of the extensor compartment tendinoses.

C.8.a Diagnostic Studies

There are no special tests that are typically performed for extensor compartment tenosynovitis.

C.8.a.i X-Rays

Not Recommended - are usually not helpful and therefore are not recommended. The threshold for testing for confounding conditions such as diabetes mellitus and hypothyroidism should be low.

Evidence for the use of Special Studies - Extensor Compartment Tenosynovitis

C.8.a.ii MRI

Not Recommended - to diagnose extensor compartment tenosynovitis.

Recommended- in select circumstances where there is unclear diagnosis, and/or lack of appropriate response to clinical treatments, especially injection

Evidence for the Use of MRI to Diagnose Extensor Compartment Tenosynovitis

C.8.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.8.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Extensor Compartment Tenosynovitis

Recommended - for treatment of acute, subacute, or chronic extensor compartment tenosynovitis.

Indications – For acute, subacute, or chronic , NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.8.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.8.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.8.b.iv Acetaminophen for Treatment of Wrist compartment Tendinoses Pain

Recommended - for treatment of wrist compartment tendinoses pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with wrist compartment tendinoses pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.8.b.v Opioids

Not Recommended – for acute, subacute, or chronic extensor compartment tenosynovitis.

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.8.c Treatment

Initial care usually involves limitation of the physical factors thought to be contributing. Thumb spica splints for de Quervain's and wrist braces for the other compartment tendinoses are generally believed to be helpful. Thumb spica splints have been widely used for treatment of wrist compartment tendinoses while non-spica wrist splints have been used for treatment of other compartment tendinoses. NSAIDs are often prescribed for initial treatment.

C.8.c.i Mobilization / Immobilization

C.8.c.i.a Thumb Spica and Wrist Splints for Acute and Subacute Thumb Extensor Compartment Tenosynovitis

Recommended - for treatment of acute and subacute thumb extensor compartment tendinoses, and non-spica wrist splints for treatment of other extensor compartment tendinoses.

Frequency/Duration – Generally recommended to be worn while awake.

Indications for Discontinuation – Failure to respond or resolution.

Evidence for the Use of Splints - Extensor Compartment Tenosynovitis

C.8.c.ii Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.8.c.ii.a Therapy: Active

C.8.c.ii.a.i Therapeutic Exercise – Acutely

Not Recommended – as most patients with extensor tendon entrapment do not require an exercise program.

C.8.c.ii.a.ii Therapeutic Exercise – Residual Defects

Recommended – particularly post-operatively.

Frequency/Dose/Duration – Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.8.c.ii.b Therapy: Passive

C.8.c.ii.b.i Iontophoresis for Acute and Subacute Extensor Compartment Tenosynovitis

Recommended – using glucocorticosteroids and sometimes NSAIDs for select patient with wrist compartment tendinoses. who either fail to respond adequately to NSAIDs, splints, and activity modifications or decline injection.

Frequency/Duration – Generally two or three treatments to ascertain efficacy; an additional four to six treatments may be scheduled if efficacious. If improvements continue at 6 treatments, additional four to six treatments are reasonable.

Indications for Discontinuation – Failure to respond, development of adverse effects, resolution.

C.8.c.iii Other Passive Interventions

Not Recommended - Other Non-operative Interventions Including Manipulation and Mobilization, Massage, Deep Friction Massage, or Acupuncture for Acute, Subacute, or Chronic Extensor Compartment Tenosynovitis

Evidence for the Use of Acupuncture - Extensor Compartment Tenosynovitis

Evidence for the Use of Exercise - Extensor Compartment Tenosynovitis

C.8.c.iv Injection Therapy

C.8.c.iv.a Glucocorticosteroid Injections

Recommended - for treatment of acute, de Quervain's or other wrist compartment tendinosis.

Indications – Wrist compartment symptoms of pain over a compartment. Generally at least one week of non-invasive treatment to determine if condition will resolve without invasive treatment. It is reasonable to treat cases with an initial injection.

Frequency/Duration – It is recommended that a single injection be scheduled and the results evaluated to document improvement. Failure of a response or suboptimal response within two to three weeks should result in reconsideration of the diagnosis and consideration of second injection. Recurrence of symptoms may indicate the need for surgery evaluation.

Evidence for the Use of Glucocorticosteroid Injections for Wrist Compartment Tendinoses

C.8.d Surgery

C.8.d.i Surgery – Surgical Release

Recommended - for patients with subacute or chronic extensor compartment tenosynovitis who fail to respond to injection.

Indications – Wrist compartment tenosynovitis that fails to respond to non-operative interventions generally including 2 glucocorticosteroid injections.

Evidence for the Use of Surgery - Extensor Compartment Tenosynovitis

C.9 Ulnar Nerve Entrapment at the Wrist (Including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome)

Ulnar nerve entrapment involves delayed conduction of the ulnar nerve with associated symptoms. The location of the lesion affecting the ulnar nerve as it crosses through Guyon's canal and the wrist is predictive of clinical symptoms. This canal is dissimilar to the carpal canal in that the tendons and their tenosynovium do not accompany the nerve, thus most of the usual postulated causal mechanisms for carpal tunnel syndrome are not possible. However, use of the hypothenar area of the hand as a hammer is a postulated occupational mechanism.

C.9.a Diagnostic Studies

C.9.a.i Electrodiagnostic Studies

Recommended - to confirm clinical suspicion of ulnar nerve entrapment at the wrist.

Rationale for Recommendation - studies need to be performed by well-trained electrodiagnosticians, preferably certified by the American Board of Electrodiagnostic Medicine.

Evidence for the Use of Electrodiagnostic Studies - Ulnar Nerve Entrapment at the Wrist

C.9.a.ii MRI or Ultrasound

Not Recommended – to diagnose ulnar nerve entrapment at the wrist.

Recommended- for a suspected soft-tissue mass. MRI is generally preferable for soft tissue masses such as ganglion cysts.

Evidence for the Use of MRI and Ultrasound - Ulnar Nerve Entrapment at the Wrist

C.9.a.iii CT

Recommended - to diagnose ulnar nerve entrapment at the wrist if a hook of the hamate fracture is suspected based upon the history, a mechanism of potential fracture, focal pain at the hamate and where there are ulnar nerve symptoms. CT is preferable for evaluation of fractures

Evidence for the Use of CT - Ulnar Nerve Entrapment at the Wrist

C.9.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol)

may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.9.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Ulnar Nerve Compression at the Wrist

Recommended - for treatment of acute, subacute, or chronic ulnar nerve compression at the wrist.

Indications – For acute, subacute, or chronic ulnar nerve compression at the wrist, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.9.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.9.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for

primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.9.b.iv Acetaminophen for Treatment of Ulnar Nerve Compression at the Wrist Pain

Recommended - for treatment of ulnar nerve compression at the wrist pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with ulnar nerve compression at the wrist pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for Ulnar Nerve Compression at the Wrist

C.9.b.v Opioids

Not Recommended – for acute, subacute, or chronic ulnar nerve entrapment at the wrist.

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.9.b.vi Glucocorticosteroids - Oral and/or Injected

Not Recommended - for treatment of acute, subacute, or chronic ulnar nerve compression at the wrist.

C.9.c Treatments

C.9.c.i Splinting

C.9.c.i.a Neutral Wrist Splinting

Recommended – as first-line treatment for acute, subacute, or chronic ulnar nerve compression at the wrist

Evidence for the Use of Splints for Ulnar Nerve Compression at the Wrist

C.9.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.9.d.i Therapy – Active

C.9.d.i.a Therapeutic Exercise

Not Recommended – for acute ulnar nerve compression at the wrist

Recommended – for post-operatively for ulnar nerve compression at the wrist

Recommended – for subacute and chronic ulnar nerve compression at the wrist if functional deficits exist

Rationale for Recommendation - Exercise is generally not indicated acutely; however, exercise may be needed in the recovery or post-operative phases. Functional goals should include increased grip strength, key pinch strength, range of motion, advancing work abilities.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.9.d.ii Therapy - Passive

C.9.d.ii.a Ice – Self-application

Recommended - for treatment of acute, subacute, or chronic radial nerve entrapment.

C.9.d.ii.b Heat – Self-appliation

Recommended - for treatment of acute, subacute, or chronic radial nerve entrapment.

C.9.d.ii.c Manipulation/Mobilization

Not Recommended - - for treatment of acute, subacute, or chronic radial nerve entrapment

C.9.d.ii.d Iontophoresis

Not Recommended- for treatment of acute, subacute, or chronic radial nerve entrapment.

C.9.d.ii.e Massage, Friction Massage

Not Recommended- for treatment of acute, subacute, or chronic radial nerve entrapment.

C.9.d.ii.f Acupuncture

Not Recommended - for treatment of acute, subacute, or chronic radial nerve entrapment

Evidence for the Use of Physical Methods/Rehabilitation for Ulnar Neuropathy at the Wrist

C.9.d.iii Activity Modification

Recommended - with particular avoidance of significant localized mechanical compression of the nerve or use of the hand as a hammer is recommended for treatment of ulnar nerve compression at the wrist.

Evidence for the Use of Activity Modification for Ulnar Nerve Compression at the Wrist

C.9.e. Surgery

C.9.e.i Surgical Decompression

Recommended - for subacute or chronic ulnar nerve compression at the wrist after failure of non-operative treatment or if space-occupying lesions are present

Rationale for Recommendation - It is recommended for select patients who failed trials of other non-operative treatments or if space occupying lesions are present. It may also be preferential in those with diabetes mellitus.

Evidence for the Use of Surgery for Ulnar Neuropathy at the Wrist

C.10 Radial Nerve Entrapment

Radial nerve entrapment usually presents as radial nerve palsies affecting the hand and wrist, most commonly occurring at points along the course of the arm and forearm, well proximal to the wrist. The medical history should include a search for sensory symptoms. Symptoms may also include pain over the course of the nerve, wrist extensor weakness and wrist drop.

C.10.a Medical History

Assessment of motor symptoms, including wrist extensor weakness as well as wrist drop, are also helpful

C.10.b Diagnostic Studies

C.10.b.i Electrodiagnostic Studies

Recommended - to confirm clinical suspicion of a radial nerve motor neuropathy.

Rationale for Recommendation are recommended as an objective test to evaluate radial nerve motor neuropathy. However, studies need to be performed by well-trained electrodiagnosticians, preferably certified by the American Board of Electrodiagnostic Medicine.

C.10.b.ii Ultrasound (Diagnostic)

Not recommended - to confirm clinical suspicion of a radial nerve neuropathy.

Evidence for the Use of Ultrasound for Radial Nerve Motor Neuropathy

C.10.c Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.10.c.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Radial Nerve Compression Neuropathy

Recommended - for treatment of acute, subacute, or chronic radial nerve compression at the wrist.

Indications – For acute, subacute, or chronic radial nerve compression neuropathy, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.10.c.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.10.c.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.10.c.iv Acetaminophen for Treatment of Radial Nerve Compression Neuropathy Pain

Recommended - for treatment of radial nerve compression neuropathy pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with radial nerve compression neuropathy pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for Radial Nerve Compression Neuropathy

C.10.c.v Opioids

Not Recommended – for acute, subacute, or chronic radial nerve entrapment pain.

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.10.d Treatments

C.10.d.i Splinting

C.10.d.i.a Wrist Extension or Thumb Spica Splint

Recommended - for treatment of acute, subacute, or chronic radial nerve compression neuropathy.

Evidence for the Use of Splints for Radial Nerve Compression Neuropathy

C.10.e Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.10.e.i Therapy - Active

C.10.e.i.a Therapeutic Exercise – Acute

Recommended- in select patients to keep the paralyzed joints supple while awaiting spontaneous recovery of nerve function.

C.10.e.i.b Therapeutic Exercise – Post -Operative

Recommended – for patients post-operatively to keep the paralyzed joints supple while awaiting recovery of nerve function.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

Evidence for the Use of Exercise for Radial Neuropathy

C.10.e.ii Therapy - Passive

C.10.e.ii.a Ice – Self-application

Recommended - for treatment of acute, subacute, or chronic radial nerve entrapment.

C.10.e.ii.b Heat – Self-appliation

Recommended - for treatment of acute, subacute, or chronic radial nerve entrapment.

C.10.e.ii.c Mobilization / Immobilization

Not Recommended - - for treatment of acute, subacute, or chronic radial nerve entrapment

C.10.e.ii.d Iontophoresis

Not Recommended - for treatment of acute, subacute, or chronic radial nerve entrapment

C.10.e.ii.e Acupuncture

Not Recommended- for treatment of acute, subacute, or chronic radial nerve entrapment

C.10.e.ii.f Massage

Not Recommended- for treatment of acute, subacute, or chronic radial nerve entrapment

C.10.f Surgery

C.10.f.i Surgical Release

Recommended - for subacute or chronic cases of radial nerve compression neuropathy that persist despite other interventions.

Rationale for Recommendation It is recommended for select patients who failed trials of other non-operative treatments or if space occupying lesions are present.

C.11 Non-Specific Hand, Wrist and Forearm Pain

Non-specific hand/wrist/forearm pain typically occurs in the absence of discrete trauma. Instead, it frequently occurs in settings of high physical job demands or ill-defined exposures. Most cases will resolve however, if there is no improvement after several weeks of treatment, focused diagnostic testing should be considered. Non-specific pain lasting more than 2 months is fairly rare. The search for a specific diagnosis should include proximal pathology including spine-related (e.g., radiculopathy, spinal tumor, infection) as well as psychological disorders particularly when widespread symptoms are elicited or a pattern or recurrent unexplained illnesses is present

Patients most commonly give a history of gradual onset of pain or other symptoms in the absence of discrete trauma. Symptoms are most often in the forearm, and frequently are not well localized.

C.11.a Diagnostic Studies

C.11.a.i Rheumatological Studies for Arthralgias

Recommended - for evaluation of select patients with persistent unexplained arthralgias or tenosynovitis.

Indications – Persistent unexplained arthralgias or tenosynovitis.

Frequency/Duration – Repeat studies may be required after passage of time as some patients, particularly those with less severe diseases, tend to develop positive anti-bodies after months to years.

C.11.a.ii Arthrocentesis for Joint Effusions

Recommended – in inexplicable joint effusions, particularly for evaluation of infections and crystalline arthropathies

Indications – Joint effusions without a clear diagnosis including suspected infection or crystalline arthropathies.

C.11.a.iii Electrodiagnostic

Recommended - to evaluate non-specific hand, wrist, or forearm pain for patients with paresthesias or other neurological symptoms.

Indications – Persistent tingling and pain, particularly symptoms characteristic of radiculopathies and entrapment neuropathies. Providers are cautioned that the prevalence rate of abnormal electrodiagnostic studies in asymptomatic populations are high and interpretations of abnormal results should be correlated with clinical findings

Frequency/Dose – Should generally be performed at least 3 weeks after symptom onset.

Evidence for the Use of Electrodiagnostic Studies to evaluate non-specific hand, wrist, or forearm pain

C.11.a.iv X-Rays

Recommended - for evaluation of cases in which non-specific hand, wrist, or forearm pain persists.

Indications – Persistent non-specific hand, wrist, or forearm pain.

Evidence for the Use of X-rays for Evaluation of Non-specific Hand, Wrist, or Forearm Pain

C.11.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.11.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Non-specific hand/wrist/forearm Pain

Recommended - for treatment of acute, subacute, or chronic non-specific hand/wrist/forearm pain.

Indications – For acute, subacute, or chronic Non-specific hand/wrist/forearm pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.11.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.11.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.11.b.iv Acetaminophen for Treatment of Non-specific hand/wrist/forearm Pain

Recommended - for treatment of Non-specific hand/wrist/forearm pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with Non-specific hand/wrist/forearm pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for Non-specific hand/wrist/forearm Pain

C.11.b.v Opioids

Not Recommended – for acute, subacute, or chronic non-specific hand, wrist or forearm pain.

C.11.c Treatments

C.11.c.i Relative Rest

Recommended –in select cases of acute non-specific hand, wrist, or forearm pain particularly where there are high ergonomic exposures (high force or high force combined with other risk factors).

Rationale for Recommendation - For patients with high ergonomic exposures, relative rest may be helpful.

Evidence for the Use of Relative Rest for Acute Non-specific Hand, Wrist, or Forearm Pain

C.11.c.ii Splinting

Recommended - for treatment of select patients with acute or subacute non-specific hand, wrist, or forearm pain.

Not Recommended - for chronic use

Rationale for Recommendation - Splinting may at times be helpful, but enforces debility. It is generally not recommended for chronic use.

Evidence for the Use of Splints for Acute or Subacute Non-specific Hand, Wrist, or Forearm Pain

C.11.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.11.d.i Therapy - Active

C.11.d.i.a Therapeutic Exercise

Recommended - for treatment of acute, subacute, or chronic non-specific hand, wrist, or forearm pain.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

Evidence for the Use of Physical or Occupational Therapy for Acute, Subacute, or Chronic Non-specific Hand, Wrist, or Forearm Pain

C.10.d.i.b Therapeutic Exercise

Recommended- for select patients with acute, subacute or chronic non-specific hand/wrist/forearm pain which does not resolve with initial care

Evidence for the Use of Exercise for Acute, Subacute, or Chronic Non-specific Hand, Wrist, or Forearm Pain

C.11.d.ii Therapy:Passive

C.11.d.ii.a Self-application of Ice or Heat

Recommended - for treatment of acute or subacute non-specific hand, wrist, or forearm pain.

C.12 Scaphoid Fracture

Scaphoid fractures, also known as wrist navicular fractures, are among the most common fractures of the carpal bones. Most are not occupational, but some clearly are work-related. The primary mechanism of scaphoid injury is a fall on the outstretched hand, or from axial loading with a closed fist such as grasping a steering wheel in an auto accident. Scaphoid fractures are prone to non-union and avascular necrosis, particularly those involving the proximal third of the navicular, and especially if displaced. Healing problems in the proximal third have been attributed to limited blood supply that is disrupted by the fracture plane. The main initial tasks are to confirm a fracture, identify those patients with fractures best treated with surgery, and treat those with a high clinical suspicion of fracture with appropriate splinting. Patients frequently complain of persistent swelling and tenderness near the thumb base in the area of the scaphoid.

C.12.a Diagnostic Studies

C.12.a.i X-Rays

Recommended - for diagnostic purposes that include at least 3 to 4 views including a “scaphoid view.”

C.12.a.ii X-Rays – Follow-up in two weeks

Recommended - for evaluation of potential scaphoid fractures,) particularly for patients with a high clinical suspicion of fracture, but negative initial x-rays.

Evidence for the Use of X-rays for scaphoid fractures

C.12.a.iii MRI

Recommended – in select patients for diagnosis of occult scaphoid fractures when clinical suspicion remains high despite negative x-rays.

Indications – Clinical suspicion of scaphoid fracture but negative x-rays.

Rationale for Recommendation - MRI is not required for the majority of scaphoid fractures, but may be indicated for patients with a clinical suspicion of scaphoid fracture, but negative x-rays.

Evidence for the Use of MRI for Scaphoid Fracture

C.12.a.iv CT Imaging

Recommended - to diagnose occult scaphoid fractures when clinical suspicion of fracture remains high with negative x-rays and MRI is contraindicated.

Evidence for the Use of CT Imaging for Diagnosing Scaphoid Fractures

C.12.a.v Bone Scan

Recommended – for select patients to diagnose occult scaphoid fractures when clinical suspicion remains high despite negative x-rays.

Indications – At least 48 hours after the injury with continuing clinic suspicion of scaphoid fracture.

Rationale for Recommendation Bone scans are not required for evaluation of the majority of patients with scaphoid fractures; however, in those patients with a clinical suspicion of scaphoid fracture, but negative x-rays, bone scans may assist in securing an earlier diagnosis that may obviate prolonged splinting in those without a fracture. Thus, bone scans are recommended for these select patients.

Evidence for the Use of Bone Scans for Scaphoid Fractures

C.12.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.12.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Scaphoid Fractures Pain

Recommended - for treatment of acute, subacute, or chronic scaphoid fractures pain.

Indications – For acute, subacute, or chronic Scaphoid fractures pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.12.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.12.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.12.b.iv Acetaminophen for Treatment of Scaphoid Fractures Pain

Recommended - for treatment of scaphoid fractures pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with scaphoid fractures pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for Scaphoid Fractures Pain

C.12.b.v Opioids

Limited Use of Opioids for Acute and Post-operative Pain Management

Recommended – for limited use (less than seven days) for acute and post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For acute injury and post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen, elevation, splinting) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.12.c Treatments

C.12.c.i Splinting

C.12.c.i.a Wrist Splinting

Recommended - for treatment of scaphoid tubercle fractures.

Rationale for Recommendation - Splinting may suffice, as these fractures heal well due to adequate blood supply.

C.12.c.i.b Cast Immobilization

Recommended for treatment of stable non displaced scaphoid fractures.

Frequency/Duration – Casting should be performed for 6 to 8 weeks with cast removal clinical reevaluation, and re-xray to determine whether additional casting is required. ,

C.12.c.i.c Thumb Immobilization with Spica Casting

Recommended - concurrent immobilization of the thumb with the wrist for treatment of scaphoid fractures.

Frequency/Duration – Casting should be performed for 6 to 8 weeks with cast removal clinical reevaluation, and re-xray to determine whether additional casting is required.

C.12.c.i.d Spica Splint

Recommended - for patients with suspicion of scaphoid fracture, but with negative x-rays.

Duration – 2 weeks, follow up with repeat clinical examination and repeat x-ray. If x-ray is negative consider discontinuation of splint.

Evidence for Casting with Thumb Immobilization for Scaphoid Fractures

C.12.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.12.d.i Therapy:Active

C.12.d.i.a Therapeutic Exercise - for Post-operative Scaphoid Fractures

Recommended - for the treatment of post-operative scaphoid fractures

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part

of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

Evidence for the Use of Physical Methods/Rehabilitation for Scaphoid Fractures

C.12.e Surgery

C.12.e.i Surgical Fixation

Recommended – for displaced scaphoid fractures

Rationale for Recommendation - Displaced fractures are believed to require surgical treatment with fixation.

High-risk scaphoid fractures should be promptly referred to hand or orthopaedic surgical specialists for definitive treatment because of the higher risk of these fractures developing a nonunion, malunion, or degenerative joint disease.

C.12.e.ii Surgical Intervention of Non-Displaced or Minimally Displaced Scaphoid Fractures

Recommended - for select patients requiring earlier functional recovery.

Not Recommended –in general, non displaced fractures are best treated with cast immobilization.

Rationale for Recommendation –Surgical intervention may be appropriate in patients with non-displaced or minimally displaced scaphoid fractures who cannot or do not wish to be treated with an attempt at non-operative treatment. This includes athletes. It also may include patients who are unable to work until the fracture is healed. The decision to surgically treat a non-displaced scaphoid fracture is a decision between the orthopedist and patient with a discussion suggested to include the benefits of earlier functional recovery versus the longer term risks of osteoarthritis.

Evidence for the Use of Surgery vs. Non-operative Treatment for Scaphoid Fractures

C.12.e.iii Hardware Removal

Recommended- In select cases where there is hardware placed, subsequent hardware removal is indicated, as per doctor / patient preference.

Indications: in cases as per doctor / patient preference where there is 1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

C.13 Distal Phalanx Fractures and Subungual Hematoma

Fingertip or distal phalangeal fractures are frequently cited as the most common fractures of the hand, with the tuft being the most common.

- Tuft fractures are most often usually due to a crush injury of the fingertip, resulting in comminuted or transverse fractures and are a common occupational injury. Often, they are accompanied with nail bed laceration and subungual hematoma. Tuft fractures are generally stable and heal uneventfully because of the soft tissue support of the fibrous septae and nail plate.
- Crush fractures or avulsion fractures involving the proximal base of the distal phalanx however may also involve flexor or extensor tendons and may require surgical intervention.
- Mallet fracture or mallet finger is a common fracture-dislocation injury of the distal phalanx involving loss of continuity of the extensor tendon over the distal interphalangeal joint.
- Subungual Hematoma, blood trapped under the nail after trauma.

C.13.a Diagnostic Studies

C.13.a.i X-rays

Recommended - to diagnose tuft fractures.

Frequency/Duration – Obtaining x-rays once is generally sufficient. Follow-up x-rays are rarely indicated aside from complicated healing.

Evidence for the Use of X-rays for Diagnosing Tuft Fractures

C.13.a.ii MRI / CT / Ultrasound / Bone Scan Imaging

Not recommended - for diagnosing tuft fractures.

Evidence for the Use of MRI/CT/Ultrasound/Bone Scan Imaging for Diagnosing Tuft Fractures

C.13.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less

effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.13.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Tuft Fractures Pain

Recommended - for treatment of acute, subacute, or chronic tuft fractures pain.

Indications – For acute, subacute, or chronic tuft fractures pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.13.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.13.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the

NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.13.b.iv Acetaminophen for Treatment of Tuft Fractures Pain

Recommended - for treatment of tuft fractures pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with tuft fractures pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for Tuft fractures Pain

C.13.b.v Opioids

Limited Use of Opioids for Acute and Post-operative Pain Management

Recommended – for limited use (less than seven days) for acute and post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For acute injury and post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen, elevation, splinting) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.13.b.vi Antibioitic Prophylaxis

Not Recommended - use of post-trephination antibiotic prophylaxis for open fractures.

Evidence for the Use of Antibiotic Prophylaxis for Open Fractures

C.13.b.vi Tetanus Immunization

Recommended - that tetanus immunization status to be updated as necessary.

Indications – Wounds that are not clean or burns if more than 5 years have elapsed since last tetanus immunization.

Evidence for the Use of Tetanus Immunization

C.13.c Treatments

Tuft fractures associated with nail avulsion may require reduction of the nail plate under the eponychium, or removal if reduction cannot be performed. Orthopedic assistance is usually not required for uncomplicated closures.

Open fractures with extensive soft tissue damage frequently are associated with chronic pain and disability and generally require assistance from an orthopedic or hand surgeon.

C.13.c.i Trephination

Recommended - for management of subungual hematoma.

C.13.c.ii Nail Removal or Nail Bed Laceration Repair

Not Recommended - for the management of subungual hematoma in the absence of nail bed laceration.

Recommended- for the management of subungual hematoma associated with nail bed laceration to avoid future cosmetic defects.

C.13.c.iii Reduction Of The Nail Plate Under the Eponychium

Recommended- in select cases

C.13.c.iv Removal of the Nail Plate Under the Eponychium

Recommended- in select cases if reduction of the nail plate under the eponychium cannot be performed.

Evidence for the Use of Trephination and Nail Removal or Laceration Repair

C.13.c.v Immobilization: Splinting

C.13.c.v.a Protective splinting of the distal phalanx to the PIP

Recommended - for fractures.

Duration – Approximately 3 weeks.

C.13.c.v.b Finger splinting of tuft fractures

Recommended- splinting the finger to prevent further discomfort or injury.

C.13.c.vi Reduction of (the relatively uncommon) significantly displaced fractures

Recommended- *Reduction and splint immobilization*

In the small percentage of patients where reduction cannot be achieved, referral to an orthopedic surgeon may be indicated.

C.13.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.13.d.i Therapy: Active

C.13.d.i.a Therapeutic Exercise

Recommended – in select cases for treatment of tuft fractures.

Rationale for Recommendation - Joint mobilization therapy may be useful for complicated injuries or post surgical fixation.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or

up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

Evidence for the Use of Physical or Occupational Therapy for tuft fractures

C.13.e Surgery

C.13.e.i Recommended- for fractures that are extremely displaced, unable to be reduced or are unstable.

Rationale for Recommendation- Distal phalangeal diaphyseal fractures rarely require operative fixation, except those that are extremely displaced, unable to be reduced or are unstable. Retrograde percutaneous Kirschner-wire fixation is the preferred internal fixation technique.

C.13.e.ii Hardware Removal

Recommended - In select cases where there is hardware placed, subsequent hardware removal is indicated, as per doctor / patient preference.

Indications: in cases as per doctor / patient preference where there is 1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

Evidence for the Use of Surgery for Distal phalangeal diaphyseal fractures

C.14 Middle and Proximal Phalangeal and Metacarpal Fractures

Fractures of the proximal and middle phalanges represent approximately 46% of fractures of the hand and wrist. Fortunately, most are uncomplicated and are non-surgical cases. Metacarpal fractures comprise roughly 1/3 of hand fractures, with fifth metacarpal neck fractures (sometimes called “Boxer’s fracture”) accounting for 1/3 to 1/2 of these injuries, and fractures of the thumb constituting another 25%.

Physicians who encounter hand fractures must be able to properly diagnose and manage these hand fractures, as improper management may result in permanent impairment and disability from bone shortening, permanent angulation, joint and finger stiffness, and loss of hand function. Proximal phalangeal fractures particularly have a significant potential for

hand impairment particularly if suboptimally managed because of the importance of this bone in longitudinal transfer of axial forces between the carpal and distal phalangeal joints, and the PIP joint for digit mobility. Decisions for surgical intervention should be offered upon careful consideration balancing risk of superior radiographic reduction with higher risk of debilitating stiffness from the post-operative rehabilitative state, with confidence that non-operative therapy can be improved upon.

C.14.a Diagnostic Studies

C.14.a.i X-Rays

Recommended - for diagnosing phalangeal or metacarpal fractures and should include three projections, including a posteroanterior, lateral, and oblique view. A true lateral projection isolating the involved digit is required.

Evidence for the Use of X-rays for Diagnosing Phalangeal or Metacarpal Fractures

C.14.a.ii MRI, CT, Ultrasound, or Bone Scanning for Diagnosing Phalangeal or Metacarpal Fractures

Not Recommended - for diagnosing phalangeal or metacarpal fractures.

C.14.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.14.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Phalangeal or Metacarpal Fracture Pain

Recommended - for treatment of acute, subacute, or chronic phalangeal or metacarpal fracture pain.

Indications – For acute, subacute, or chronic phalangeal or metacarpal fracture pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.14.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.14.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.14.b.iv Acetaminophen for Treatment of Phalangeal or Metacarpal Fracture Pain

Recommended - for treatment of phalangeal or metacarpal fracture pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with phalangeal or metacarpal fracture pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.14.b.v Opioids

Limited Use of Opioids for Acute and Post-operative Pain Management

Recommended – for limited use (less than seven days) for acute and post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For acute injury and post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen, elevation, splinting) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.14.b.vi Antibiotic Prophylaxis

Not Recommended - for open phalangeal fractures.

Evidence for the Use of Antibiotic Prophylaxis for open phalangeal fractures

C.14.b.vii Tetanus Immunization Status for Open Fractures

Recommended - status to be updated as necessary.

Indication – Wounds that are not clean or burns if more than 5 years have elapsed since last tetanus immunization.

Evidence for the Use of Tetanus Immunization for Open Fractures

C.14.c Initial Management

Initial management should include treatment of soft tissue injuries and pain control following completion of physical examination.

Regional anesthesia may be administered as clinically indicated to complete diagnostic assessment (passive range of motion, rotational alignment) and to perform closed reduction of the fracture, although not until neurovascular examination is documented.

C.14.c.i Immobilization

Immobilization or fixation technique is dictated by the physical and radiographic findings. More than 90% of phalangeal fractures can be managed non-operatively. Non-operative management techniques include padded aluminum splints, buddy tape, functional splinting, and gutter casting.

C.14.c.i.a Immobilization

Recommended - for treatment of middle and proximal phalanx fractures.

Frequency/Duration – When percutaneous fixation with wire is used, supplemental stabilization with splint or casting for three to four weeks should also be used as the wire does not provide sufficient rigidity.

C.14.c.i.b Non-operative management (immobilization) of non-displaced and stable transverse diaphyseal fractures of the middle and proximal phalanges

Recommended - as these fractures do not require fixation and can be managed without surgery.

Frequency/Duration – Immobilization of the affected digit with neighboring digit in 70 to 90° of MCP flexion for three weeks

Rationale for Recommendation - These fractures have good results with non-operative management. The tolerance limits for non-operative management after closed reduction are angulation of 10°, shortening less than 2mm, bone apposition of greater than 50%, and no malrotation. Displacement outside these limits should be evaluated for treatment with closed reduction and percutaneous fixation, or upon failure of closed reduction, open reduction and internal fixation.

C.14.c.i.c Non-operative Management of Non-displaced Oblique Fractures of the Middle and Proximal Phalanges

Recommended - as these fractures are usually stable and require rigid immobilization alone.

C.14.c.i.d Closed Reduction with Splinting

Recommended - for base phalanx fractures.

Indications – Involvement of less than 40% of the middle phalanx base.

C.14.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.14.d.i Therapy - Active

C.14.d.i.a Therapeutic Exercise

Recommended - for Post-operative Middle and Proximal Phalangeal and Metacarpal Fractures

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.14.d.ii Therapy: Passive

C.14.d.ii.a Ice, Compression, and Elevation for Acute Metacarpal and Phalangeal Fractures

Recommended - for controlling edema related to acute metacarpal and phalangeal fractures.

C.14.e Management

C.14.e.i Surgery

C.14.e.i.a Surgical Management of Condylar Fractures

Recommended - as these fractures are unstable.

C.14.e.i.b Surgical Management for Malrotated Phalangeal Fractures

Recommended – if malrotation cannot be corrected and stabilized by closed reduction.

Rationale for Recommendation - Surgical management for malrotated phalangeal and metacarpal fractures is recommended, to prevent or reduce rotational deformity that can result in fingers crossing over each other or interfering with hand function, if malrotation cannot be corrected and stabilized by closed reduction.

C.14.e.i.c Metacarpal Fractures

Non-Operative Treatment of Distal Metacarpal Head Fracture using closed reduction and protective immobilization with radial or ulnar gutter splint

Recommended - for fractures with less than 20% of joint involvement.

Rationale for Recommendation - Cases with greater than 20% joint involvement likely require open reduction and internal fixation followed by nearly immediate motion.

C.14.e.ii Non-Operative

C.14.e.ii.a Non-operative Treatment of Distal Metacarpal Neck Fracture with Acceptable Angulation

Recommended - Degree of angulation 30 degrees in the ring finger and 10° in the index and long fingers.

C.14.e.ii.b Non-operative Treatment of Fifth Metacarpal Neck Fractures (Boxer's Fracture)

Recommended - before surgical treatment for most 5th metacarpal neck fractures (less than 45 degrees angulation).

C.14.e.ii.c Use of Functional Therapies (including taping, functional bracing and strapping) for Fifth Metacarpal Neck Fractures

Recommended – rather than casting or ulnar splinting

C.14.e.ii.d X-rays in Follow-up of Non-Operative Fifth Metacarpal Neck Fractures

Recommended for patients at risk for displacement after reduction

Rationale for Recommendation - Follow-up radiographs are indicated if physical examination suggests loss of reduction or instability. Radiographs may be indicated 7 to 10 days after injury to ensure no (further) displacement or malrotation.

C.14.f Shaft Metacarpal Fractures

Shaft metacarpal fractures are usually transverse, oblique, spiral or comminuted.. Decisions for non-operative versus surgical intervention balance acceptance of potential metacarpal shortening with risks accompanying surgical intervention.

C.14.f.i Surgery

C.14.f.i.a Surgical Management of Metacarpal shaft fractures.

Recommended- fixation (pinning, wire, plate, lag screws).

Indication: for fractures that cannot be reduced, are unstable, or have multiple neighboring shaft fractures

C.14.f.i.b Surgical Management for Base Fractures of the Proximal Metacarpal

Recommended - as these fractures are rarely stable.

C.14.f.i.c Surgical Management Bennett's Fracture and Rolando's Fracture

Recommended - for Bennett's and Roland's fractures as these fracture types are unstable.

C.14.f.i.d Surgical Management for Malrotated Phalangeal fractures

Recommended - as deformity and impairment may result.

C.14.f.i.e Hardware Removal

Recommended- In select cases where there is hardware placed, subsequent hardware removal is indicated, as per doctor / patient preference.

Indications: in cases as per doctor/patient preference where there is 1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

Evidence for the Use of Surgery for Malrotated Phalangeal Fractures

C.14.f.ii Non-Operative

C.14.f.ii.a Non-operative Management of Metacarpal Shaft Fractures

Recommended- Non-operative management of metacarpal shaft fractures is recommended in select patients.

Indications: If adequate closed reduction is achieved and the fracture is stable, with cast immobilization

C.15 Distal Forearm Fractures

There are several types of distal forearm fractures in adults, the most common being Colles' fracture. The distinguishing feature for Colles' fracture is that fracture fragments are displaced or angulated dorsally on a lateral view x-ray. Other adult distal radial fractures include displaced fracture fragments that have an anterior angulation and displaced fracture fragments that are displaced palmarly and may have an anterior angulation. Despite the severity of these injuries, with proper diagnosis and management most patients will have a satisfactory outcome.

Distal radial fractures are the result of traumatic forces, most commonly related to falling on the outstretched hand. The typical mechanism for Colles' fracture is breaking the fall with the hand outstretched and wrist in dorsiflexion, although a minority occur due to an impact on the dorsal aspect of the hand while the wrist is flexed (jam injury into the dorsum of hand) or a direct blow to the radial styloid.

Wrist injuries associated with significant pain, swelling, ecchymosis, crepitation, or deformity should be considered to be fractured until proven otherwise. Forearm fractures may also result in concomitant vascular, neurological, ligament and tendon injuries. Further, as distal forearm fractures are the result of trauma, careful inspection for other traumatic injuries should be included, such as elbow, shoulder, neck, head, and hip. In general, most distal forearm fractures should be managed by an orthopedic or hand surgeon and consultation is recommended.

C.15.a Diagnostic Studies

C.15.a.i X-ray for Suspected Distal Forearm Fractures

Recommended - as a first-line study for suspected distal forearm fractures; posterior-anterior, lateral and, if available, oblique views are recommended.

Recommended- Contralateral wrist x-ray images should be considered as a comparison that may improve reliability of some radiographic measurements.

Rationale for Recommendation Radiographic evaluation should provide the provider necessary information on location, configuration, displacement, subluxation, likelihood of stability, and concomitant

potential of soft tissue injury. Contralateral wrist x-ray images should be considered as a comparison that may improve reliability of some radiographic measurements, particularly for a more accurate determination of stability and provide greater guidance on indication for treatment.

Evidence for the Use of X-rays for Suspected Distal Forearm Fractures

C.15.a.ii MRI

Recommended - to diagnose suspected soft-tissue trauma after x-ray images confirm a complex displaced, unstable, or comminuted distal forearm fractures.

Indication – X-ray confirmation of complex displaced, unstable, or comminuted distal forearm fracture.

Rationale for Recommendation - Upon confirmation of displaced, comminuted or unstable fracture, MRI may be an important diagnostic technique for the evaluation of suspected injuries of soft tissues related to distal radius fractures, such as to the flexor and extensor tendons or the median nerve. Other potential indications include identification of triangular fibrocartilage complex perforations, ruptures of carpal ligaments, and demonstration of contents of the carpal tunnel.

Evidence for the Use of MRI for Diagnosing Distal Forearm Fractures

C.15.a.iii CT

Recommended - for investigation of occult and complex distal forearm fractures to gain greater clarity of fracture displacement, articular involvement, and subluxation of the distal radioulnar joint.

Indication – Negative x-rays with occult fracture strongly suspected.

Rationale for Recommendation - In contrast to MRI, CT should be considered when x-ray images are negative but on the basis of physical findings an occult fracture is strongly suspected. CT may also be useful for evaluation of complex comminuted fractures, providing superior depiction of distal radial articular surface involvement, fragment positioning, and diagnosis of subluxations of the distal radioulnar joint

Evidence for the Use of CT for Diagnosis and Classification of Occult and Complex Distal Forearm Fractures

C.15.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol)

may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.15.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Distal Forearm Fractures Pain

Recommended - for treatment of acute, subacute, or chronic distal forearm fractures pain.

Indications – For acute, subacute, or chronic distal forearm fractures pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.15.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.15.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for

primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.15.b.iv Acetaminophen for Treatment of Distal Forearm Fractures Pain

Recommended - for treatment of distal forearm fractures pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with distal forearm fractures pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for Distal Forearm Fractures Pain

C.15.b.v Opioids

Limited Use of Opioids for Acute and Post-operative Pain Management

Recommended – for limited use (less than seven days) for acute and post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For acute injury and post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen, elevation, splinting) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.15.c Treatments

Recommendations for treatment should be based upon the following criteria: is a fracture open or closed, stable or unstable, or likely to become unstable.

Non Displaced Distal Radial Fracture

C.15.c.i Immobilization

C.15.c.i.a Cast Immobilization for *Non-displaced* or Minimally Displaced Distal Radius Fractures

Recommended - Cast immobilization for 6 weeks.

Evidence for Immobilization/Fixation for Non-displaced Colles' Fracture

Displaced Distal Radial Fracture

Distal radial fractures with radiographic measurements of 10° or more of dorsal angulation, more than 2 mm of radial shortening or with any degree of unstable fractures are defined as fractures with bone loss or bone involvement that will not allow for structural integrity without the use of internal or external fixation of the bone.

C.15.c.i.b Closed Reduction and Casting for Displaced Distal Radial Fractures

Recommended – reduction and casting of fractures which are stable on reduction

Evidence for the Use of Closed Reduction Technique for Distal Radial Fractures

C.15.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.15.d.i Therapy - Active

C.15.d.i.a Therapeutic Exercise after Cast Removal for Acute Colles' Fracture

Recommended – for patients with functional deficits or those unable to return to work

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.15.d.i.b Education after Cast Removal for Acute Colles' Fracture

Recommended – for select patients

C.15.d.ii Therapy - Passive

C.15.d.ii.a Low Frequency Electromagnetic Fields to Stimulate Bone Healing of Distal Radial Fractures

Not Recommended - to stimulate bone healing in patients with non-displaced fractures

Evidence for the Use of Electromagnetic Fields for Distal Radial Fractures

C.15.e Surgery

C.15.e.i Closed Reduction

Recommended - for treatment of severely displaced extra-articular fractures which are stable on reduction

C.15.e.ii Medullary Pinning (k-wire) or Intramedullary Fixation Techniques

Recommended - In select patients

C.15.e.iii Open Reduction and Internal Fixation

Recommended - if fracture remains unstable by other treatment methods.

C.15.e.iv Triangular Fibrocartilage Complex (TFCC) Repair for Distal Radial Fractures

Not Recommended - Triangular Fibrocartilage Complex (TFCC) Repair for Distal Radial Fractures.

C.15.e.v Hardware Removal

Recommended- In select cases where there is hardware placed, subsequent hardware removal is indicated, as per doctor / patient preference.

Indications in cases as per doctor / patient preference where there is 1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

Evidence for Surgery for Displaced Distal Forearm Fractures

C.15.e.vi Cast Immobilization

Recommended - for treatment of extra-articular fractures or distal forearm fractures that include moderately displaced extra-articular fractures, which are stable on reduction non-comminuted or non-displaced intra-articular fractures.

C.16 Ganglion Cyst

Ganglion cysts occur in nearly any joint of the hand and wrist, they account for 50 to 70 % of all wrist masses identified and most are asymptomatic. Other causes include giant cell tumors also known as localized nodular tenosynovitis and fibrous xanthoma, epidermal inclusion cysts and fibromas.

C.16.a Diagnostic Studies

Generally, diagnosis is based on physical examination findings. Diagnosis is usually confirmed upon aspiration of mucinous fluid from the mass.

C.16.a.i X-Rays

Recommended - to diagnose dorsal or volar wrist ganglia in select patients

Indications –to evaluate patients with ganglia occurring in the context of trauma (fractures, dislocations, and sprains)

Frequency/Duration – Obtaining x-rays once is generally sufficient.

Not Recommended – for routine use to evaluate non traumatic dorsal or volar wrist ganglia

Evidence for the Use of X-rays for Diagnosis of Wrist Ganglia

C.16.a.ii MRI

Not Recommended – for routine evaluation of wrist pain with suspected occult dorsal or volar wrist ganglia.

Recommended - for select patients who have had persistence of pain lasting at least three weeks, unresponsive to treatment (injections or splinting) where an occult ganglion cyst is suspected.

Rationale for Recommendation- MRI may be useful in distinguishing synovitis from ganglion, which may be helpful in determining the course of treatment.

Evidence for the Use of MRI for Evaluation of Wrist Pain with Suspected Occult Dorsal or Volar Wrist Ganglia

C.16.a.iii Ultrasound

Not Recommended – is generally not recommended for the evaluation of chronic wrist pain with suspected occult dorsal or volar wrist ganglia.

Recommended- for the evaluation of chronic wrist pain with suspected occult dorsal or volar wrist ganglia in whom an MRI is contraindicated (MRI is preferred).

Evidence for the Use of Ultrasound for Evaluation of Chronic Wrist Pain with Suspected Occult Dorsal or Volar Wrist Ganglia

C.16.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.16.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Wrist Ganglia Pain

Recommended - for treatment of acute, subacute, or chronic wrist ganglia pain.

Indications – For acute, subacute, or chronic wrist ganglia pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.16.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.16.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.16.b.iv Acetaminophen for Treatment of Wrist Ganglia Pain

Recommended - for treatment of wrist ganglia pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with wrist ganglia pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.16.b.v Opioids

Not Recommended – for acute, subacute, or chronic radial nerve entrapment pain.

C.16.c Treatments

C.16.c.i Conservative Management for Acute Asymptomatic Wrist and Hand Ganglia

Recommended - as first-line management for asymptomatic ganglia as the natural history for spontaneous resolution is more than 50%, and in recognition of the high recurrence rate of most other treatment strategies.

Rationale for Recommendation - In the asymptomatic patient, it is reasonable to provide patients reassurance that the mass is benign, and that the natural course is for most to resolve without treatment, making waiting a reasonable option.

Evidence for Non-Operative Management for Acute Asymptomatic Wrist and Hand Ganglia

C.16.c.ii Aspiration (without Other Intervention) for Ganglia Related Pain

Recommended - as it may result in immediate of ganglia related pain.

Duration – One aspiration is recommended. There is no recommendation on how many times aspiration should be attempted before advancing to other interventions..

Evidence for Aspiration for Acute Cosmetic and Ganglia Related Pain

C.16.c.iii Aspiration with Steroids

Not Recommendation - the addition of steroids with aspiration.

Evidence for Aspiration with Steroids

C.16.c.iv Aspiration and Multiple Punctures of Cyst Wall

Not Recommended - as it does not provide improved benefit over simple aspiration.

Rationale for Recommendation

C.16.c.v Immobilization

C.16.c.v.a Splinting after Aspiration for Acute or Subacute Dorsal or Volar Wrist Ganglia

Not Recommended - after aspiration for the treatment of acute or subacute dorsal or volar wrist ganglia.

Evidence for use of Splinting after Aspiration for Treatment of Dorsal or Volar Wrist Ganglia

C.16.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.16.d.i Therapy: Active

C.16.d.i.a Therapeutic Exercise – Acute

Not Recommended – for acute ganglion cyst

Rationale for Recommendation - Exercise is generally not indicated acutely; however, exercise may be needed in the recovery or post-operative phases. Functional goals should include increased grip strength, key pinch strength, range of motion, advancing work abilities.

C.16.d.i.b Therapeutic Exercise – For Residual Deficits

Recommended – particularly post-operatively

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

Evidence for the Use of Exercise for Upper Extremity Ganglia

C.16.e Injection Therapy

C.16.e.i Hyaluronidase Instillation after Aspiration

Not Recommended – installation of hyaluronidase into the cystic structure after aspiration.

Evidence for Installation of Hyaluronidase into Cystic Structure

C.16.e.ii Aspiration and Sclerosing Agents

Not Recommended – use of sclerosing agents such as phenol and hypertonic saline, which when instilled are intended to result in scarring and closure of the cystic potential space

Evidence for Use of Aspiration and Sclerosing Agents

C.16.f Surgery

C.16.f.i Surgical Excision for Subacute or Chronic Wrist-Ganglia

Recommended – in select patients for the treatment of subacute or chronic wrist ganglia.

Evidence for Surgical Excision of Upper Extremity Ganglia

Evidence for Arthroscopic versus Open Excision for Ganglia

C.17 Hand / Arm Vibration Syndrome (HAVS)

The term “hand arm vibration syndrome (HAVS)” has been used since the 1980s to describe the constellation of adverse physiological responses causally associated with high-amplitude vibratory forces, such as those experienced through the use of various hand tools including pneumatic drills, riveters and chain saws or from vibratory rich activities such

as driving off-road vehicles. Other terms commonly used to describe these responses include Raynaud's phenomenon of occupational origin, white fingers, dead fingers, traumatic vasospastic disease (TVD), and "vibration-induced white finger."

The adverse effects of HAVS are characterized by circulatory disturbances associated with digital arteriole sclerosis and manifest as vasospasm with local finger blanching; sensory and motor disturbances manifest as numbness, loss of finger coordination and dexterity, clumsiness and inability to perform intricate tasks; and musculoskeletal disturbances manifest as swelling of the fingers, bone cysts and vacuoles. There are also several reports of association of CTS with HAVS and exposure to vibration.

Epidemiologic evidence indicates there is a latency period of from 1 to 16 years of exposure before onset of HAVS, with a trend for decreasing prevalence as changes in work-practice and anti-vibratory tools and dampening actions have been implemented..

The pathophysiologic changes related to vibration are initially reversible, but with increasing duration and intensity of exposure, the disorder may continue to progress or become permanent.

C.17.a Diagnostic Studies

C.17.a.i Cold Provocation Test, Cold Stress Thermography (Finger Skin Temperature, Infrared, Dynamic Infrared, Laser Doppler Imaging), Finger Systolic Blood Pressure, Vibrotactile Threshold Testing, Thermal Aesthesiometry, or Nerve Conduction Velocity Studies to Diagnose Hand Arm Vibration Syndrome

Not Recommended – to diagnose HAVS

Evidence for Special Studies for HAVS

C.17.a.ii Serologic Tests (Thrombomodulin, Soluble Intracellular Adhesion Molecule 1 [s1-CAM 1]) to Diagnose Hand Arm Vibration Syndrome

Not Recommended - to diagnose HAVS.

C.17.a.iii Testing for Connective Tissue Disorders

Not Recommended - to diagnose HAVS.

Rationale for Recommendations - There does not appear to be any serologic tests that currently provide objective evidence or staging of HAVS.

Evidence for the Use of Serologic Testing or Connective Tissue Disorders Testing

C.17.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol)

may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.17.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic HAVS Pain

Recommended - for treatment of acute, subacute, or chronic HAVS pain.

Indications – For acute, subacute, or chronic HAVS pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.17.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.17.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the

potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.17.b.iv Acetaminophen for Treatment of HAVS Pain

Recommended - for treatment of HAVS pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with HAVS pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.17.b.v Opioids

Not Recommended – for acute, subacute, or chronic HAVS pain.

C.17.c Treatments

The most prudent form of treatment is to first remove or reduce the exposure to vibration. Smoking has been identified as a risk factor for HAVS.

C.17.c.i Smoking Cessation

Recommended – smoking is identified as a **risk factor**.

Other common advice based on the proposed pathophysiology of vasospasm includes avoidance of beta-blockers, sympathetic stimulants including caffeine, decongestants and amphetamines as they may act as potential triggers. Further, maintenance of hand and body temperature in cold environments may help avoid or reduce the risk of symptoms.

C.17.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective

functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.17.d.i Therapy:Active

C.17.d.i.a Therapeutic Exercise

Recommended - for the treatment of functional deficits related to HAVS.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

Evidence for the Use of Exercise for HAVS

C.17.e Work Activities

C.17.e.i Vibration Exposure Work Restrictions for HAVS

Recommended- For patients with HAVS, it is recommended that their work be restricted to those tasks that do not involve high-amplitude, low-frequency vibration exposures from hand-held tools.

Indications – HAVS from high-amplitude, low-frequency vibration exposures through vibrating hand-held tools.

C.17.e.ii Cold Exposure Work Restrictions for HAVS

Recommended- for select patients with HAVS, it is recommended that their work be restricted to those tasks that do not involve cold exposures.

Indications – HAVS that is not controlled through avoidance of vibration exposures, or patients having recurring problems with vasospasm or other complications that are unresolved with other treatments.

C.18 Laceration Management

The primary purpose of wound and laceration management is to avoid infection, detect if a nerve injury has occurred, manage tendon lacerations, and achieve a cosmetically acceptable result with the highest degree of function and patient satisfaction.

C.18.a Diagnostic Studies

C.18.a.i X-Rays

Recommended - for the evaluation of traumatic injury resulting in skin lacerations to rule out fracture or if a radiopaque foreign body is suspected.

Evidence for the Use of X-ray for Evaluation of Lacerations with Suspected Fracture or Foreign Body

C.18.a.ii Ultrasound

Recommended - for evaluating suspected radiolucent materials or as an alternative test when radiopaque foreign body is suspected but not detected on x-ray images.

Evidence for the Use of Ultrasound for Evaluation of Suspected Superficial Foreign Bodies

C.18.a.iii CT

Not Recommended - for suspected superficial foreign bodies.

Recommended- for the evaluation of suspected radiolucent materials and as an alternative test when radiopaque foreign body is suspected but is not detected on x-ray images or ultrasound.

Evidence for the Use of CT for Evaluation of Suspected Superficial Foreign Bodies

C.18.b Medications

C.18.b.i Antibiotic Prophylaxis

Not Recommended - for uncomplicated hand and forearm lacerations.

Evidence for the Use of Antibiotic Prophylaxis

C.18.b.ii Non-Steroidal Anti-Inflammatory Drugs/Acetaminophen

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.18.b.iii Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Upper Extremity Post-Laceration Repair Pain

Recommended - for treatment of acute, subacute, or chronic upper extremity post-laceration repair pain.

Indications – For acute, subacute, or chronic upper extremity post-laceration repair pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.18.b.iv NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.18.b.v NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.18.b.vi Acetaminophen for Treatment of Upper Extremity Post-Laceration Repair Pain

Recommended - for treatment of upper extremity post-laceration repair pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with upper extremity post-laceration repair pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for Upper Extremity Post-Laceration Repair Pain

C.18.b.vii Opioids

Limited Use of Opioids for Acute and Post-Laceration Repair Pain Management

Recommended – for limited use (less than seven days) for acute and post-laceration repair pain management as adjunctive therapy to more effective treatments.

Indications: For acute injury and post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen, elevation) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-laceration repair patients with primary use at night to achieve sleep post-laceration repair.

C.18.c Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.18.c.i Therapy:Active

C.18.c.i.a Therapeutic Exercise

Recommended - for the treatment of functional deficits related to lacerations.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.19 Human Bites, Animal Bites and Associated Lacerations

Although most bites occur from animals known to the victim, occupations that may be at higher risk for animal bites include veterinarians, animal handlers, police officers, utility services personnel who access private property, mail carriers, and other similar professions. Human bites are common in care givers, educators, law enforcement officers,

and in instances of accident or workplace violence that may involve the fist or hand being cut by contact with teeth.

Other than deep destruction of tissue requiring reconstruction, risk of infection is the primary concern for animal bites. There also are other zoonotic diseases such as rabies, cat scratch fever, and human blood borne pathogens exposures that should also be considered. Rates may be higher for wounds of the hand, depth of penetration into the skin, and length of time before wound is irrigated and cleaned. For purposes of this guideline, discussion and recommendations are made based on bites and/or contact with saliva regarding rabies risk to the extremities or trunk as well.

C.19.a Physical Exam

A careful history for time and location of the bite and/or contact with saliva should be obtained as it will help guide clinical decisions regarding prophylaxis. If possible, information about the type of animal and its health status as well as the circumstances related to why the bite occurred should be obtained. Tetanus and rabies immunization status should be established and prophylaxis given if indicated.

A detailed medical history pertaining to tetanus and in the case of animal bites, exposure to saliva, rabies immunization status, and underlying medical conditions such as diabetes mellitus or other immune-compromising conditions is important. Tetanus immunization (per CDC recommendations) and rabies prophylaxis (per CDC recommendations) should be given if indicated. Most wounds are puncture wounds, but some wounds may be considered for suturing.

C.19.b Diagnostic Studies

C.19.b.i Routine Wound Culture and Sensitivity of Animal and Human Bites

Not Recommended - as it has not been shown to be an effective predictor for infection or subsequent treatment of infected wounds.

Evidence for the Use of Bite Wound Cultures and Sensitivity of Animal and Human Bites

C.19.c Medications

C.19.c.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Animal or Human Bites Pain

Recommended - for treatment of acute, subacute, or chronic animal or human bites pain

Indications – For acute, subacute, or chronic wrist sprain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.19.c.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.19.c.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.19.c.iv Acetaminophen for Treatment of Animal and Human Bites Pain

Recommended - for treatment of animal and human bites pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with animal and human bites pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

C.19.c.v Opioids

Not Recommended – for the treatment of animal and human bites pain

C.19.d Treatments

C.19.d.i Initial Care

C.19.d.i.a Blood Borne Pathogen Protocol for Human Bites

Recommended - exposures that could be considered high risk for viral blood borne pathogen transmission be evaluated and treated according to blood borne pathogen protocols.

Rationale for Recommendation- Exposures that could be considered high risk for transmitting viral blood borne pathogens (HIV, HBV, HCV), such as a traumatic bite lacerations should be considered for testing and prophylaxis according to standard protocols particularly as injuries with HIV contaminated blood carry substantially reduced risk of transmission if prophylactic anti-virals are administered in a timely manner.

C.19.d.i.b Prophylactic Antibiotics for Dog Bite Wounds

Recommended - for treatment of dog bite wounds.

Indication – All dog bites.

Dose/Frequency – Different antibiotics have been used in the quality studies, including penicillin VK, cloxacillin, dicloxacillin, erythromycin, co-trimoxazole, cephalexin, and amoxicillin/clavulnate. Strong Gram positive coverage is required

Evidence for the Treatment of Dog Bites

C.19.d.i.c Prophylactic Antibiotics for Treatment of Human Bite Wounds.

Recommended - for treatment of human bite wounds.

Rationale for Recommendation - Given the reported higher incidence of wound infections related to human bites, the balance of evidence suggests prophylactic treatment is appropriate. Pathogens are usually gram-positive bacteria; prophylactic coverage from a broad-spectrum oral antibiotic is suggested to cover most typical staphylococcal and streptococcal species.

Evidence for the Treatment of Human Bites

C.19.d.i.d Prophylactic Antibiotics for Treatment of Cat Bite Wounds.

Recommended - for treatment of cat bite wounds.

Rationale for Recommendation - Reported incidence rates of infections from cat bites is 20 to 40%, and complications related to cat bites may be more significant. Therefore, broad spectrum antibiotics that include coverage for *Pasteurella multocida*, which is the most common pathogen contracted from cat bites, may be indicated.

Evidence for the Use of Prophylactic Antibiotics for Cat Bite Wounds

C.20 Hand / Finger Osteoarthritis

For most purposes, a history and physical examination is sufficient but sometimes x-rays are used. X-rays may be used to document the degree and extent of involvement. However, x-rays can be negative in those with symptomatic osteoarthritis or may demonstrate evidence of disease among those who are asymptomatic.

C.20.a Diagnostic Studies

C.20.a.i X-Rays to Evaluate Hand Osteoarthritis

Recommended – in select patients to define objective evidence of the extent of hand osteoarthritis.

Rationale for Recommendation - Most patients do not require x-rays for diagnosis and can be managed clinically. However, in select cases, x-rays are helpful and may assist in diagnosing and treating the condition.

Evidence for the Use of X-rays for Hand/Finger Osteoarthritis

C.20.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol)

may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.20.b.i Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic upper Hand Osteoarthritis Pain

Recommended - for treatment of acute, subacute, or chronic hand osteoarthritis pain.

Indications – For acute, subacute, or chronic hand osteoarthritis pain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.20.b.ii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.20.b.iii NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for

primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.20.b.iv Acetaminophen for Treatment of Hand Osteoarthritis Pain

Recommended - for treatment of hand osteoarthritis pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with hand osteoarthritis pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the Use of NSAIDs and Acetaminophen for Hand Osteoarthritis

C.20.b.v Topical NSAIDs

May achieve tissue levels that are potentially therapeutic. Overall the low level of systemic absorption can be advantageous, allowing the topical use of these medications when systemic administration is relatively contraindicated (such as patients with hypertension, cardiac failure, peptic ulcer disease or renal insufficiency).

Recommended - to control pain associated with hand osteoarthritis.

Indications – Mild, moderate, or severe hand osteoarthritis.

Frequency/Duration – See manufacturer's recommendation.

Indications for Discontinuation – Resolution, intolerance, adverse effects, or lack of benefits.

Evidence for the Use of Topical NSAIDs for Hand Osteoarthritis

C.20.b.vi Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol)

Not Recommended – for acute, subacute, or chronic hand/finger osteoarthritis pain.

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

Complimentary / Alternative Therapies

C.20.b.vii Complimentary/ Alternative Therapies

Not Recommended - Glucosamine, chondroitin sulfate, methyl-sulfonyl methane, diacerein (diacerhein, diacetylrhein), harpagophytum, avocado soybean unsaponifiables, ginger, oral enzymes, and rose hips are often classified as complementary and alternative therapies that are sometimes used by patients for treatment of osteoarthritis.

C.20.b.viii Capsaicin

Recommended - for treatment of chronic hand osteoarthritis or acute flares of osteoarthritis.

Indications – Hand osteoarthritis pain or acute flares (study has also included rheumatoid arthritis patients).

Frequency/Duration – Up to 4 times a day.

Dose – See manufacturer’s recommendation.

Indications for Discontinuation – Excessive burning of the skin or other intolerance. Not recommended for continual use, rather periods without use have been recommended.

Evidence for the Use of Complementary and Alternative Therapies for Hand Osteoarthritis

C.20.c Treatment

C.20.c.i Splinting

Recommended - for acute flares or chronic hand osteoarthritis.

Indications – Hand osteoarthritis symptoms insufficiently treated with NSAIDs, acetaminophen, and/or topical medications.

C.20.c.ii Injection Therapy

C.20.c.ii.a Intraarticular Glucocorticosteroid Injections

Recommended – in select patients for the treatment of subacute or chronic hand osteoarthritis.

Indications – Moderately severe or severe hand osteoarthritis pain with insufficient control with NSAID(s), acetaminophen, and potentially splinting and/or exercise. Its usual purpose is to gain sufficient relief to either resume medical management or to delay operative intervention.

Frequency/Duration – One injection should be scheduled, rather than a series of three.

Indications for Discontinuation – In patients who respond with a pharmacologically appropriate several weeks of temporary partial relief of pain, but who then have worsening pain and function, a repeat injection is an option. If there has not been a response to a first injection, a second injection is not recommended. However, if the physician believes the medication was not well placed and/or if the underlying condition is so severe that one steroid bolus could not be expected to adequately treat the condition, a second injection may be indicated. There are not believed to be benefits beyond approximately three injections in a year.

Rationale for Recommendations - Intraarticular Glucocorticosteroid Injections are a short to intermediate intervention with approximately three months of benefit. They are recommended as an option for treatment of hand OA patients particularly after inadequate results from NSAID trials or other non-operative interventions.

C.20.c.ii.b Intraarticular Hyaluronate Injection

Recommended – in select patients for the treatment of subacute or chronic hand osteoarthritis where other treatments have failed.

Indications – Hand osteoarthritis pain with insufficient control with NSAID(s), acetaminophen, and potentially splinting and/or exercise. Its usual purpose is to gain sufficient relief either to resume medical management or to delay operative intervention.

Dose/Frequency – See manufacturer’s recommendations.

Indications for Discontinuation – Sufficient relief to not require additional injection(s), failure to improve, or allergic reactions.

Evidence for the Use of Intraarticular Injections for Hand Osteoarthritis

C.20.c.ii.c Prolotherapy Injections

Not Recommended - the use of prolotherapy injections for treatment of subacute or chronic hand osteoarthritis.

Evidence for the Use of Injections for Hand Osteoarthritis

C.20.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.20.d.i Therapy - Active

C.20.d.i.a Therapeutic Exercise

Recommended - for treatment of acute flares or chronic hand osteoarthritis.

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.20.d.ii Therapy - Passive

C.20.d.ii.a Self-Application of Ice

Recommended - for chronic hand osteoarthritis.

C.20.d.ii.b Self-Application of Heat

Recommended - for acute flares or chronic hand osteoarthritis.

Indications – Hand osteoarthritis symptoms insufficiently treated with NSAIDs, acetaminophen, and/or topical medications.

Frequency/Dose – Self-applications of heat, most commonly 15 to 20 minutes, 3 to 5 times a day.

C.20.d.ii.c Low-level laser therapy

Not Recommended - for treatment of hand osteoarthritis.

Evidence for the Use of Low-Level Laser Therapy for Hand Osteoarthritis

Evidence for Splinting and Exercise for Hand Osteoarthritis

C.20.e Surgery

Various surgical procedures are utilized to treat patients with hand osteoarthritis. Among these are arthrodesis, arthroplasty and various other reconstructive procedures.

C.20.e.i Reconstructive Surgery

Recommended - for treatment of select patients with trapeziometacarpal arthrosis.

C.20.e.ii Trapeziectomy

Recommended - for treatment of thumb CMC joint osteoarthritis. The alternative approaches are at the discretion of the surgeon.

C.20.e.iii Fusion

Recommended - for treatment of select patients with hand osteoarthritis

Rationale for Recommendation - Joint fusion is generally helpful for patients under age 40 with significantly symptomatic osteoarthritis and vigorous work activities, who fail to achieve sufficient relief from other treatments.

C.20.e.iv Hardware Removal

Recommended - In select cases where there is hardware placed, subsequent hardware removal is indicated, as per doctor / patient preference.

Indications: in cases as per doctor / patient preference where there is 1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

C.21 Dupuytren's Disease

There is insufficient evidence relating Dupuytren's disease to occupational activities

Dupuytren's disease is a disorder of the hand involving the formation of fibrosis (scar tissue) in the palm and digits with subsequent contractures. It has strong age and inheritance patterns. Purported risks include the use of alcohol, smoking, diabetes mellitus, and epilepsy. There are some reported associations with both heavy and manual work. To help provide improved care for patients, this disorder is included as an appendix to the Hand, Wrist, and Forearm Disorders Guideline.

C.21.a Treatments

C.21.a.i Injection Therapy

C.21.a.i.a Collagenase Injections

Recommended – in select patients for treatment of Dupuytren's disease.

Indications – Dupuytren's contractures sufficient to result in impairment,

Frequency/Dose – Clostridial collagenase 10,000 U injection; repeat injection(s) at 4 to 6 week intervals for up to 3 injections.

Discontinuation – Resolution of contracture, adverse effects.

Evidence for the use of Collagenase Injections for treatment of Dupuytren's disease

Evidence for the Use of 5-Flourouracil for Dupuytren's Disease

C.21.b Medications

For most patients, ibuprofen, naproxen, or other older generation NSAIDs are recommended as first-line medications. Acetaminophen (or the analog paracetamol) may be a reasonable alternative to NSAIDs for patients who are not candidates for NSAIDs, although most evidence suggests acetaminophen is modestly less effective. There is evidence that NSAIDs are as effective for relief of pain as opioids (including tramadol) and less impairing.

C.21.b.i Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

Recommended - to treat post-operative swelling from surgery for Dupuytren's disease.

C.21.b.ii Non-Steroidal Anti-inflammatory Drugs (NSAIDs) for Treatment of Acute, Subacute, or Chronic Dupuytren's disease Pain

Recommended - for treatment of acute, subacute, or chronic Dupuytren's disease pain

Indications – For acute, subacute, or chronic wrist sprain, NSAIDs are recommended for treatment. Over-the-counter (OTC) agents may suffice and should be tried first.

Frequency/Duration: As needed use may be reasonable for many patients.

Indications for Discontinuation: Resolution of symptoms, lack of efficacy, or development of adverse effects, that necessitate discontinuation.

C.21.b.iii NSAIDs for Patients at High Risk of Gastrointestinal Bleeding

Recommended – for concomitant use of cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers, and proton pump inhibitors for patients at high risk of gastrointestinal bleeding.

Indications: For patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications should be considered, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, elderly, diabetics, and cigarette smokers.

Frequency/Dose/Duration: Proton pump inhibitors, misoprostol, sucralfate, H2 blockers recommended. Dose and frequency per manufacturer. There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding.

Indications for Discontinuation: Intolerance, development of adverse effects, or discontinuation of NSAID.

C.21.b.iv NSAIDs for Patients at Risk for Cardiovascular Adverse Effects

Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should have the risks and benefits of NSAID therapy for pain discussed.

Recommended - Acetaminophen or aspirin as the first-line therapy appear to be the safest regarding cardiovascular adverse effects.

Recommended - If needed, NSAIDs that are non-selective are preferred over COX-2 specific drugs. In patients receiving low-dose aspirin for primary or secondary cardiovascular disease prevention, to minimize the potential for the NSAID to counteract the beneficial effects of aspirin, the NSAID should be taken at least 30 minutes after or 8 hours before the daily aspirin.

C.21.b.v Acetaminophen for Treatment of Acute, Subacute or Chronic Dupuytren's disease Pain

Recommended - for treatment of Dupuytren's disease pain, particularly in patients with contraindications for NSAIDs.

Indications: All patients with animal and human bites pain, including acute, subacute, chronic, and post-operative.

Dose/Frequency: Per manufacturer's recommendations; may be utilized on an as-needed basis. There is evidence of hepatic toxicity when exceeding four gm/day.

Indications for Discontinuation: Resolution of pain, adverse effects or intolerance.

Evidence for the use of NSAIDs and Acetaminophen for Post-Op Dupuytren's Disease

C.21.b.vi Opioids

Recommended – for limited use (not more than seven days) for post-operative pain management as adjunctive therapy to more effective treatments.

Indications: For post-operative pain management, a brief prescription of opioids as adjuncts to more efficacious treatments (especially NSAIDs, acetaminophen) is often required, especially nocturnally.

Frequency/Duration: Prescribed as needed throughout the day, then later only at night, before weaning off completely.

Rationale for Recommendation: Some patients have insufficient pain relief with NSAIDs, thus judicious use of opioids may be helpful, particularly for nocturnal use. Opioids are recommended for brief, select use in post-operative patients with primary use at night to achieve sleep post-operatively.

C.21.c.Other

C.21.c.i Radiotherapy

Not Recommend - to prevent the progression of Dupuytren's disease.

Evidence for use of Radiotherapy for Prevention of Progression of Dupuytren's Disease

C.21.d Rehabilitation

Rehabilitation (supervised formal therapy) required as a result of a work-related injury should be focused on restoring functional ability required to meet the patient's daily and work activities and return to work; striving to restore the injured worker to pre-injury status in so far as is feasible.

Active therapy requires an internal effort by the patient to complete a specific exercise or task. Passive therapy are those interventions not requiring the exertion of effort on the part of the patient, but rather are dependent on modalities delivered by a therapist. Generally passive interventions are viewed as a means to facilitate progress in an active therapy program with concomitant attainment of objective functional gains. Active interventions should be emphasized over passive interventions.

The patient should be instructed to continue both active and passive therapies at home as an extension of the treatment process in order to maintain improvement levels.

Assistive devices may be included as an adjunctive measure incorporated into the rehabilitation plan to facilitate functional gains.

C.21.d.i Therapy: Active

C.21.d.i.a Therapeutic Exercise - for Post-operative Dupuytren's disease

Recommended - for the treatment of post-operative Dupuytren's disease crush injuries

Frequency/Dose/Duration –Total numbers of visits may be as few as two to three for patients with mild functional deficits or up to 12 to 15 with more severe deficits with documentation of ongoing objective functional improvement.

When there are ongoing functional deficits, more than 12 to 15 visits may be indicated if there is documentation of

functional improvement towards specific objective functional goals (e.g., increased grip strength, key pinch strength, range of motion, advancing ability to perform work activities). As part of the rehabilitation plan a home exercise program should be developed and performed in conjunction with the therapy.

C.21.e Surgery

C.21.e.i **Surgery for Treatment of Dupuytren’s Contracture**

Recommended - using the technique of regional or selective fasciectomy for contracture due to Dupuytren’s disease.

C.21.e.ii **Percutaneous Needle Fasciotomy (aka Needle Aponeurotomy)**

Recommended - for patients with contractures due to Dupuytren’s disease. However there is a higher recurrence rate with fasciotomy.

C.21.e.iii **“Firebreak” Full-thickness Skin Graft for Dupuytren’s Contracture, Extensive Fasciectomy, or Dermofasciectomy for Treatment of Dupuytren’s Contracture**

Not Recommended - for routine Dupuytren’s contracture surgery.

Recommended- in select patients for severe_recurrent cases of Dupuytren’s Contracture.

Evidence for Dupuytren’s Disease – Surgery

Appendix One - Evidence Tables

Evidence for the Use of Ergonomic Interventions

There is 1 high-(365) and 5 moderate-quality(342, 362, 363, 366, 370) RCTs incorporated into this analysis. There are 4 low-quality RCTs(372, 388-390) in Appendix 2.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Rempel 2012 Cluster RCT Sponsored in part by grant from National Institute for Occupational Safety and Health (CDC). No mention of COI.	8.0	N = 110 (100 females/10 males) dentists and dental hygienists. Mean±SD age: narrow handle 42.9±10.8 years; wide handle 46.6±9.8 years.	Heavy Instrument, Narrow Handle (34g, 8mm diameter handle) (n = 56) vs. Light Instrument, Wide Handle (14g (curette tips and 11mm–diameter handle) (n = 54). Follow-up for 4 months.	Mean (SEM) adjusted score change shoulder pain: Heavy instrument 0.19 (0.16) vs. light instrument 0.52 (0.17); p = 0.02. Mean (SEM) adjusted score change wrist/hand pain: Heavy instrument 0.14 (0.17) vs. light 0.40 (0.18); p = 0.15.	“To prevent or reduce arm pain, practitioners should consider using lightweight instruments with large diameters when performing scaling and root planning procedures.”	Data suggest use of wider handled and lighter instrument associated with improved pain scores for distal upper extremity and shoulder.
Rempel 1999 RCT Sponsored by Northwest Trade Adjustment Assistance Center and by Key Tronic Corporation. No mention of COI.	7.5	N = 20 (13 females/7 males) with hand or wrist symptoms who used keyboard ≥10 hours per week. Mean age 42.6 years.	Keyboard A- Protouch keyboard, Key Tronic Corporation) (n = 12) vs. Keyboard B-MacPro Plus keyboard with 2-ounce rubber domes, Key Tronic Corporation (n = 12). Both keyboards were of conventional layout (101 keys). Follow-up for 3 months.	Pain ratings significantly lower (p = 0.05) for keyboard A (6 weeks: 2.7 vs. 2.9; 12 weeks: 1.9 vs. 4.3).	“We conclude that use of keyboard A for 12 weeks led to a reduction in hand pain and an improved physical examination finding when compared with keyboard B.”	Small sample size. Keyboard associated with fewer symptoms required modestly greater force (0.71N vs. 0.58N) and greater displacement (1.69mm vs 0.58mm) to activate. Suggests lower typing force may not be helpful.
Rempel 2006 RCT Sponsored in part by a grant (RO1 OH04253) from Centers for Disease Control/National Institutes for Occupational Safety and Health. COI: Dr Rempel has done consulting work for Logitech Corp., company which markets trackball tested in the study.	5.5	N = 182 (173 females and 8 males) customer service works who perform 20 hours or more of computer work per week. No neck, shoulder or upper extremity workers compensation claims. Mean Age was 40.02 years.	Ergonomic Training only: included conventional recommendations such as chair height and position (n = 46) vs Ergonomic training and trackball (n = 45) vs Ergonomic training and arm board-arm board is wraparound, padded arm support that attaches to top, front edge of work surface (n = 46) vs Ergonomic training and trackball and arm board (n = 45). Follow-up for 1 year.	Sixty-three (63) participants diagnosed with 1 or more incident MSDs. 12 month incidence rates for any upper body MSD by intervention group (47.7% vs. 35.7% vs. 29.5% vs. 31.8%). Adjusted hazard rate ratios for armboard for neck/shoulder disorders (HR = 0.49, 95% CI 0.24 to 0.97), reduced neck/shoulder pain (p = 0.01) and right upper extremity pain (p = 0.002).	“Providing a large forearm support combined with ergonomic training is an effective intervention to prevent upper body musculoskeletal disorders and reduce upper body pain associated with computer work among call centre employees.”	Dropout rate 31.3%. Return on investment estimated at 10.6 months.
Conlon 2008 RCT	5.0	N = 206 (57 females/149 males) engineers who worked at a computer for at least 20 hours per	Conventional Mouse Group (n = 52) vs. Alternative Mouse Group- neutral forearm posture (n = 52) vs. Board and conventional mouse- Forearm	No significant differences for use of an alternative mouse or use of forearm ergonomic support board vs. use of conventional mouse for both crude and adjusted hazard ratios (p> 0.05).	“In engineers who use a computer for more than 20 h per week, a forearm support board may reduce right upper extremity discomfort attributed to computer use.”	No meaningful differences in outcomes between conventional mouse and experimental mouse designs.

No mention of sponsorship or COI.		week. Mean Age 42.87 years.	support board (n = 51) vs. Board and alternative mouse- Forearm support board (n = 52). Follow-up for 1 year.	Unadjusted model showed significant decrease in discomfort score in right upper extremity using forearm support board; -0.41 (-0.83 to -0.001) (p ≤0.05).		
Gerr 2005 RCT Sponsored by the US National institute for Occupational Safety and Health. No COI.	4.5	N = 362 (279 females/83 males) workers who operated a computer for at least 15 hours or more per week. Age ≥18 years.	Group A: Alternate Intervention based on protective factors for both neck/shoulder and hand/arm (n = 122) vs. Group B: Conventional Intervention based on recommendations from OSHA, NIOSH and private industry (n = 125) vs. Group C- Control group, no intervention (n = 115). Follow-up for 6 months.	Among other differences, alternative involved greater elbow extension and keyboard position further recessed from edge of desk. No significant differences in distal upper extremity or neck/shoulder symptoms (p >0.05).	“This study provides evidence that two specific workplace postural interventions are unlikely to reduce the risk of upper extremity musculoskeletal symptoms among computer users.”	Suggests 90° posture not superior.
Tittiranonda 1999 RCT No mention of sponsorship or COI.	4.5	N = 80 (46 females/34 males) with CTS and/or tendonitis. Mean age 43.65.	Placebo Group- Standard Keyboard (slope 8.0°) (n = 20) vs. Keyboard 1- Apple adjustable keyboard (slope 3.8 to 7.0°) (n = 20) vs. Keyboard 2- Comfort Keyboard System (slope -44.0 to 38.5°) (n=20) vs. Keyboard 3- Microsoft natural keyboard (slope 5.5 or -2.6°) (n = 20). Follow-up for 6 months.	High dropouts among keyboard that was completely split in two with sharply angled, but somewhat adjustable slopes. Changes in overall pain severity: placebo (-0.29±1.5) vs. split1 (0.52±2.0) vs. split/sharply angled (0.84±1.9) vs. split2 (1.21± 3.1), p = 0.11. More differences present in tendonitis subgroup (p = 0.088) than CTS (p = 0.57).	“These results provide evidence that keyboard users may experience a reduction in hand pain after several months of use of some alternative geometry keyboards.”	CTS and tendonitis were combined. Dropouts high in keyboard group with widely separated hands and more steeply angled surfaces.

Evidence for the Use of Return-to-Work Programs

There is 1 moderate-quality RCT incorporated into this analysis.(394) There is one other study(395) in Appendix 2 (see Chronic Pain Guideline for additional studies).

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Abasolo 2007 RCT Sponsored by grants from Fondo de Investigaciones Sanitarias of the Spanish Ministry of Health. No mention of COI.	4.0	N = 13,077 (gender not specified) workers on sick leave with diagnosis of MSD. Mean age for intervention and control groups: 40.8 and 40.6.	Multifaceted intervention program vs non-interventional control	Mean durations of temporary work disabilities for CTS patients (n = 74) 100.4 in controls vs. 27.8 days in intervention group (p < 0.001).	“The implementation of this type of specialist-run, protocol-based early intervention program would be very beneficial in the treatment of patients with work disability related to MSDs, except for those with knee pain (excluding osteoarthritis).”	Scored for CTS patients within trial. Overall participation rate 62.8%.

Evidence for Work Restrictions

There are 5 moderate-quality RCTs incorporated into this analysis. (342, 362, 363, 366, 370) There are 2 low-quality RCTs in Appendix 2.(389, 390)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: work restriction, ergonomics, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, burning, tingling, itching, numbness, hand, palm, finger, pain controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 37 articles in PubMed, 609 in Scopus, 13 in CINAHL, and 45 in Cochrane Library. We considered for inclusion 3 from PubMed, 3 from Scopus, 1 from CINAHL, 0 from Cochrane Library and 6 from other sources. Of the 13 articles considered for inclusion, 7 randomized trials and 6 systematic studies met the inclusion criteria.*

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Rempel 1999 RCT Sponsored by Northwest Trade Adjustment Assistance Center and by Key Tronic Corporation. No mention of COI.	7.5	N = 20 (13 females/7 males) with hand or wrist symptoms who used a keyboard ≥10 hours per week. Mean age 42.6 years.	Keyboard A- Protouch keyboard, Key Tronic Corporation) (n = 12) vs. Keyboard B-MacPro Plus keyboard with 2-ounce rubber domes, Key Tronic Corp. (n = 12). Both keyboards conventional layout (101 keys). Follow-up for 3 months.	Pain ratings significantly lower (p = 0.05) for keyboard A (6 weeks: 2.7 vs. 2.9; 12 weeks: 1.9 vs. 4.3).	“We conclude that use of keyboard A for 12 weeks led to a reduction in hand pain and an improved physical examination finding when compared with keyboard B.”	Small sample size. Keyboard associated with fewer symptoms required modestly greater force (0.71N vs. 0.58N) and greater displacement (1.69mm vs 0.58mm) to activate. This suggests lower typing force may not be helpful.
Rempel 2006 RCT Sponsored in part by grant from Centers for Disease Control/National Institutes for Occupational Safety and Health. COI: Dr Rempel has done consulting work for Logitech Corp., company which markets trackball tested in study.	5.5	N = 182 (173 females/8 males) customer service workers who perform 20 hours or more of computer work per week. No neck, shoulder or upper extremity workers compensation claims. Mean age 40.02 years.	Ergonomic Training only: Included conventional recommendations such as chair height and position (n = 46) vs. Ergonomic training and trackball (n = 45) vs. Ergonomic training and arm board- arm board is a wraparound, padded arm support that attaches to the top, front edge of work surface (n = 46) vs. ergonomic training and trackball and arm board. Follow-up for 1 year.	Sixty-three (63) participants diagnosed with 1 or more incident MSDs. 12 month incidence rates for any upper body MSD by intervention group (47.7% vs. 35.7% vs. 29.5% vs. 31.8%). Adjusted hazard rate ratios for armboard for neck/shoulder disorders (HR = 0.49, 95% CI 0.24 to 0.97), reduced neck/shoulder pain (p = 0.01) and right upper extremity pain (p = 0.002).	“Providing a large forearm support combined with ergonomic training is an effective intervention to prevent upper body musculoskeletal disorders and reduce upper body pain associated with computer work among call centre employees.”	Dropout rate 31.3%. Return on investment estimated at 10.6 months.
Conlon 2008 RCT No mention of sponsorship or COI.	5.0	N= 206 (57 females/149 males) engineers who worked at computer for at least 20 hours per week. Mean age 42.87 years.	Conventional Mouse Group- (n = 52) vs. Alternative Mouse Group- neutral forearm posture (n = 52) vs. Board and conventional mouse- Forearm support board (n = 51) vs. Board and alternative mouse- Forearm support board (n = 52). Follow-up for 1 year.	No significant differences for use of alternative mouse or forearm ergonomic support board vs. use of conventional mouse for crude and adjusted hazard ratios (p>0.05). Unadjusted model showed significant decrease in discomfort score in right upper extremity using forearm support board; -0.41 (-0.83 to -0.001) (p ≤0.05).	“In engineers who use a computer for more than 20 h per week, a forearm support board may reduce right upper extremity discomfort attributed to computer use.”	No meaningful differences in outcomes between conventional mouse and experimental mouse designs.
Gerr 2005 RCT Sponsored by US National institute	4.5	N = 362 (279 female/83 male) workers who operated a computer at least 15 hours or more per week. Age ≥18 years.	Group A: Alternate Intervention- based on protective factors for both neck/shoulder and hand/arm (n = 122) vs. Group B: Conventional Intervention based on recommendations from OSHA, NIOSH and	Among other differences, alternative involved greater elbow extension and keyboard position further recessed from edge of desk. No significant differences in distal upper extremity or neck/shoulder symptoms (p>0.05).	“This study provides evidence that two specific workplace postural interventions are unlikely to reduce the risk of upper extremity musculoskeletal symptoms among computer users.”	Suggests 90° posture not superior.

			private industry (n = 125) vs. Group C- Control group, no intervention (n = 115). Follow-up for 6 months.			
Tittiranonda 1999 RCT No mention of sponsorship or COI.	4.5	N = 80 (46 female/34 male) with CTS syndrome and/or tendonitis. Mean age 43.65 years.	Placebo Group- Standard Keyboard (slope 8.0°) (n = 20) vs. Keyboard 1: Apple adjustable keyboard (slope 3.8-7.0°) (n = 20) vs. Keyboard 2: Comfort Keyboard System (slope -44.0-38.5°) (n = 20) vs. Keyboard 3: Microsoft natural keyboard (slope 5.5 or -2.6°) (n = 20). Follow-up for 6 months.	High dropouts among keyboard that was completely split in two with sharply angled, but somewhat adjustable slopes. Changes in overall pain severity: placebo (-0.29±1.5) vs. split1 (0.52±2.0) vs. split/sharply angled (0.84±1.9) vs. split2 (1.21± 3.1), p = 0.11. More differences present in tendonitis subgroup (p = 0.088) than CTS (p = 0.57).	“These results provide evidence that keyboard users may experience a reduction in hand pain after several months of use of some alternative geometry keyboards.”	CTS and tendinitis were combined. Dropouts were high in the keyboard group with widely separated hands and more steeply angled surfaces.

Evidence for the Use of Electrodiagnostic Studies

There are 20 moderate-quality studies incorporated into this analysis.(319, 445, 451-453, 455, 456, 459-471) There are 4 low-quality studies in Appendix 2.(472-475)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: electrodiagnostic studies, nerve conduction study (NCS), electromyography (EMG); carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 96 articles in PubMed, 371 in Scopus, 23 in CINAHL, and 23 in Cochrane Library. We considered for inclusion 20 from PubMed, 30 from Scopus, 5 from CINAHL, 6 from Cochrane Library and 30 from other sources. Of the 91 articles considered for inclusion, 67 trials and 7 systematic studies met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Population/ Case Definition	Investigative Test	Gold Standard / Comparative Test	Results	Conclusion	Comments
Dale 2015 Diagnostic Sponsored by CDC/NIOSH and Washington University Institute of Clinical and Translational Sciences Award (CTSA) grant from NCATS of NIH. No COI.	7.0	N = 62 (19 females and 43 males) subjects that originally underwent NC-Stat automated NCS; mean age 33.66 (9.43).	NC-Stat an automated Nerve Conduction Studies (NCS) machine	Traditional NCS using a NeuroMax 1002 device in an electrodiagnostic lab.	Higher agreement between Median nerve parameter rather than Ulnar nerve parameter. Highest receiver operating curve (ROC) area 0.97 and 0.96 for median nerve parameter. 100% sensitivity and 74% specificity for Ulnar Distal Motor latency and Distal sensory latency. Highest specificity in median ulnar sensory difference, 100%.	“In conclusion, the NC-stat device has been previously shown to have excellent agreement with traditional methods of median nerve testing in clinical populations; this study shows that this excellent agreement extends to use in a general worker population with low prevalence of disease.”	Study reports automated nerve conduction study was comparable to the traditional EDS for detection of median nerve conduction abnormalities in a general worker population.
Buch-Jaeger 1994 Diagnostic No mention of sponsorship or COI.	7.0	N = 112 with signs of carpal tunnel, 60 bilaterally. Patients confirmed through clinical analysis. The mean age of 52 years, ranging from 29-81 years.	Nerve Conduction studies (NCS), positive when distal motor latency in the abductor brevis muscle was greater than 4ms.	Clinical evaluation focusing on 11 different criteria including paraesthesiae in territory of median nerve, occasional pain, nocturnal recrudescence of symptoms, numbness leading to clumsiness of hand, Phalen’s test, Tinel’s test, dealt, Vibratory sensibility, Threshold sensibility, Gilliat’s test, McMurthry’s sign, Static 2-point discrimination.	NCS positive in 68 cases (61%) and negative in remaining 44 cases (39%). Of negative NCS patients, 10 spontaneously recovered, 4 unchanged, 5 had symptoms after heavy tasks, 3 thought to be malingering, and 20 diagnosed with other disease. Of NCS confirmed CTS group 33 had surgical findings; 40 (93%) had complete disappearance and intervention.	“Our findings suggest that typical clinical features and positive provocation tests are not sufficient to lead a surgeon to decompress the carpal tunnel, and we feel that electrodiagnostic examination is necessary in every case.”	Study supports nerve conduction studies to be a key component in diagnosis of CTS as other clinical tests have fair sensitivity and specificity.

<p>Atroschi 2003</p> <p>Diagnostic</p> <p>Sponsored by research grants from the Skåne and Kristianstad County Councils. No mention of COI.</p>	<p>7.0</p>	<p>N = 125 (gender not specified) CTS group and symptomatic controls with possible/unlikely CTS (n = 155) and asymptomatic Control group (n = 124) no signs of CTS (n = 124) Mean age 51±14. All participants collected from 3,000 sample in Sweden. Mean age 52 ± 13.</p>	<p>Bilateral Nerve Conduction Tests including median nerve distal motor latency (M) DML. Long Finger-wrist sensory latency, and sensory conduction velocity (SCNV) in forearm, wrist-Palm, and palm digit segments. Also an ulnar nerve small finger-wrist sensory latency.</p>	<p>Patients clinically diagnosed using Phalen’s Test, Tinels Test, recurrent numbness or tingling, and filled out a hand diagram.</p>	<p>Receiving operating Characteristic (ROC) area under curve Median-ulnar nerve SL difference test (Area (95% CI)): 0.80 (0.01-0.08) (p=0.004). Median-ulnar nerve digit-wrist SL difference had a sensitivity of 70%, specificity of 82%, a Positive predictive value of 19%, and a negative predictive value of 98%.</p>	<p>“Using the clinical diagnosis of CTS as the criterion standard, nerve conduction tests had moderate sensitivity and specificity and a low positive predictive value in population-based CTS. Measurement of median-ulnar sensory latency difference had the highest diagnostic accuracy.”</p>	<p>Study suggests nerve conduction study to diagnose CTS had only modest sensitivity and specificity and measuring the median-ulnar sensory latency difference was a better predictor of true CTS diagnosis.</p>
<p>Leffler 2000</p> <p>Diagnostic</p>	<p>6.5</p>	<p>N = 75 symptomatic hands referred to electrophysiological lab; Mean age 49 ± 12 vs. n = 22 asymptomatic volunteers.</p>	<p>An automated electro diagnostic device (AEND).</p>	<p>A conventional diagnostic device conducted within a lab by a neurologists.</p>	<p>Linear regression showing AEND and conventional results correlation was 0.90 (p <0.001). AEND sensitivity for very symptomatic hands 89% specificity 90%. Lower severe had sensitivity of 87%, also 90% specificity.</p>	<p>“This study demonstrated that the Distal Motor latency provided by an AEND is highly correlated with the Distal Motor Latency obtained by conventional testing.”</p>	<p>Study suggests MNW diagnosis is improved with addition of AEND as compared to modeling based solely on clinical findings.</p>

Graham 2008 Diagnostic	6.5	N = 143 clinically diagnosed with CTS	Standard electrodiagnostic tests, Sensory nerve conduction by technician and evaluated by neurologist, use of stringent and Lax criteria used to confirm CTS.	CTS-6 evaluation which is a clinical diagnosis aid.	Using CTS-6 the pretest probability was 0.81 ± 0.22 . After the Stringent Criteria posttest probability was 0.91 and Lax was 0.83. Average change in probability was -0.02 ± 0.10 with stringent and -0.06 ± 0.16 with lax.	“For the majority of patients who are considered to have carpal tunnel syndrome on the basis of their history and physical examination alone, electrodiagnostic tests do not change the probability of diagnosing this condition to an extent that is clinically relevant.”	Study suggests if there is a high CTS probability based on history and physical exam, electrodiagnostic tests do not change the probability of this diagnosis to a clinically meaningful extent.
Pastare 2009 Diagnostic	6.5	N = 66 consecutive patients investigated for sensory hand symptoms. Mean Age; 51 years	Nerve Conduction Studies vs. Ultrasound	Clinical Diagnosis of CTS	Nerve Conduction studies showed greater diagnostic sensitivity than ultrasound; 54 wrists 82% vs. 41 62% for highly likely clinical diagnosis of CTS.	“In summary, our study shows that NCS have better sensitivity in supporting a diagnosis of CTS. However, because of its high positive predictive value, lack of discomfort, and ease of use, US can be used as a screening method for CTS.”	Reports nerve conduction studies superior to sonography in detecting CTS. But, sonography may be used as first-line screening tool if clinical index of suspicion for CTS is high.
Nathan 1993 Diagnostic	6.5	N = 2,334 hands of industrial workers, workers’ compensation patients, and students. Mean age 40.6 years.	Maximum latency difference (MLD) determined by centimetric technique.	Clinical diagnosis of CTS. MLD was compared with 8-cm latency (S8) and 14-cm latency (S14).	MLD most sensitive measurement (86%) and had greatest efficiency of correct classification (84%). The S14 was most specific measurement (94%)	“Based on these findings, we recommend that confirmatory nerve conduction studies be performed in all cases where CTS is suspected.”	Controls younger than CTS group. Study reports maximum latency difference (MLD) most reliable measurement for predicting CTS. Study recommends nerve conduction studies be performed when high index of suspicion for CTS.

Lee 2009 Diagnostic	6.0	N = 153 with clinically suspected CTS. Mean age 52.5±12.3 vs. 100 clinically healthy volunteers; mean age 48.5±11.4.	Electrodiagnostic testing including Median Terminal latency differences, motor conduction study and sensory conduction study.	Clinical criteria and diagnosis was used as the parameter to test for sensitivity.	Sensitivity of top EDX testing: Wrist-Palm Sensory Conduction Velocity (SCV): 90.5%, Distal-Proximal ratio SCV 92.3%, Wrist-Digit 2 SCV 89.1%, Wrist-Digit 3 89.1%. Terminal Latency ratio of Wrist-Palm Motor conduction 81.8%.	“The terminal latency ratio of the wrist to the palm is a valuable technique for the diagnosis of carpal tunnel syndrome, and it requires only a simple additional stimulus compared to existing methods.”	Study suggests median terminal latency ratio in the third finger as the most sensitive technique for detection of CTS.
Concannon 1997 Diagnostic	6.0	N = 349 (460 hands) patients who underwent carpal tunnel release.	Electrodiagnostic Studies	N/A	398/460 hands had positive electrodiagnostic studies. 60 clinical CTS diagnosis but normal electro-diagnostic studies. Phalen’s only significant test with regression coefficient: -0.91; OR 0.40 CI: 0.17 – 0.96 (p = 0.04). Indicated model predicts higher probability of negative electromyogram than positive electromyogram. 76% (n = 348) of affected hands had mild to moderate electrodiagnostic findings, 11% had severe CTS (n = 50), and 13% had normal electrodiagnostic findings. Patients who were older tended to have severe electrodiagnostic findings (p = 0.0001). Significant association between gender and maximal electrodiagnostic findings (p = 0.02). Patients with severe CTS had highest incidence of muscle wasting (22%, p <0.02).	“[E]lectrodiagnostic studies in suspected carpal tunnel syndrome should be reserved for use in the patient with equivocal findings and should not be considered a necessary criterion when history and clinical examination provide this diagnosis.”	Approximately 13% of patients receiving electrodiagnostic studies only to diagnose CTS would be excluded and should be used only in cases of equivocal findings.

Chang 2006 Diagnostic	6.0	N = 280 suspected CTS patients (360 hands).	Median wrist-palm motor conduction velocity (W-P MCV)	Standard sensory conduction techniques	Abnormal hand number, sensitivity (%), and specificity (%) of Motor DL/ Sensory DL (D1)/ Sensory DL (D2)/ Sensory DL (D4)/ W-P MCV/ W-P SCV/ W-P SCT/ median-radial sensory latency difference/ median-ulnar sensory latency difference were: 234, 65, and 99.3/ 289, 80.3 and 98.7/ 261, 72.5 and 99.3/ 276, 76.7 and 100/ 294, 81.7 and 100/ 265, 73.6, and 100/ 291, 80.8 and 100/ 312, 86.7 and 98.7/ 314, 87.2 and 96.7	“W-P MCV is a valuable motor conduction technique for the diagnosis of CTS and it is confirmed again that W-P MCV is equal to or more sensitive than W-P SCV and W-P SCT.”	Data suggest W-P-MCV as being a tool for electrodiagnosis of CTS with reported comparable sensitivity to W-R-SCV and W-P-SCT.
Wang 2013 Diagnostic	6.0	N = 162 CTS patients (248 hands) and 83 controls (166 hands).	Median-to-ulnar comparative Nerve conduction studies: Sensory median-ulnar difference (MS-US), Mixed median-ulnar palm latency difference (PM-PU), and Distal latency differences between second lumbrical and interossei (2L-INT).	N/A	168/248 (67.7%) hands had abnormal findings. 80 (32.3%) hands received 2L-INT, MS-US, and PM-PU additional tests. 88.3% symptomatic hands had at least an abnormal findings. The sensitivity of MS-US/ 2L-INT/ PM-PU were: >0.5 ms in 21.3% of hands/ >0.4 ms in 27.5% of hands/ >0.4 ms in 47.5% of hands. MP-UP had the greatest sensitivity in contrast to L2-INT and MS-US (p = 0.014 and p<0.001). Conventional EDX with PM-PU had a sensitivity of 83%.	“For CTS patients with normal results from the standard methods, PM-PU is a good additional comparative test to further improve diagnostic rate.”	Data suggest PM-PU may be beneficial in testing CTS patients who tested normal from traditional testing methods to further identify true positives.

Lew 2005 Diagnostic	5.5	control healthy hands; Mean Age 44.0 ± 12.9 (n = 44) vs. symptomatic hands suspected of CTS; Mean Age 51.5 ± 18.2 (n = 136).	Nerve Conduction Studies varying in segment length. Sensory Nerve conduction velocity of Long segment from wrist to Digits 1, 2, 3, and 4. transcarpal mixed nerve conduction velocity of Short segment palm to wrist. Transcarpal sensory Nerve Conduction Velocity wrist-digit and palm to digit difference.	Nerve Conduction Study (NCS) results from control group.	Average Sensitivity of the different segment lengths: Long segment 39.5%. Short segment 56%. Two segment 40.5%	“Our Study showed that among the 8 median NCV tests, the short, segment, onset latency-based transcarpal NCV was most sensitive in diagnosing CTS. This study also suggests that direct measurement of a single nerve segment is superior to either long-segment studies or differential subtraction between 2 segments of the same nerve.”	3:1 matched study suggests a single short nerve segment measurement was superior to both long segment studies or differential subtraction between 2 segments of the same nerve for CTS diagnosis.
Kuntzer 1994 Diagnostic	5.5	N = 75 healthy subjects with no symptoms of CTS vs. 102 patients suspected on clinical grounds of having CTS	19 different sensorimotor and sympathetic parameters in electrodiagnostic studies.	Normal control group values for different electrophysiological tests. (EDX)	Specificity (%) and Sensitivity (%) of the following EDX tests: Median Motor Distal Latency 98.6 and 47. Thenar CMAP amplitude 100 and 15. Median Nerve Palm to wrist velocity 97 and 83. Median nerve digit to wrist velocity, 100 and 49. Median nerve digit to wrist amplitude 100 and 61. Median-Ulnar digit to wrist latency difference 100 and 10. Median sensory distal index, 99 and 69. SSR amplitude ratio, 100 and 10.	“The results obtained in this study demonstrate that patients with CTS form a heterogeneous group with a wide variation in a specific nerve conduction parameter between individual patients, reflecting the different degrees of nerve pathology. It is therefore not recommended to use a specific procedure for the evaluation of each patient suspected of CTS, but (i) to use only sensitive parameters with high specificity as an optimal routine for the investigation of the average CTS patient, (ii) to perform needle EMG in forearm and arm muscles for each patient suspected to have CTS with radiating pain to the arm, and (iii) to perform ulnar motor and sensory nerve conduction studies in order to exclude superimposed peripheral neuropathy.”	Data suggest median sensory nerve conduction studies appear abnormal compared to motor nerve conduction studies in CTS patients. Study does not recommend use of a specific procedure for all suspected CTS patients.

Bodofsky 2005 Diagnostic	5.5	Patients randomly sampled from electrodiagnostic studies. Divided into 3 groups. 1) Normal Patients (Confirmed using physical exam, history, EMG and NCS) 2) Probable CTS (Symptoms, Physical Exam consistent with CTS. Normal EMG and NCS) 3) Definite CTS (Symptoms, Physical Exam consistent with CTS. EMG and NCS also consistent with CTS)	(Median Sensory - Ulnar Motor) Latency difference (MSUMLD) as a more sensitive and specific diagnostic tool for CTS.	Other Electrodiagnostic techniques including, Median Sensory Latency, Ulnar sensory latency, Ulnar Motor Latency, (Median-Ulnar) Sensory Latency Difference.	MSUMLD had a median value of 0.4 msec in group 1, 1.0 msec in group 2, 2.0 in group 3 (p<0.0001). 95% CI for MSUMLD in normal group is 0.1-0.7 msec. 83% of group 2 patients were added to diagnostically confirmed CTS. 100% of group 3 were diagnosed with CTS using MSUMLD. Sensitivity and Specificity of MSUMLD is 95% and 100%, respectively.	"[T]he results in this study strongly suggest that, in patients with symptoms and signs of CTS, the (Median Sensory-Ulnar Motor) Latency difference is an easy simple, highly sensitive and specific test."	Data suggest median sensory ulnar latency is obtainable and yields a good sensitivity and specificity in the detection of mild CTS.
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Khosrawi 2013 Diagnostic	5.0	N = 100 healthy hand volunteers and 64 hands of patients with clinical symptoms of CTS	Electrodiagnostic tests (EDX) including Sensory Distal Latency (SDL), Distal Motor Latency (DML), Motor Nerve Conduction velocity (MNCV), Residual Latency (RL)	Clinical Diagnosis of Carpal Tunnel Syndrome. Also comparison of values of Electrodiagnostic readings in control vs diagnosed patients.	Sensitivity and Specificity (%) (95% CI) of EDX tests: SDL 87.3 (83.6-89.1) and 91.2 (89-95.6), DML 70.3 (65.6-71.9) and 100 (96.5-100), MNCV 97.2 (94.4-98.6) and 90.4 (88.5-94.2), RL 85.9 (84.4-87.5) and 91.1 (87.8-92.2). Median-Ulnar DML difference 84.0 (82.6-85.1) and 89.9 (89-91.1). Median and Ulnar SDL 90.5 (88.1-93.4) and 93.7 (90.2-95.6).	“It seems that, in mild cases of CTS which traditional NCS shows abnormalities only in sensory studies, RL may better demonstrate the effect on median nerve motor fibers.”	Data suggest in mild CTS cases, RL may be a tool to demonstrate the effect on the median nerve motor fibers thus increasing the sensitivity of NCS.
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Zagnoli 1999 Diagnostic	5.0	N = 20 patients (40 wrists) with CTS. Mild (n = 13), moderate (n = 12), severe (n = 8). Follow-up at 31 months.	Electrodiagnostic Studies (Vickers HME device)	MRI	33/40 wrists showed abnormal electrodiagnostic findings. 11 had isolated sensory abnormalities, and 13 cases showed sensory and motor abnormalities. 2 symptomatic wrists showed normal electrodiagnostic findings (sensitivity 94%) and 2 asymptomatic wrists showed mild to moderate findings (specificity 94%). 32 cases (94%) had sensory abnormalities, 25 had decreased sensory nerve conduction velocity, 29 had decreased sensory nerve potential amplitude. MRI: 20 control wrists normal, 9 clinical symptoms of CTS, 10 had electrodiagnostic abnormalities. 73% sensitivity and 92% specificity of MRI for the diagnosis of CTS. Of 26 MRI studies, 70% had bowing of the transverse carpal ligament. There were 55% of median nerve enlargement and 57% of high median nerve signal. These were correlated with moderate or severe CTS (p <0.001).	“When electrodiagnostic abnormalities suggest more severe disease than expected otherwise discordant with clinical findings, demonstration by magnetic resonance imaging of high median nerve signal and/or median nerve enlargement may help to select those patients most likely to benefit from surgical treatment.”	Small sample size. Data suggest MRI is useful in diagnosing more severe CTS diseases after electrodiagnostic abnormalities have been found.
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Violante 2004 Diagnostic	5.0	114 meat workers (228 hands) at risk of CTS; mean age 38.0±10.0 years.	median nerve conduction studies (NCS)	N/A	Significant difference between symptomatic and asymptomatic hands in WSL, SCV-WP, WML, MCV-WP, and the SCV-WP/SCV-EW ratio (all p <0.001). NCS parameters and symptoms had more agreements in non-dominant hand, which was shown in WSL (95% CI: 0.31–0.82) and SCV-WP (95% CI: 0.22–0.59), (p <0.001 and p <0.001).	“Given the importance of the dominant hand in working populations, these data support use of SCV-WP (or WSL) as an informative NCS parameter for occupational studies on CTS.”	Study population of meat workers with no prior diagnosis of CTS found use of SCV-WP (WSL) a useful NCS parameter for occupational CTS studies in the dominant hand of these workers.
Sheu 2006 Diagnostic	5.0	N = 131 hands of CTS patients and 136 hands of controls. Mean age 49.5 years.	Nerve conduction studies	Carpal tunnel diagnosis.	The distoproximal latency ratio (DPLR) of the median nerve showed the highest sensitivity (77%) but had a misclassification rate of 6.9%. The sensitivity of DPLR was not significantly greater than DIM-D1R (p>0.05).	“Optimal transformation of NCS data is mandatory to diminish the effect of skewness and enhance the diagnostic accuracy. As compared to the comparative tests, the segmental study of the median nerve is more easily applied and yields higher sensitivity in detecting mild CTS.”	Data suggest segmental study of median nerve has application ease and has a higher sensitivity when detecting mild CTS.
Aydin 2004 Diagnostic	4.5	N = 525 (818 hands) with suspected CTS confirmed through electrophysiological evaluation. Mean age 49.1± 11.7 years.	Compared sensitivity of first 3 digital branches of median nerve.	Electrophysiological testing was used as the standard diagnostic test in this study.	Most common abnormal physiological findings in Sensory Nerve Conduction Velocity over palm-wrist segment and Digit 1-Wrist segment with sensitivity of 98.5% and 95.4%, respectively.	“The sensory nerve conduction velocity test of the digit 1–to-wrist segment has the most sensitivity among the three digital branches of the median sensory nerve, and it may be used more widely in the electrodiagnosis of carpal tunnel syndrome.”	Data suggest sensory nerve conduction velocity test if digit 1 to the wrist segment is the most sensitive among the 3 digital branches of the median sensory nerve.

Elkowitz 2005 Diagnostic	4.0	N = 72 who had traditional electrodiagnostic testing (EDX) as well as portable NC-Stat testing	A portable Electrodiagnostic testing device (NC-Stat)	Traditional Electrodiagnostic testing as the comparison.	All patients who underwent both types of testing indicated that NC-Stat more comfortable. Both tests had a significantly ($p < 0.001$) linear relationship between Distal motor latencies.	“This portable electrodiagnostic device provides a reliable, convenient, and relatively inexpensive way to obtain objective data and that can be used in diagnosing, evaluating, and treating CTS.”	Data suggest portable NC-Stat is reliable and convenient for diagnosing, evaluating and treating CTS.
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Evidence for the Use of Ultrasound

There are 4 moderate-quality studies incorporated into this analysis. (465, 488-490) There are 3 low-quality studies in Appendix 2.(475, 491, 492)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: ultrasound diagnostic studies; carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; diagnostic, sensitivity and specificity, positive predictive value, negative predictive value, Predictive Value of Tests, efficacy, efficiency. We found and reviewed 304 articles in PubMed, 370 in Scopus, 4 in CINAHL, and 13 in Cochrane Library. We considered for inclusion 35 from PubMed, 15 from Scopus, 3 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 53 articles considered for inclusion, 43 diagnostic studies and 10 systematic review met the inclusion criteria.

Author/Year Study Type	Score (0-11)	N	Area of Upper Extremity	Diagnoses	Type of Ultrasound	CT used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Ziswiler 2005 Diagnostic No mention of sponsorship or COI.	7.0	N=74 (gender not specified) (107 wrists).	Wrist	CTS. Mean age 51±16 years.	5-12 MHz linear array transducer (ATL 3500, Philips Medical System)	-	-	-	-	-	-	-	-	CTS present wrists: 81. CTS absent wrists: 26. ROC curve area under the curve: 0.89 (95% CI 0.82, 0.96); cutoff value 10 mm ² ; sensitivity 82%; specificity 87%. Likelihood ratios (LR): cutoff of 8 mm ² satisfactory power to rule out CTS, fitted-negative LR 0.13 for cross-sectional areas <8 mm ² ; cutoff of 12 mm ² excellent power to rule in CTS, fitted-positive LR 19.9 for areas ≥12 mm ² .	“Depending on setting and purpose, different cutoff values for the largest cross-sectional area may be used to accurately rule in or rule out CTS.”	Data suggest high correlation between sonography and nerve conduction studies with almost equal sensitivity and specificity.

Pastare 2009 Diagnostic No mention of sponsorship or COI.	6.5	N = 66 (gender not specified) consecutive patients investigated for sensory hand symptoms. Mean age 51 years.	W	Carpal tunnel Syndrome	Ultrasound was performed using a 12-MHz lineararray transducer	-	-	-	+	-	-	+	-	Nerve Conduction studies showed greater diagnostic sensitivity than ultrasound; 54 wrists 82% vs. 41 62% for highly likely clinical diagnosis of CTS.	“In summary, our study shows that NCS have better sensitivity in supporting a diagnosis of CTS. However, because of its high positive predictive value, lack of discomfort, and ease of use, US can be used as a screening method for CTS.”	Data suggest nerve conduction studies are superior to sonography in detecting CTS.
Visser 2008 Diagnostic No mention of sponsorship. No COI.	6.0	N= 168, N=137 volunteer controls. 53 men and 84 women. Mean age at onset, 52 (± 14).	Forearm, Wrist	CTS based on clinical signs and symptoms without previous splinting or surgical treatment for CTS. Mean age 52±14 years, controls 46±15 years.	5-12 mHz linear-array transducer	-	-	-	-	-	-	-	-	Sensitivity/specificity (%; 95% CI) Sonography – wrist: cross-sectional area >0.1 cm ² : 78 (70-84)/91 (86-95). Sensitivity/specificity (%; 95% CI) EMG: DSL digit 4 >3.2 msec 54 (46–62)/ 97 (89–100); Median-ulnar digit 4 difference >0.4 msec 82 (75–88)/ 88 (78–95); DML median nerve >3.8 msec 74 (66–81)/ 97 (88–100).	“In patients with a clinical diagnosis of CTS, the accuracy of sonography is similar to that for EMG.”	Data suggest sonography is comparable to EMG in patients with a clinical diagnosis of CTS but study states EMG should still be first diagnostic test utilized in patients with atypical symptoms.

Wang 2008	6.0	N = 37 (20 controls). Mean age CTS patients (44±9.4 years) and healthy subjects (43.7 ± 12.91 years).	Wrist	Classic or probable symptoms of CTS for 1-60 months	Sequoia 512 with 8-15 MHz broad line transducer	-	-	-	-	-	-	-	-	-	Cross-sectional area at pisiform level (P-CSA): ROC curve area under curve (AUC) = 0.901 (p<0.001); optimal cut-off of 9.875 mm ² ; sensitivity 82%; specificity 87.5%. Longitudinal compression sign (LCS): ROC curve AUC = 0.842 (p<0.001); optimal cut-off value ≥1.5; sensitivity 50%; specificity 95.8%. Retinacular bowing: ROC curve AUC = 0.781 (p<0.001); optimal cut-off ≥2.11 mm; sensitivity 77%; specificity 75%.	“CTS can be diagnosed by HRUS. The most useful diagnostic criterion is a median nerve CSA of ≥9.875 mm ² at the pisiform level.”	Small sample suggesting HRUS can be useful in diagnosing CTS. The most useful criterion is when the median nerve CSA is of ≥ 9.875 mm ² at pisiform level.
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Evidence for the Use of Magnetic Resonance Imaging and Diffusion Tensor Imaging

There are 6 moderate-quality studies incorporated into this analysis.(469, 544-548) There are 5 low-quality studies in Appendix 2.(475, 549-552)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: magnetic resonance imaging, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy,; diagnostic, sensitivity and specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency. We found and reviewed 287 articles in PubMed, 383 in Scopus, 8 in CINAHL, and 5 in Cochrane Library. We considered for inclusion 66 from PubMed, 6 from Scopus, zero from CINAHL, zero from Cochrane Library and 3 from other sources. Of the 75 articles considered for inclusion, 68 diagnostic studies and 1 systematic review met the inclusion criteria.

Author/Year Study Type	Score	Number	Area of Upper Extremity	Diagnoses	Type of MRI used	Type of CT used	T1 weighted images	T2 weighted images	X-ray	Myelography	More than one rater	Surgery Performed	Clinical outcomes assessed	Long term follow-up	Results	Conclusion	Comments
Jarvik 2002 Diagnostic Sponsored by Royalty Research Fund, University of Washington. No mention of COI.	7.0	N = 120 (gender not specified) with clinically suspected CTS. Age <18 or >70 years.	W	CTS	MRI using 1.5 Tesla Magnets	-	+	+	-	-	+	-	-	-	Intrareader reliability was substantial to near perfect (kappa = 0.76 - 0.88). Interreader lower but still substantial (kappa = 0.60 - 0.67). Sensitivity of MRI was greatest for the overall impression of the images (96%) followed by increased median nerve signal (91%) and with lower specificities (33 - 38%).	“The reliability of MRI is high but the diagnostic accuracy is only moderate compared with a research-definition reference standard.”	Study used a mixed cohort (both men and women) to enhance diagnostic accuracy (those who were true positive for CTS) using high resolution MRI. Data suggest MRI has a “moderate” diagnostic accuracy at best compared to the reference standard for CTS. Also, assumption that a high STIR signals within the palmar bursa as being a marker for CTS was likely incorrect as normal signals within palmar bursa were associated with CTS presence.

Bulut 2014 Diagnostic No mention of sponsorship or COI.	5.5	N = 120 (90 females and 30 males) with CTS. The mean ages of the CTS and control, 43.07 ± 7.40 (25–57) and 41.85 ± 7.81 (31–55).	W	Carpal Tunnel Syndrome	1.5-T whole-body MRI system was used for all MRI examinations.	-	+	-	-	-	-	-	-	-	Diffusion tensor imaging (DTI) showed significant correlations with electrophysiological studies (EPS). DTI parameter (Fractional anisotropy-FA and apparent diffusion coefficients (ADC)) evaluated and significant difference between CTS and controls with CTS patients showing significantly lower FA and ADC scores ($p \leq 0.001$).	“DTI parameters can provide helpful information for CTS. The correlations of FA and ADC measurements versus EPS measurements based on severity were significant.”	Data suggest significant differences between all subgroups for mean FA and ADC suggesting FA and ADC threshold values could be useful for diagnosing and grading CTS. The DTI parameters well significant versus EPS for assessment of severity.
Uchiyama 2005 Diagnostic	5.5	105 wrists of 105 women. 36 wrists of 36 female volunteers.	W	Idiopathic CTS	1.5 Tesla with a circular extremity coil.	-	+	+	-	-	-	+	-	-	Flattening of nerve more significant at distal TCL level than other levels. Cross sectional area larger in mild to moderate group vs. controls at DRUJ/ pisiform/hook of hamate/distal TCL levels: 14.1 (4.8) vs. 9.0 (2.5)/14.6 (4.8) vs. 9.1 (2.3)/10.8 (3.0) vs. 8.8 (1.8)/ 10.9 (3.2) vs. 8.3 (2.0); ($p < 0.05$ all levels). Severe and extreme groups cross sectional area progressively larger from hook of hamate level, had high signal intensity. At pisiform and hook of hamate, correlation between average of carpal tunnel and palmar bowing of TCL in CTS groups (0.489, $p < 0.0001$).	“Severity of the disease could be judged by evaluating not only longitudinal changes of signal intensity and configuration of the median nerve, but also palmar bowing of the TCL. Increased palmar bowing of the TCL was found to be associated with an increase in the area of the carpal tunnel.”	Data suggest disease severity associated with palmar bowing of TCL as well as longitudinal changes of signal intensity and median nerve confirmation as study found bowing of TCL in CTS group larger than in controls. Studied only female subject as CTS more prevalent in females.
Zagnoli 1999 Diagnostic	5.0	20	W	Carpal tunnel	MRI vs. electrodiagnosis	-	+	+	-	-	-	+	-	3	33/40 wrists showed abnormal electrodiagnostic findings. 11 cases showed isolated sensory abnormalities, and 13 cases	“When electrodiagnostic abnormalities suggest more severe disease than expected	Small sample size. Data suggest MRI may detect abnormalities after electrodiagnostic abnormalities have been found.

				l syndr ome	c (Vicker s HME device)									o nt hs	showed sensory and motor abnormalities. 2 symptomatic wrists showed normal electrodiagnostic findings (sensitivity 94%) and 2 asymptomatic wrists showed mild to moderate findings (specificity 94%). 32 (94%) had sensory abnormalities, 25 had decreased sensory nerve conduction velocity and 29 had decreased sensory nerve potential amplitude. In MRI, 20 control wrists normal, 9 had clinical CTS symptoms and 10 wrists had electrodiagnostic abnormalities. 73% sensitivity and 92% specificity of MRI for diagnosis of CTS. Of 26 MRI studies, 70% had bowing of transverse carpal ligament. 55% of median nerve enlargement and 57% of high median nerve signal. These were correlated with moderate or severe CTS (p <0.001).	otherwise discordant with clinical findings, demonstration by magnetic resonance imaging of high median nerve signal and/or median nerve enlargement may help to select those patients most likely to benefit from surgical treatment.”	
Brienza 2014 Diagnostic	4.5	30 Subjects, 15 with CTS and 15 healthy controls.	W	Carp al tunne l syndr ome	3-Tesla magnetic resonan ce imaging with diffusio n tensor imaging (DTI)	-	-	-	-	-	+	-	-	-			Results do not reflect MRI, focused only on Electroneurography. Data suggest a high degree of correlation between DTI and ENG of the peripheral nervous system.
Wang 2012 Diagnostic	4.0	40, 21 patients and 19 asympto matic volunteer s.	W	Carp al tunne l syndr ome	Diffusi on tensor imaging (DTI). 1.5-T whole body with a microsc opy coil.	-	+	+	-	-	-	-	-	-	Overall results of FA and ADC at different levels (distal radius, pisiform bone, middle of tunnel, and hamate bone) were similar. Only CTS had significant effects on FA and ADC (p <0.05). Linear correlation between distal latency of motor conduction velocity of median nerve (MNDL) and length of abnormal intensity of median nerve (N_Len). If N_Len >15mm used as criteria for CTS, there was 1 false negative case and no false positive cases (r ² = 0.529, p <0.001).	“FA and ADC measurements at the distal radius, pisiform bone, in the carpal tunnel and at the hamate bone were independent of the finger posture in symptomatic patients and healthy volunteers. Mean FA was decreased while mean ADC was increased by CTS. The correlations of FA and ADC versus EPS parameters were significant.”	Small study population (n = 40). Data suggest FA and ADC were independent of finger posture and measuring location. Mean FA was decreased by CTS and ADC was increased by CTS. Study reports DTI imaging of FA and ADC were significant as compared with EP for CTS.

Evidence for the Use of Exercise for CTS

There are 5 moderate-quality RCTs incorporated into this analysis.(610, 611, 621-623) There are 4 low-quality RCTs in Appendix 2.(624-627)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: gliding exercise, tendon-gliding, tendon gliding, nerve-gliding, nerve gliding, neurodynamic mobilization, upper limb tension test, ULTT; carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 26 articles in PubMed, 19 in Scopus, 8 in CINAHL, and 31 in Cochrane Library. We considered for inclusion 13 from PubMed, 1 from Scopus, 1 from CINAHL, 1 from Cochrane Library and 1 from other sources. Of the 17 articles considered for inclusion, 10 randomized trials and 4 systematic studies met the inclusion criteria.*

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Bringer 2007 RCT Sponsored by the School of Health and Rehabilitation Science Development Fund, School of Health and Rehabilitation Sciences, University of Pittsburg, PA. No COI.	6.0	N = 61 (41 females and 10 males) with a positive Tinel sign or Phalen maneuver and complaints of nocturnal numbness and tingling. Mean age 50 years.	Neutral wrist and meta-carpophalangeal (MCP) splint, custom splint positioning MCP joints from 0° to 10° of flexion, NW/MCP (n =17) vs. neutral wrist and MCP exercise group (tendon and nerve gliding exercises 3 to 5 times a day with 10 repetitions in each position, and to hold each position for 5 seconds), NW/MCP-X (n=16) vs. wrist cock-up splint prefabricated that immobilized the wrist in 20° of extension, WCU (n=12) vs. wrist cock-up splint and exercise, WCU-X (n=16). All groups wore the splint during sleep for 4 weeks and received and educational brochure on CTS. Assessments at baseline, 4 weeks, and 8 weeks.	All groups saw significant decrease in CTS symptoms (no p-value reported).	“Our results provide further evidence of the effectiveness of splinting, designed to target an underlying anatomic problem, for reducing symptoms and improving functional status in patients with mild-to-moderate CTS.”	Small group numbers. No table or graphic for results. Baseline comparability for group strength different between groups.
Baysal 2006 RCT No mention of sponsorship or COI.	5.5	N = 36 females EDS confirmed CTS, all bilateral, all right handed. Mean age: Group I 47.8±5.5 years, Group II: 50.1±7.3 years, Group III: 51.4±5.2 years.	Group I: tendon- and nerve-gliding exercises 5 sessions daily, each exercise repeated 10 times/session for 3 weeks plus splinting full-time for 3 weeks (n = 12) vs. Group II: ultrasound 15 minutes per session to palmar carpal tunnel at frequency pf 1 MHz and intensity of 1.0 W/cm ² once a day 5 days a week, 3 weeks plus splinting (n = 12) vs. Group III: ultrasound, splinting and tendon-nerve-gliding exercises (n = 12). Follow-up at end of treatment at after 8 weeks.	Pain score before treatment/after treatment I/after treatment II: Group I: 4.8±2.3/3.3±2.9/ 2.6±2.8; Group II: 5.7±2.7/ 2.2±1.9/ 2.5±2.8; Group III: 5.6±3.5/ 1.3±1.8/ 0.8±0.9. Functional status score: Group I: 20.6±7.8/14.8±7.5/ 14.9±6.6; Group II: 21.9±9.1/16.1±8.5/ 16.1±8.7; Group III: 20.5±7.1/11.7±3.6/ 12.6±3.4. NS between groups.	“The result of this study emphasizes the efficacy of conservative treatment in CTS. In all patients groups, the treatment combinations were significantly effective immediately and 8 weeks after the treatment.”	All groups were splinted precluding judgment of utility of splinting. Unclear if there is an independent effect of exercise.

Bialosky 2009 RCT No sponsorship. No mention of COI.	5.5	N = 40 females with >12weeks signs and symptoms of CTS. Mean age: 46.90+10.25 years.	Neurodynamic technique (n = 20) vs. Sham technique (n = 20). Assessment at baseline and 3weeks. No long-term follow-up.	Values for between-group comparisons of clinical pain and disability were not reported.	“Collectively, these findings suggest that NDT specific to the median nerve in individuals with CTS is no more effective than a sham technique that produces adequate blinding and similar expectations for treatment effect over a 3-week period.”	Few differences between treatment arms were seen. Relatively short follow-up time (3 weeks).
Schmid 2012 RCT No sponsorship or COI.	4.5	N = 21 with mild to moderate CTS. Mean age: 53.9 years.	Nerve and tendon gliding exercise home program (n = 11) vs. Night splinting (n = 10). Follow-up at 1-week.	No significant differences present between groups. Within group Baseline vs. Follow-up – Exercise: Pain intensity VAS (0.7 vs. 0.8; p>0.16). Numbness VAS (1.5 vs. 1.6; p >0.16). Splinting: Pain intensity VAS (1.2 vs. 1.1; p>0.16). Numbness VAS (2.3 vs. 1.9; p >0.16).	“The findings of this study suggest that a reduction in intraneural edema is a therapeutic mechanism of both nerve and tendon gliding exercises and splinting... there seems to be no preference for splinting or nerve and tendon gliding exercises.”	Small sample size (N=21). Data suggest no differences.
Akalin 2002 RCT No mention of sponsorship or COI.	4.0	N = 28 EDS confirmed CTS. Mean age 51.93±5.1 years.	Full-time splint (n=14) vs. full-time splint plus nerve tendon gilding exercises 5 sessions daily with each exercise repeated 1- times per session (n=14) for 4 weeks. Follow-up 8 weeks after treatment.	Grip strength (mean ± SD) – Pre-/post-treatment: Group I (splint): 38.44±14/ 49.88±15.3; Group II (exercise + splint): 38.61± 13.8/54.94±17 p (between groups) = 0.14. Symptom severity score (mean ± SD): Group I: 36.11±9.0/21.88 ±8.8; Group II: 35.9±6.0/18.2±5.85 p (between groups) = 0.210	“Although the results in group 2 were better than group 1, the difference was not statistically significant. Further investigations are required to establish the role of nerve and tendon gliding exercises in the treatment of carpal tunnel syndrome.”	No clear evidence of benefit.

Evidence for the Use of Yoga for CTS

There is 1 moderate-quality RCT incorporated into this analysis.(628)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: yoga and carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, tingling, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 16 articles in PubMed, 183 in Scopus, 7 in CINAHL, 17 in Cochrane Library and zero in other sources. We considered for inclusion 2 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the 2 articles considered for inclusion, 1 randomized trials and 1 systematic studies met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Garfinkel 1998 RCT Sponsored by Commonwealth of Pennsylvania. No mention of COI.	6.0	N = 51 (28 female/13 male) with CTS, EDS confirmed. Median age 52 years.	Standard splint to supplement current treatment (n = 26) vs. Iyengar yoga focused on upper body, 1-1.5 hour, 2x a week for 8 weeks; current treatment not described (n = 25). Follow-up at 8 weeks.	Grip strength yoga (161.6±70.4 to 187.4±68.8) vs. splint (183.9±69.5 to 190.5±68.2mm Hg). Pain reduced (p = 0.02). Median nerve sensory conduction yoga (4.40±1.5ms to 3.97±1.5) vs. splint (4.66±1.4 to 4.36±1.6ms) (NS).	“In this preliminary study, a yoga-based regimen was more effective than wrist splinting or no treatment in relieving some symptoms and signs of carpal tunnel syndrome.”	Grip strength improvement may be from activity in yoga as comparison was presumably an inactive splint which may have caused greater improvement not related to CTS. Lack of description of controls limits interpretations.

Evidence for the Use of NSAIDs and Acetaminophen for CTS

There are 2 high-(639, 640) and 5 moderate-quality(631, 636-638, 641) RCTs incorporated into this analysis. There is 1 low-quality RCT in Appendix 2.(642)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: anti-inflammatory agents, non-steroidal, non-steroidal, anti-inflammatory, NSAIDS, aspirin, diflunisal, salsalate, ibuprofen, dexibuprofen, naproxen, fenoprofen, ketoprofen, dexketoprofen, flurbiprofen, oxaprozin, loxoprofen, indomethacin, tolmetin, sulindac, etodolac, ketorolac, diclofenac, nabumetone, piroxicam, meloxicam, tenoxicam, droxicam, lornoxicam, isoxicam, celecoxib, etodolac, etoricoxib, lumiracoxib, meclofenamic acid, mefenamic acid, nimesulide, parecoxib, rofecoxib, tolfenamic acid, valdecoxib; carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, burning, tingling, itching, numbness, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 41 articles in PubMed, 302 in Scopus, 10 in CINAHL, and 2 in Cochrane Library. We considered for inclusion 11 from PubMed, 0 from Scopus, 1 from CINAHL, 0 from Cochrane Library and 1 from other sources. Of the 13 articles considered for inclusion, 9 randomized trials and 1 systematic studies met the inclusion criteria.*

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
NSAIDs vs. Placebo						
Chang 1998 RCT Sponsored by NSC 86-2314-B-075B-012 to Ming-Hong Chang. No mention of COI.	7.0	N = 73 (53 female/20 male) with clinical signs and symptoms of CTS, EDS confirmed without abnormalities in radial and ulnar nerves. Mean age diuretic 45.7±4.8 years, NSAID-SR 47.4±5.7 years, steroid 45.4±5.2, placebo 44.2±5.4.	Trichlor-methiazide (diuretic), 2mg daily for 4 weeks (n = 16) vs. Tenoxicam-SR (NSAID-SR), 20mg daily for 4 weeks (n=18) vs. prednisolone (steroid) 20mg/day for 2 weeks, then 2-week dose of 10mg daily (n = 23) vs. placebo for 4 weeks (n = 16). Assessments at baseline, 2 weeks and 4 weeks.	Mean±SD global symptom score (GSS) baseline/2 weeks/4 weeks: placebo 22.9±5.9/21.6±6.4/20.8± 6.6 vs. diuretics 26.0±3.8/22.3±5.5/21.6±6.3 vs. NSAID-SR 29.7±8.4/24.7±8.6/24.0±9.7 vs. steroid 27.9±6.9/15.0±6.8/10.0±7.5 (p <0.0005 at week 2 steroid vs. other treatment groups; p <0.00001 at week 4 steroid vs. placebo).	“For patients with mild to moderate CTS who opt for conservative treatment, corticosteroids are of greater benefit.”	Suggests oral steroids effective but diuretic and NSAID are not effective compared with placebo.
NSAID vs. Other Treatments						
Yildiz 2011 RCT No mention of sponsorship or COI.	8.0	N = 51 (43 females/8 males) with signs and symptoms of CTS for more than a month and mild-to-moderate CTS after electrodiagnostic test confirmation. Age range 39-66 years.	Group 1: sham ultrasound (US), ultrasound in off mode 15 minute sessions 1x a day, 5x a week for 2 weeks plus splinting with neutral custom-molded thermoplastic volar wrist splint at night and during day for 8 weeks (n = 17, 25 median nerves) vs. Group 2: US, pulse mode (1:4) with gel without medication at 1 MHz frequency and 1 W/cm ² intensity plus splinting (n = 17, 26 median nerves) vs. Group	Mean±SD VAS (baseline/2 weeks/8 weeks): Group 1, 5.76±2.45/2.72±2.07/3.28±2.74 vs. Group 2, 4.96±2.50/2.41±2.43/2.77±2.74 vs. Group 3, 6.04±2.40/3.03±1.96/0.98±1.65 (p = 0.002, Group 3> Group 1; p = 0.004, Group 3 > Group 2).	“Our results suggest that ketoprofen PH in addition to splinting is superior to the combination of US and splinting with respect to pain only in middle term patients with CTS.”	Ultrasound plus splinting not superior to splinting alone. Ketoprofen plus splinting was associated with a reduction in pain at 8 weeks.

			3: ketoprofen phonophoresis (PH), US pulse mode (1:4) with 2.5% ketoprofen gel at 1 MHz frequency and 1 W/cm ² intensity plus splinting (n = 17, 25 median nerves). Follow-up for 8 weeks.			
Chang 1998	See above.					
Jarvik 2009 RCT Sponsored by the Intramural Research Program of the NIH Clinical Center. No COI.	7.0	N = 116 (62 female/54 male) considering surgery for diagnosed carpal tunnel syndrome. Mean age 50.7 years.	Surgery group: open surgery or endoscopic surgery depending on surgeon's preference (n = 57) vs. non-surgical therapy group: 6 visits with hand therapist focused on ligament stretching, tendon gliding, and review of splint use (splint use at night) plus prescribed NSAIDS, ibuprofen 200mg 3x a day. If no improvement after 6 weeks, received 12 sessions (2-4 per week for up to 6 weeks) of focused ultrasound at 1 Mhz, 1.0 W/cm ² in pulsed mode 1:4, 15 minutes each (n = 59). Follow-up at 3, 6, 9, 12 months.	Primary outcome was Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ). Surgical group showed significantly lower CTSAQ function score vs. non-surgical group at 6 months; 1.91 vs. 2.44 (p = 0.0006) and at 12 months; 1.74 vs. 2.17 (p = 0.0081). Secondary outcome of CTSAQ symptoms was also significantly lower in surgery group vs. non-surgical group at 6 months; 2.02 vs. 2.42 (p = 0.018) and 12 months; 1.74 vs. 2.07 (p = 0.036).	"Overall, these data indicate that, in patients with carpal tunnel syndrome without denervation, surgery modestly improves hand function and symptoms by 3 months compared with a multimodality non-surgical treatment regimen, and this benefit is sustained through 1 year."	At 12 months, surgical group was significant for improved symptoms and function.
Celiker 2002 RCT No mention of sponsorship or COI.	5.5	N = 23 with unilateral or bilateral CTS, EDS confirmed. Mean age Group A 49.6±15.3 years, Group B 46.9±10.0 years.	Group A: acetaminophen 120mg a day with splints at night, light-weight, neutral-positioned (n=11) vs. Group B: 40mg methylpred-nisolone acetate 1ml (n=12). Follow-up at 2 weeks and 8 weeks.	VAS pain scores (baseline/2nd week/8th week): NSAID plus splint 7.9±1.4/4.3±0.9/1.7±1.0 vs. injection 7.0±2.2/3.1±2.5/1.8±1.9 (p>0.05). Symptom severity scale results similar.	"Both splinting combined with the use of a nonsteroidal anti-inflammatory drug and steroid injection into the carpal tunnel resulted in significant improvement in carpal tunnel syndrome."	Not placebo controlled. Suggests splinting and NSAID may be as effective as injection.
Davis 1998 RCT Sponsored by a grant from the National Chiropractic Mutual Insurance Company. No mention of COI.	5.0	N = 91 with self-reported symptoms of CTS and EDS confirmed CTS. Mean age ibuprofen group 38±5 year, manipulation group 36±6 years.	Ibuprofen (800mg 3x a day for 1 week, then 2x a day for 1 week, then PRN 7 weeks) and nocturnal cock-up wrist supports (n = 46) vs. high velocity, low amplitude manual thrust procedures: manipulation to upper extremity and spine (3 treatments a week for 2 weeks; 2 treatments a week for 3 weeks; 1 treatment a week for 4 weeks) plus ultrasound applied over carpal tunnel for half of chiropractic treatment visits, 1 MHz and 1.0-1.5 W/cm at 50% duty cycle for 5	CTS outcome assessment physical distress (mean±SD) baseline to end of study: IBU and splint 14.66±9.89 to 5.74± 6.28 vs. ultrasound and manipulation 12.47±8.07 to 9.25±8.14 (p = 0.0132). CTS outcome assessment mental distress (mean±SD) baseline to end of study: IBU and splint 33.61±12.02 to 14.94±11.33 vs. ultrasound and manipulation 28.94±11.69 to 17.29±13.24 (p = 0.0085). No significance between group difference in EDS.	"Carpal tunnel syndrome associated with median nerve demyelination but not axonal degeneration may be treated with commonly used components of conservative medical or chiropractic care."	Baseline did not exclude prior ibuprofen use or manipulation, but prior use of these treatments is likely differential between the 2 groups and is a potentially fatal study flaw. Ibuprofen use was PRN after 2 weeks and subject contact differed between groups, providing bias in favor of manipulation/ultrasound. High dropout rates. Study mainly compares variable dose ibuprofen vs. manipulation plus ultrasound as both splinted. Since ibuprofen not effective and evidence that ultrasound is, results suggest manipulation is not effective.

			minutes plus nocturnal wrist supports (n = 45). Study duration 9 weeks. Assessments at baseline and end of study.			
Nalamachu 2006 MedGenMed RCT Sponsored by Endo Pharmaceuticals. COI, Nalamachu received research grants and consulting fee from Endo Pharmaceuticals. PharmD is employed by Endo Pharmaceuticals as Senior Director, Medical Affairs, and receives annual stock options from Endo. Gould is employed by Endo Pharmaceuticals as Associate Director, Medical Affairs, and receives annual stock options from Endo.	4.5	N = 100 age 18-75 with CTS, clinical and EDS confirmed. Mean age lidocaine patch 55.7±16.0 years, naproxen 51.5±11.8 years.	Lidocaine patch 5% up to a maximum of 3 patches, 420 cm ² , per day (n=52) vs. naproxen 500 mg twice daily (n = 48) for 6 weeks. Assessments at baseline after 1, 3, and 6 weeks of treatment.	Brief Pain Inventory (BPI) scores reduced between baseline and Week 6 for both lidocaine patch 5% (p <0.0001) and naproxen 500 mg twice daily (p = 0.0004), but no between group differences (p = 0.083). Clinical Global Impression of Improvement (CGI-I) scores also favored patch (51.1% vs. 24.3%, p = 0.016). Percentages satisfied or very satisfied 71.8% lidocaine patch vs. 63.2% naproxen (NS).	“This study demonstrates that the lidocaine patch 5% is effective in significantly relieving the pain associated with CTS and is well tolerated. The patch may offer patients an effective, non-systemic, noninvasive treatment for the management of their symptoms. Further controlled studies are warranted.”	More diabetics in naproxen group (23.59% vs. 9.6%). Severity (39.69% vs. 32.7%) and mean pain intensity somewhat worse in naproxen group (4.9±2.6 vs. 4.5±2.5). Excluded pain patch use, but not prior NSAID use. All appears to bias in favor of patch. Potential other painful diagnoses being treated appear possible.
Post-operative NSAIDs						
Husby 2001 RCT No mention of sponsorship or COI.	8.0	N = 77 who underwent surgery for CTS of Dupuytren’s contracture (DC). Mean age 59 years.	Post-op naproxen 500mg BID (n = 26) vs. paracetamol 1,000mg QID (n = 26) vs. placebo tablets (n = 25) for 3 days immediate post-op carpal tunnel release surgical treatment; 2nd trial included 35 with Dupuytren’s contracture. Opioid analgesic allowed for supplementary analgesic. No mention of follow-up time.	Postoperative CTS swelling as a percentage of preoperative volume 3.5±3.3 vs. 4.6±3.2 vs. 3.8±2.6. For Dupuytren’s contracture releases: 5.6±3.8 vs. 6.9±3.7 vs. 8.2±5.1. Additional analgesics used were 0, 2, and 8 in naproxen, paracetamol, and placebo groups.	“Naproxen might have a clinical relevant effect on swelling when used on minor surgery in the hand, unlike paracetamol. Naproxen might be a useful analgesic during the immediate post-operative phase.”	Results suggest a beneficial effect of naproxen over paracetamol, which is superior to placebo, which the studies were not powered to detect.

Evidence for the Use of Oral Glucocorticosteroids

See Intracarpal Tunnel Glucocorticosteroid Injections (“Steroid Injections”) Section.

Evidence for the Use of Diuretics for CTS

There are 2 moderate-quality RCTs incorporate into this analysis. (636, 652)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Diuretics, Trichlormethiazide, Hydrochlorothiazide, carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, tingling, wrist, hand, palm, finger, pain, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, and prospective studies. We found and reviewed 14 articles in PubMed, 1556 in Scopus, 3 in CINAHL, 27 in Cochrane Library and 2 in other sources. We considered for inclusion 2 from PubMed, 1 from Scopus, 0 from CINAHL, 1 from Cochrane Library and 2 from other sources. Of the 6 articles considered for inclusion, 2 randomized trials and 4 systematic studies met the inclusion criteria.*

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Chang 1998 RCT Sponsored by the National Science Council Grants. No mention of COI.	7.0	N = 91 (53 female/20 male) with confirmed CTS via electrodiagnosis; Mean (±SD) age 44.2 (±5.4) for placebo group, 45.7 (±4.8) for diuretic group, 47.4 (±5.7) for NSAID-SR group and 45.4 (±5.2) for steroid group.	Trichlor-methiazide, 2mg daily (n = 16) vs. Tenoxicam-SR, 20mg daily (n = 18) vs. 2 weeks prednisolone at 20mg daily, followed by 2-week dose 10mg daily (n = 23) vs. Placebo or control group (n = 16). Assessments at baseline, 2 and 4 weeks.	No significant reduction from baseline GSS seen at 2nd and 4th weeks in placebo, NSAID-SR, and diuretic groups. However, mean score at 4 weeks in steroid group decreased significantly from a baseline of 27.9±6.9 to 10±7.54, (p < 0.00001).	“For patients with mild to moderate CTS who opt for conservative treatment, corticosteroids are of greater benefit.”	Suggests oral steroids effective but diuretic and NSAID are not.
Pal 1988 RCT No mention of sponsorship or COI.	6.0	N = 48 (43 female/5 male) with CTS diagnosed via nerve conduction tests; Mean (±SD) age 41 (±13) for Bendrofluazid group and 53 (±13) for placebo control group.	Bendrofluazide 5 mg a day (n = 23; 41 hands) vs. Placebo (N =25; 40 hands) for 4 weeks. Assessments at baseline, 4 weeks and 6 months.	No significant difference in clinical improvement outcomes between the two groups at follow-up assessments.	“Bendrofluazide 5mgm daily for one month does not confer additional clinical benefit in the idiopathic CTS, but further trials with stronger diuretics and/or longer periods of treatment are warranted.”	Study suggests no short or long-term benefit.

Evidence for the Use of Pyridoxine for CTS

There is 1 high-quality RCT(745) and 1-moderate-quality randomized crossover trial(743) incorporated into this analysis. There is 1 low-quality RCT in Appendix 2.(746)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: vitamin B6, Vitamin B12, Pyridoxine, carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness , tingling , , controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 15 articles in PubMed, 3,114 in Scopus, 6 in CINAHL, 251 in Cochrane Library and 0 in other sources. We considered for inclusion 4 from PubMed, 0 from Scopus, 1 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 5 articles considered for inclusion, 3 randomized trials and 2 systematic studies met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
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Conflict of Interest (COI)						
Spooner 1993 RCT Sponsored by the Clinical Teaching and Research Fund of the College of Medicine at the University of Saskatchewan in Saskatoon. No mention of COI.	8.5	N = 35 (22 female/ 13 male) with CTS, EDS confirmed; mean age 42.5 years.	200mg pyridoxine once daily (n = 18) vs. Placebo (N = 17) for 12 weeks. Assessments at 6 and 12 weeks.	Mean score (SD) of night discomfort symptoms in treatment group: Entrance: 2.4 (1.4); 12 weeks: 1.9 (1.2) vs. control: Entrance 2.6(1.3); 12 weeks: 2.4 (1.3), NS. Mean score of median palmar distal latency (ms) in treatment group: Entrance 2.5(0.6); 12 weeks: 2.6(0.4) vs. control: Entrance 2.8 (0.6); 12 weeks: 2.7 (0.4), NS. Mean (SD) swelling treatment: entrance 2.1 (1.6); 12 weeks: 1.3 (1.4) vs. control: entrance 2.6 (1.3); 12 weeks: 2.3 (1.2) (p <0.05). Mean (SD) movement discomfort treatment: 3.1 (1.2); 1.7 (1.4) vs. control 3.1 (1.3); 2.7 (1.3) (p <0.001).	“Our findings do not support the use of pyridoxine for treating carpal tunnel syndrome.”	No statistical differences. Symptoms trended in favor of pyridoxine.
Ellis 1982 RCT Crossover Trial Sponsored by Rober A Welch Foundation. No mention of COI.	6.5	N = 7 males with evidence of entrapment of median nerve, symptoms in ulnar nerve region with or without evidence of entrapment of median nerve. Age 43-77.	Pyridoxine 50mg vs Placebo for 12 weeks.	Aggregate mean symptom scores control 53 ± 10 (n = 4) vs. pyridoxine 11 ± 6 (n = 7), p <0.001.	“Clinical improvements of the syndrome with pyridoxine therapy may frequently obviate hand surgery.”	Small sample size. Variable timeframes for measurements limit strength of conclusions.

Evidence for the Use of Topical Lidocaine Patches for CTS

There are 2 moderate-quality RCTs incorporated into this analysis. There are 2 low-quality RCTs in Appendix 2.(753, 754)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: lidocaine or lidocaine patch, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, meadian nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies. We found and reviewed 56 articles in PubMed, 14 in Scopus, 2 in CINAHL, and 40 in Cochrane Library. We considered for inclusion 3 from PubMed, 1 from Scopus, 0 from CINAHL, Cochrane Library and other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 0 systematic studies met the inclusion criteria.*

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Nalamachu MedGenMed 2006 RCT No mention of sponsorship or COI.	4.5	N = 40 (28 female/12 male) neuropathic pain associated with CTS. Age 18-75.	Lidocaine patch 5%, up to 3, every 24 hours (n = 52) vs. Naproxen 500mg twice daily for 6 weeks (n = 48). Follow-up for 6 weeks.	Reductions in API scores between baseline and Week 6 for both lidocaine patch 5% (p <0.0001) and naproxen (p = 0.0004), but no differences between treatments (p = 0.083). Significant difference in CGI-I for lidocaine patch 5% (51.1%) compared with naproxen 500mg 2x daily (24.3%) (p = 0.016); 71.8% lidocaine patch patients “satisfied” to “very satisfied” vs. 63.2% naproxen (NS).	“This study demonstrates that the lidocaine patch 5% is effective in significantly relieving the pain associated with CTS and is well tolerated.”	More diabetics in naproxen group (23.59% vs. 9.6%) suggest potential randomization failure and subsequent confounding. Severity (39.69% vs. 32.7%) and mean pain intensity somewhat worse in naproxen group (4.9±2.6 vs. 4.5±2.5). Excluded pain patch use, but not prior NSAID use. All appear to bias in favor of patch. Potentially, may have included treatment of other painful confounding diagnoses.

Nalamachu J Fam Prac 2006 RCT Sponsored by Endo Pharmaceuticals. Dr. Nalamachu has served as consultant to Endo, Dr. Crockett is a statistician for B&B Clinical Innovations.	4.5	N = 40 (28 female/12 male) electrodiagnostic evidence of CTS included median motor nerve distal latency >4.10m sec. Mean age 48.	Lidocaine patch 5% (n = 20) vs methylprednisolone acetate 40mg depot injection (n = 20). Follow-up for 4 weeks.	Not significant between-group differences. Mean pain scores at 4 weeks: 2.2 patch vs. -2.1 injection (NS). Global improvements 88% patch vs. 74% injection.	“This pilot trial demonstrated that the lidocaine patch 5% was efficacious in reducing pain associated with CTS.”	Unclear whether patients had other painful diagnoses that explained the results.
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Evidence for the Use of Gabapentin for CTS

There is 1 high-quality RCT incorporated into this analysis.(755)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Gabapentin, Neurontin, Fanatrex, Gabarone, Neupentin, Neogab, Horizant, Gralise, carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, tingling, wrist, hand, palm, finger, pain, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, and prospective studies. We found and reviewed 7 articles in PubMed, 627 in Scopus, 1 in CINAHL, 41 in Cochrane Library and 0 in other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 1 articles considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.*

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Hui 2011 RCT Sponsored by Pfizer, Inc. No COI.	8.0	N = 140 (114 males/26 males) with diagnosed CTS lasting >3 months; Mean (SD) age 52.3 (10.6) for gabapentin group and 51.0 (8.3) for placebo.	Gabapentin group receiving 300mg daily for first week, 600mg daily 2nd week and 900mg daily remaining treatment weeks (n = 71) vs. Placebo control group (n = 69). Assessments at baseline, 2 and 8 weeks.	During 2 and 8 weeks assessment, no significant difference reported between groups for global symptom scores reduction. Both groups showed improvement from baseline.	“As gabapentin appears to have limited efficacy and would be required to be taken for a long time (because the majority of patients symptoms persist if left untreated), current evidence does not support its routine use for CTS”	Gabapentin not effective.

Evidence for the Use of Magnets for CTS

There are 1 high-(757) and 2 moderate-quality RCTs incorporated into this analysis.(756, 758) There are 3 low-quality RCTs in Appendix 2.(759-761)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Magnet, pulsed magnetic field therapy, carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, tingling, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies.*

We found and reviewed 34 articles in PubMed, 33 in Scopus, 9 in CINAHL, and 865 in Cochrane Library. We considered for inclusion 8 from PubMed, 0 from Scopus, 2 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 10 articles considered for inclusion, 6 randomized trials and 4 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Magnet vs. Placebo						
Carter 2002 RCT Sponsored by The Oklahoma Center for Family Medicine Research. No mention of COI.	6.0	N = 30 (26 female/4 male) with wrist pain attributed to CTS. Mean age magnet 50.7±15.5 years, placebo 48.5±11.7 years.	Placebo magnet (N=15) vs. 1,000 gauss magnet (N=15); 45 minute treatment. Follow-up at 2 weeks.	Magnet mean (SD) vs. placebo mean (SD): Post-treatment pain: 3.6(3.1) vs. 2.6(2.7), NS; Pain at 2 weeks follow-up: 4.3(2.9) vs. 4.3(3.5), NS.	“The use of a magnet for reducing pain attributed to carpal tunnel syndrome was no more effective than use of the placebo device.”	Short-term study. Data suggest lack of efficacy.
Static Magnetic Field Therapy						
Colbert 2010 RCT Sponsored by National Institutes of Health and Oregon Clinical and Translational Research Institute. No COI.	8.5	N = 60 (45 female/15 male) with clinical evidence of carpal tunnel syndrome. Mean age: 50 years.	All magnets neodymium magnetized to deliver Static Magnetic Field (SMF). All devices applied at night. 15 mT (n = 20) vs. 45 mT (n = 20) vs. 0 mT aluminum disk (control) (n = 20). Outcomes measured after 6 week treatment period and 12 week no-treatment period.	No significant differences between groups for symptom severity or functional status at either 6 weeks (end treatment) or 12 weeks post-treatment.	“Participants in the active magnet groups and the control group experienced clinically relevant improvement after 6 weeks of treatment, but no significant between-group differences in outcome measures were shown.”	Data suggest lack of efficacy as groups (including sham) showed similar results.
Weintraub 2000 RCT Crossover No sponsorship or COI.	5.0	N = 8 (4 females/1 male) hands from 6 patients with moderately severe carpal tunnel syndrome. Mean age: 62.5 years for females and 75 years for males.	Static (sub-maximal) magnetic field therapy applied 24hrs/day for 4 weeks (n = 8 hands) vs. Placebo device applied 24 hrs/day for 4 weeks (n = 8 hands). No long-term follow-up.	Magnet vs. Placebo – Mean neuropathic pain score improvement: 57% vs. 13% (p = 0.046).	“In conclusion, this novel treatment has the potential to positively influence mild cases of acroparesthesias of hands secondary to carpal tunnel syndrome and 57% of moderately advance cases.”	Small sample size (n=8). Pilot study

Evidence for the Use of Wrist Splinting for CTS

There is 1 high-(763) and 18 moderate-quality(387, 611, 622, 628, 631, 647, 764-766, 774, 775, 777-783) RCTs incorporated into this analysis. There are 9 low-quality RCTs and 1 prospective randomized blinded trial(614, 626, 767, 768, 784-789) in Appendix 2.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: wrist joint, wrist, wrists, splints, splint, splinting, nocturnal splint; carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, burning, tingling, itching, numbness, hand, palm, finger, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, and systematic review. We found and reviewed 71 articles in PubMed, 499 in Scopus, five in CINAHL, and 77 in Cochrane Library. We considered for inclusion 27 from PubMed, eight from Scopus, zero from CINAHL, zero from Cochrane Library and four from other sources. Of the 39 articles considered for inclusion, 23 randomized trials and five systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Splints vs. No Treatment or Different Timing of Wearing Splints						
Manente 2001 RCT Sponsored by a grant from the Italian Ministry for Scientific and Technological Research. COL, Manente is owner of patent for brace.	6.5	N = 83 (69 female/11 male) with CTS, EDS confirmed or signs, symptoms of CTS. Mean age splint group 46.10±12.94 years, control group 50.0±12.65 years.	Nocturnal hand brace called Manu every night for 4 weeks (N=41) vs. No treatment, observational period before starting any treatment (N=42), for 4 weeks. Assessments at 2 weeks and 4 weeks.	BCTQ symptomatic score (baseline/4 weeks): splint 2.75±0.7 to 1.54±0.4 at 4 weeks vs. controls 2.77±0.7 to 2.61±0.6 (p <0.001). Sensory conduction velocities not different (p = 0.55). BCTQ function scores improved more in treated group from 1.89 to 1.48 vs. control from 2.02 to 2.03 (p < 0.001).	“The study demonstrates that this hand brace is highly efficient in relieving symptoms and functional loss in CTS.”	Study evaluated a unique hand brace. Non-intervention controls may bias in favor of intervention.
Premoselli 2006 RCT No mention of sponsorship or COI.	6.0	N = 50 (23 female/2 male) with CTS electrodiagnostic study confirmed. Mean age splint group 53.1±13.3 years, control group 46.5±13.8 years.	Nocturnal splint (custom molded) for a minimum of 6 hours (N=25) vs. No treatment (N=25) for 6 months. Assessments at baseline, 3 months, and 6 months.	Follow-up symptoms splint vs. control group (mean±SD): 3 months: 1.63±0.25 vs. 2.57±0.31 (p = 0.001); 6 months: 1.48±0.19 vs. 2.38±0.40 (p = 0.001); Sensory latency (ms): Recruitment: 2.74±0.28 vs. 2.79±0.38 (p = 0.63); 3 months: 2.59±0.39 vs. 2.85±0.336 (p = 0.02); 6 months: 2.61 ±0.37 vs. 2.71±0.43 (p = 0.50)	“Symptom relief and neurophysiological improvement after night-only splint wear therapy lasted up to the six-month follow-up visit.”	Dropout rate 28% over 6 month trial. Non-intervention controls may bias in favor of intervention.
Walker 2000 RCT No sponsorship or COI.	5.0	N = 21 (30 hands) with unilateral or bilateral CTS, EDS confirmed. Mean age 60±11.2 years.	Nocturnal splints (N=13) vs. Full-time splints (N=11). Follow-up for 6 weeks.	Symptoms severity (baseline/ follow-up): night only (2.89±0.96/2.30±0.93) vs. full-time (2.79±0.69/2.09±0.62) (NS). Functional deficits: night (2.75±1.01/2.14±0.87) vs. full time (2.27±1.03/1.93±0.77) (NS). Motor (p = 0.04) and sensory (p = 0.05) distal latencies improved more in full-time use.	“The study provides added evidence to support the efficacy of neutral wrist splints in CTS and suggests that physiologic improvement is best with full-time splint wear instructions.”	Symptoms/function data suggest no difference in efficacy. NCS data favor full-time use. High noncompliance with full-time use (27% completely compliant with daytime use) raises questions about validity of conclusions.
Werner 2005 RCT Sponsored by the United Auto Workers (UAW) and General	4.5	N = 161 with signs/symptoms suggestive of CTS for >1 week or >3 times in last 6 months. No EDS used for inclusion but performed after entry. Mean age splint group 44.74±1.02 years, ergonomic education group 43.77±1.44 years.	Nocturnal splints custom made that maintained wrist in neutral posture (n = 86) vs. Ergonomic education on line (n = 75); 6 week trial. Both groups given instruction on how to reduce ergonomic stressors in work and home environments. Follow-up at 3, 6, and 12 months.	Wrist, hand, finger discomfort in prior 30 days (baseline/follow-up): splints (7.24±2.08/ 4.43±3.71) vs. controls (6.60±2.51/5.58±3.30), p = 0.03. Splinted group had more visits to plant medical department (15.5±7.1 visits vs. 3.6±4.3 visits, p = 0.02)	“Benefit from a 6-weeks nocturnal splinting trial, and the benefits were still evident at the 1-year follow-up..”	High dropout rate (30.4%) and 50% questionnaires incomplete may sharply limit the value of the data.

Motors (GM) National Joint Committee on Health and Safety. No COI.						
Hall 2013 RCT No mention of sponsorship or COI.	4.5	N = 62 age 18 and older with paresthesia in median nerve distribution in night or day, clumsiness, grasp weakness, sleep disturbances, not pregnant, and no medical (surgery or injections) and conservative (wearing hand splints) treatments in past 6 months. Mean age: 53.8 years.	Conservative treatment group: full-time wrist splint (neutral position with full finger and thumb motion) and education sessions (pathology of CTS, risk identification, goal setting for self-management of CTS symptoms) by an occupational therapist (2 treatment session in 1 st week and between weeks 2 and 4 plus a 20 minute phone call at week 7) for 8 weeks (n = 31) vs. Control group: assessed and observed but given no intervention for 8 weeks (n = 31). Assessments at end of 8 weeks.	Boston Questionnaire for Assessment of Carpal Tunnel Symptom Severity (BQSS), mean±SD (pre-treatment/post-treatment): splint 2.80±0.63/ 2.38±0.77 vs. control 2.57±0.52/ 2.60±0.62 (p <0.001). Boston Questionnaire for the Assessment of Carpal Tunnel Symptom Functional Status Scale (BQFSS), mean±SD (pre-treatment/post-treatment): splint 2.24±0.78/ 2.04±0.74 vs. control 2.00±0.71/ 2.08±0.70 (p = 0.015). VAS, mean±SD (pre-treatment/post-treatment): splint 5.84±2.46/ 4.26±2.67 vs. control 5.00±2.62/ 5.65±2.54 (p = 0.001). Phalen's test, mean±SD (pre-treatment/post-treatment): splint 24.43±17.41/24.59±18.89 vs. control 27.00±15.36/22.56±15.36 (p = 0.031). Grip strength, kg force, mean±SD (pre-treatment/post-treatment): splint 23.94±8.55/25.01±9.37 vs. control 22.05±8.37/23.90±8.88 (p = 0.020). Purdue Pegboard Test score, min, mean±SD (pre-treatment/post-treatment): splint 46.87±16.41/51.40±15.30 vs. control 40.81±17.27/53.72±11.29 (p = 0.021). Semmes-Weinstein Monofilaments (SWM) score, palmar side, mean±SD (pre-treatment/post-treatment): splint 100.91±90.92/89.78±78.98 vs. control 109.31±77.45/99.68± 87.96 (p <0.001).	“A conservative treatment program including full-time splinting and formal education as key components can improve symptoms and hand function in patients with CTS.”	Conservative treatment group better than control group for symptom improvement and function.
Splints vs. Medical Treatment including Injections						
MacDermid 2012 RCT Sponsored by IMAGINutrition/Meta	7.0	N = 63 age 18-65 with CTS verified by electro-physiology. Mean age astaxanthin group 49±7 years, placebo group 49±9 years.	Experimental group: astaxanthin 4mg capsules after evening meals for 9 weeks followed by 3 week wash-out plus neutral wrist splint at night and during day when wrist in at-risk position (n = 32) vs. Control group: placebo capsules plus	No significant differences between groups for primary outcomes, CTS Symptom Severity Scale (p=0.18) and CTS Functional Scale (p=0.40).	“This study has not identified astaxanthin to be an effective adjunct to standard conservative management.”	Comparable efficacy in groups. No benefit demonstrated for use of astaxanthin.

Response Sciences. No mention of COI.			neutral wrist splint (n = 31). Assessments at 3 week intervals.			
Celiker 2002 RCT No mention of sponsorship or COI.	5.5	N = 23 with unilateral or bilateral CTS, EDS confirmed. Mean age Group A 49.6±15.3 years, Group B 46.9±10.0 years.	Group A: (NSAID) acetaminophen 120mg a day and nocturnal splint light-weight, neutral-positioned (n = 11) vs. Group B: 40mg methylprednisolone acetate injection (n = 12). Assessments at week 2 and week 8.	VAS pain scores (baseline/2nd week/8th week): NSAID plus splint 7.9±1.4/ 4.3±0.9/1.7±1.0 vs. injection 7.0±2.2/ 3.1±2.5/1.8±1.9 (p>0.05). Symptom severity scale results not different.	“Both splinting combined with the use of a nonsteroidal anti-inflammatory drug and steroid injection into the carpal tunnel resulted in significant improvement in carpal tunnel syndrome.”	No placebo control. Results suggest splinting and NSAID may be as effective as injection.
Ucan 2006 RCT No mention of sponsorship or COI.	5.0	N = 67 hands of patients with mild, moderate, or advanced CTS confirmed by nerve conduction studies. Mean age splint 44.50±7.24 years, steroid injection plus splint 44.46±8.52 years, open carpal tunnel release 45.27±13.19 years.	Group A: Full-time splinting in neutral position with standard splint for 3 months (n = 23) vs.. Group B: Single steroid injection (20mg triamcinolone acetate with 20mg lidocaine) and splinted for 3 months (n = 23) Group C: Surgery, open carpal tunnel release (n = 11). Assessments at baseline, 3 months, and 6 months after treatment.	Boston Questionnaire scores (baseline/3rd month/6th month): splinting 2.66±0.35/ 1.39±0.37/ 1.54±0.31 vs. splint plus steroid 2.79±0.63/1.41±0.32/1.96±0.63 vs. CTR 3.09±0.5/1.86±0.6/1.41± 0.31 (p = 0.004). Palm-wrist median sensory nerve velocities: splint 27.26 ±5.3/29.6±7.16/ 29.56±4.83 vs. splint plus steroid 26.35±4.12/ 31.57± 4.33/28.74± 6.19 vs. CTR 23.98±4.28/ 32.20±4.17/ 33.15±4.1 (NS between groups). Those completely/almost satisfied 3rd/6th months splinting 69.6%/34.8% vs. splint plus steroid 100%/82.6% vs. CTR 45.5%/90.9%.	“All treatment methods were effective, but (open) CTR was superior to conservative methods in the long term despite complications and longer recovery time.”	Baseline differences. Appears to have targeted lower enrollment for surgery without stating such.
Mishra 2006 RCT No mention of sponsorship or COI.	4.0	N = 66 with CTS EDS confirmed for at least 1 month. Mean age splint group 42.91 years, steroid group 41.57 years.	Full-time splint use for 4 weeks with commercially available carpal tunnel splint (n = 20) vs. oral prednisolone 20mg a day for 2 weeks followed by 10mg a day for 2 weeks (n = 20). Follow-up at 1 and 3 months.	Mean±SD for splint vs. Steroid: Symptom severity score (SSS): SSS 0-1: 0.34±0.42 vs. 0.40±0.30 (p = 0.52); SSS 0-3: 0.30±0.54 vs. 0.49±0.44 (p = 0.42). Sensory distal latency (SDL): SDL 0-1: 0.16±0.63 vs. 0.13±0.71 (p = 0.86); SDL 0-3: 0.35±0.76 vs. 0.55±0.66 (p = 0.25).	“There was significant improvement in both groups clinically during follow-up at 1 and 3 months as well as electrophysiologically, at 3 months..”	No blinding. Suggests splinting is as effective as oral steroid, though function slightly better with splinting.
Splints vs. Surgery						
Gerritsen 2002 RCT Sponsored by a grant from the Health Care insurance Council of the Netherlands. No mention of COI.	8.5	N = 176 with CTS, EDS confirmed without previous splinting treatment or surgery. Age 18 years or older, mean age surgery group 49±11 years, splinting group 49±12 years.	Open surgical release (N=87) vs. splinting, custom made or prefabricated to immobilize wrist in a neutral position, at night for at least 6 weeks but could also wear it during the day (N=89) for 12 months. Assessments at 3, 6, 12, and 18 months.	Surgery success rates superior other than first month (1/3/6/12/18 months) surgery vs. splinting: 29 vs. 42% (p = 0.07)/80 vs. 54% (p <0.001)/94 vs. 68% (p <0.001)/92 vs. 72% (p = 0.002)/90 vs. 75% (p = 0.02). Nights awakening due to symptoms (1/3/6/12/18 months) surgery vs. splinting (mean±SD): 0.8±3.2 vs. 2.0±3.0 (p = 0.008)/ 2.6±3.5 vs. 2.2±3.1 (p = 0.49)/3.6± 2.8 vs. 2.6±3.1 (p = 0.03)/3.6±2.9 vs.	“Treatment with open carpal tunnel release surgery resulted in better outcomes than treatment with wrist splinting for patients with CTS.”	Duration of symptoms was somewhat worse in splinting group (median 52 vs. 40 weeks, NS). Both treatment arms document substantial improvement,

				2.9±3.0 (p = 0.13)/3.6±2.9 vs. 3.2±3.1 (p = 0.44). Severity of main complaint (1/3/6/12/18 months) surgery vs. splinting (mean±SD): 1.6±2.9 vs. 2.1±2.2 (p = 0.22)/5.1±3.3 vs. 3.2±2.7 (p <0.001)/6.6±2.4 vs. 4.4±3.2 (p <0.001)/6.4±2.7 vs. 5.1±3.1 (p = 0.005)/6.2±2.8 vs. 5.0±3.3 (p = 0.02). Paresthesia during day (1/3/6/12/18 months) surgery vs. splinting (mean±SD): 1.5±3.0 vs. 1.4±2.1 (p = 0.66)/4.8±3.2 vs. 2.2±3.2 (p <0.001)/5.5±2.9 vs. 3.7±3.2 (p <0.001)/5.5±2.9 vs. 4.0±3.4 (p = 0.004)/5.3±3.0 vs. 4.0±3.6 (p = 0.01). Paresthesia at night (1/3/6/12/18 months) surgery vs. splinting (mean±SD): 1.3±3.1 vs. 2.5±3.0 (p = 0.02)/4.6±3.8 vs. 3.5±3.3 (p = 0.046)/5.4±3.5 vs. 4.1±3.7 (p = 0.02)/5.2±3.6 vs. 4.5±3.4 (p = 0.20)/5.0±3.6 vs. 4.4±3.6 (p = 0.35).		which may reflect a good natural history.
Korthals-de Bos 2006 RCT Sponsored by a grant from the Health Care Insurance Council of the Netherlands. No COI.	4.0	N = 176 with CTS, EDS confirmed, 18 years of age or older.	Surgery, standard open carpal tunnel release (N=87) vs. nocturnal splinting with custom of prefabricated splint that immobilized wrist in neutral position for at least 6 weeks. Could wear splint during day if desired (n = 89). 1-year study. Assessments at baseline 3, 6, and 12 months.	Success rates higher at 12 months for surgery group, surgery 92% vs. splint 72% (95% CI 8-31). Nights awakening due to complaints not different (surgery 3.6±2.9 vs. splint 2.9±3.0), 95% CI -0.2-1.7. Severity of main complaint higher in surgery (6.4±2.7 vs. 5.1±3.1) 95% CI 0.4-2.2. Paraesthesia during the day: surgery 5.5±2.9 vs. splint 4.0±3.4 (95% CI 0.5-2.5). Paraesthesia at night: surgery 5.2±3.6 vs. splint 4.5±3.4 (95% CI -0.4-1.8). Mean aggregate costs 2,126€ surgery vs. 2,111€ splint, NS. Absenteeism comparable (50 vs. 52 days).	“In the Netherlands, surgery is more cost-effective compared with splinting, and recommended as the preferred method of treatment for patients with CTS.”	Population-based study with likely relatively suboptimal control over treatments. Small sample size. Applicability of cost data to U.S. questionable.
Splints vs. Other Treatments including Exercise and Yoga						
Garfinkel 1998 RCT Sponsored by a grant from the Commonwealth of	6.0	N = 52 with CTS signs and symptoms (at least 2 of 5 – positive Tinel sign, positive Phalen sign, pain in median nerve distribution, sleep disturbances resulting from hand symptoms, and numbness or paresthesias in median nerve distribution) EDS confirmed. Mean age yoga group 48.9, splint group 48.7 years.	Standard splint with metal insert to supplement current treatment (n = 25) vs. Iyengar yoga (1-1.5 hour, 2x a week for 8 weeks focused on upper body postures, improving flexibility, correcting alignment of hands, wrists, arms, and shoulders, stretching, increasing awareness of optimal joint position during use (n = 26). Current treatment not described. Timing of	Grip strength (pretest/posttest) mean±SD: 161.6±70.4/ 187.4±68.8 vs. splint 183.9±69.5/ 190.5±68.2mmHg (p=0.37). Pain reduced (pre-/post-test) mean±SD: yoga 5.0±2.8/2.9±2.2 (p = 0.02) vs. splint 5.2±2.1/4.3±2.2 (p = 0.16). Median nerve sensory conduction (pretest/posttest) mean±SD: yoga 4.40±1.5ms/ 3.97±1.5 (p	“In this preliminary study, a yoga-based regimen was more effective than wrist splinting or no treatment in relieving some symptoms and signs of carpal tunnel syndrome.”	Grip strength increase may be from activity in yoga as comparison presumably an inactive splint which may have

Pennsylvania. No mention of COI.			splinting not described. Assessments at baseline and 8 weeks.	= 0.18) vs. splint 4.66±1.4/ 4.36±1.6ms (p = 0.28).		caused greater improvement not related to CTS. Lack of description of controls limits interpretations.
Bringer 2007 RCT Sponsored by the School of Health and Rehabilitation Science Development Fund, School of Health and Rehabilitation Sciences, University of Pittsburg, PA. No COI.	6.0	N = 61 at least 18 years of age with a positive Tinel sign or Phalen maneuver and complaints of nocturnal numbness and tingling. Mean age 50 years.	Neutral wrist and metacarpophalangeal (MCP) splint, custom splint positioning MCP joints 0°-10° flexion, NW/MCP (n = 17) vs. neutral wrist and MCP exercise group (tendon and nerve gliding exercises 3-5x a day with 10 reps in each position held for 5 seconds), NW/MCP-X (n = 16) vs. wrist cock-up splint prefabricated that immobilized wrist in 20° of extension, WCU (n = 12) vs. wrist cock-up splint and exercise, WCU-X (n = 16). All groups wore splint during sleep for 4 weeks and received educational brochure on CTS. Assessments at baseline, 4 and 8 weeks.	All groups saw significant decrease in CTS symptoms (no p-value reported).	“Our results provide further evidence of the effectiveness of splinting, designed to target an underlying anatomic problem, for reducing symptoms and improving functional status in patients with mild-to-moderate CTS.”	Small group numbers. No table or graphic for results. Baseline comparability for group strength different between groups.
Baysal 2006 RCT No mention of sponsorship or COI.	5.5	N = 36 (72 wrists) females with bilateral CTS, EDS confirmed. Mean age Group 1 47.8±5.5 years, Group 2 50.1±7.3, Group 3, 51.4±5.2 years.	Group 1: tendon- and nerve-gliding exercises 5 daily sessions, each exercise repeated 10x each session for 3 weeks plus splinting with custom made neutral volar splint for 3 weeks all night and during day (n = 12) vs. Group 2: ultrasound 15 minutes a session to palmar carpal tunnel area, frequency 1 MHz, intensity 1.0 W/cm ² , 15 treatments 1x a day, 5x a week for 3 weeks plus splinting (n =12) vs. Group 3: ultrasound, splinting and exercises n = 12). Full-time splint use; 8 week treatment. Assessments at first treatment, end of therapy, and after 8 weeks follow-up.	Pain score before treatment/after treatment/after 8 weeks follow-up: Group I: 4.8±2.3/3.3±2.9/ 2.6±2.8; Group II: 5.7±2.7/2.2±1.9/ 2.5±2.8; Group III: 5.6±3.5/1.3±1.8/ 0.8±0.9. Functional status score: Group I: 20.6±7.8/14.8±7.5/ 14.9±6.6; Group II: 21.9±9.1/16.1±8.5/ 16.1±8.7; Group III: 20.5±7.1/11.7±3.6/ 12.6± 3.4. NS between groups for study outcomes.	“The result of this study emphasizes the efficacy of conservative treatment in CTS. In all patient groups, the treatment combinations were significantly effective immediately and 8 weeks after the treatment.”	All groups were splinted precluding judgment of utility of splinting. Unclear if there is an independent effect of exercise.
Fusakul 2014 RCT Sponsored by a grant from the Research Support Funding of the Faculty of Medicine at Vajira Hospital, Navamindradhrirja University, Thailand. No COI.	5.5	N = 66 (126 hands) aged 18 and older with CTS symptoms and a mild-to-moderate diagnosis made with clinical exams and electrodiagnosis. Mean age Group I – 50.70±1.39 years, Group II – 50.79±1.38 years.	Group I: low level laser therapy (LLL), 18J per session over carpal tunnel area, 15 sessions for 5 weeks plus neutral wrist splint at night and during day for 12 weeks (n = 63) vs. Group II: placebo treatment, red light without laser power output over carpal tunnel, 15 sessions for 5 weeks plus neutral wrist splint at night and during day for 12 weeks (n = 63). Both groups encouraged to perform tending gliding exercises. Follow-up 5 and 12 weeks after treatment.	Symptom Severity Scale (SSS) mean±SD (baseline/week 5/week 12): Group I 2.10±0.68/1.68±0.66/1.49±0.58 vs. Group II 1.68±0.56/1.43±0.49/1.35±0.51 (p=0.031 at week 5). Distal motor latency (DML) mean ±SD (baseline/week 12): Group I 4.84±0.15/4.73±0.13 vs. Group II 5.20±0.18/6.63±1.10 (p=0.015).	“[B]oth LLLT and splints improved the clinical parameters of our study, but LLLT was electroneuro-physiologically superior to splints with regard to the conduction of the median motor nerve fibers.”	LLL significantly better than sham at 3 months for median nerve distal motor latency and better for grip strength. Both groups splinted, precluding assessment of splint’s utility.

<p>Soyupek 2012</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>4.5</p>	<p>N = 52 (81 wrists) with CTS, EDS confirmed. Mean age splinting, PCS, PNSAI: 47.95±6.93 years, 50.50±8.71 years, 53.79±10.40 years.</p>	<p>Phonophoresis with corticosteroid (betamethasone valerate %0.1 cream), CS (PCS) over carpal tunnel for 10 minutes/session at frequency 3 MHz, intensity 1.5 W/cm² 5x a week for 3 weeks (n = 28) vs. phonophoresis with non-steroidal anti-inflammatory drug (diclofenac diethyl ammonium gel), NSAI (PNSAI) over carpal tunnel for 10 minutes/session frequency 3 MHz, intensity 1.5 W/cm² 5x a week for 3 weeks (n = 23) vs. wrist splinting in neutral position during day and at night first 15 days and then when CTS symptomatic (n = 23). Follow-up 3 months after treatment.</p>	<p>VAS difference from baseline to after 3 months, mean±SD (baseline/after 3 months): splinting group 50.69±23.45/37.91±23.94 (NS); PCS 60.35±18.95/30.35±18.15 (p <0.017); PNSAI 69.13±16.21/45.65±23.65 (p <0.017). Boston Questionnaire total difference from baseline to after 3 months, mean±SD (baseline/after 3 months): splinting group 43.34±10.89/39.26±10.03 (NS); PCS 54.21±11.34/39.14±10.33 (p <0.017); PNSAI 53.69±41.86/41.86±10.03 (p <0.017). Tinel’s sign, %, difference from baseline to after 3 months (baseline/after 3 months): splinting group 65.2/60.9 (NS); PCS 82.1/50.0 (p <0.017); PNSAI 82.6/65.2 (NS). Phalen’s sign, %, difference from baseline to after 3 months (baseline/after 3 months): splinting group 60.9/52.2 (NS); 89.3/50.0 (p <0.017); PNSAI 78.3/39.1 (p <0.017).</p>	<p>“[T]he most effective treatment modality for CTS was P-CS according to ultrasonographic investigations and other findings.”</p>	<p>PCS group better than splinting or PNSAI groups.</p>
<p>Kummerdee 2010</p> <p>RCT</p> <p>Sponsored by Pramonkutklao Hospital’s Foundation under Her Royal Highness Princess Maha Chakri Sirindhorn’s Patronage. No mention of COI.</p>	<p>4.0</p>	<p>N = 61 with mild-to-moderate CTS, EDS confirmed. Mean age acupuncture – 50.37±9.01 years; night splinting – 51.73±8.92 years.</p>	<p>Acu group: 10 sessions of electro-acupuncture 2x a week on meridian of affected area (n = 30) vs. NS group: prefabricated volar neutral wrist splint worn at night for 5 weeks (n = 31). Assessments at baseline and end of treatment.</p>	<p>Mean±SD VAS (baseline/end of treatment): acupuncture 22.57±22.27/7.97±14.99 vs. night splinting 22.59±26.09/17.60±22.37 (p = 0.028). NS between groups for Symptom Severity Scale (p = 0.295) and Functional Status Scale (p=0.663).</p>	<p>“Electro-acupuncture provides more pain attenuating effect than night splinting in mild-to-moderate degree CTS.”</p>	<p>Comparable efficacy, but pain symptoms relieved slightly better with acupuncture group. Study susceptible to significant contact time bias.</p>
Comparing Types of Splints						
<p>Storey 2013</p> <p>RCT</p> <p>No mention of sponsorship. No COI.</p>	<p>4.5</p>	<p>N = 49 diagnosed with CTS from history and clinical exam confirmed with nerve conduction studies. Mean age C-Trac splint 47 years, BWB 39 years.</p>	<p>C-Trac splint (C-shaped, tubular, semirigid frame contoured around dorsum of wrist and hand with air pressure bladder to control pressure to 180-190mmHg for 2 minutes) 3x a week first 4 weeks then as necessary (n = 25) vs. Beta Wrist Brace (BWB) resting splint at night and during activities that provoke symptoms first 4 weeks then as necessary (n = 24). Follow-up at 4, 8, 26, and 52 weeks.</p>	<p>No significant differences between groups for primary outcomes, Levine symptom (p = 0.213) and function (p = 0.308) scores by week 8. No significant differences between groups for secondary outcomes at 8 weeks, Semmes-Weinstein monofilament scores (p = 0.0567), grip strength (p = 0.568), lateral pinch (p = 0.728), tripod pinch (p = 0.183).</p>	<p>“These results suggest that C-Trac splint is not dissimilar in efficacy to a resting Beta Wrist Brace.”</p>	<p>Pilot study showing similar efficacy between C-Trac splints compared to Beta wrist braces at 8 weeks, 6 months and 12 months.</p>

De Angelis 2009 RCT Sponsored by the AGF Orthopaedic Devices s.r.l. company. No COI.	4.0	N = 120 age 18 or older with possible CTS, pain, numbness, and paresthesias and/or hypoesthesia in the median nerve distribution, positive Phalen test, exclusive or predominant in one, and electrophysiological diagnosis of CTS. Mean age MANU® 46.0±11.8 years, CAMP TIELLE® 46.3±7.9 years.	Hand brace MANU® that does not impede thumb-index finger pinch, thumb-little finger opposition, and wrist flexion and extension worn every night for 3 months (n = 59) vs. wrist splint CAMP TIELLE® that immobilizes wrist in dorsiflexion position with external angle of 30° and internal angle of 16° worn every night for 6 months (n = 61). Follow-up at 3 months and 6 months after treatment.	No significant differences between groups for the primary study outcomes (p = 0.097-0.821).	“Our findings demonstrate that a conservative treatment by the hand brace or a splint is effective as long as they are employed as already shown in other studies.”	High dropout rate. At 3 months, comparable efficacy
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Evidence for the Use of Acupuncture

There are 4 moderate-quality RCTs incorporated into this analysis.(781, 792-794) There are 3 low-quality RCTs in Appendix 2.(795-797)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Acupuncture, Acupuncture Therapy, carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, tingling, wrist, hand, palm, finger, pain, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, and prospective studies. We found and reviewed 40 articles in PubMed, 411 in Scopus, 83 in CINAHL, 46 in Cochrane Library and 0 in other sources. We considered for inclusion 7 from PubMed, 2 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 9 articles considered for inclusion, 8 randomized trials and 2 systematic studies met the inclusion criteria.*

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Yao 2012 RCT Sponsored by the Department of Physical Medicine and Rehabilitation, university of California and by the National Institute of Disability Research grant.	7.0	N = 41 (gender not specified) acupuncture-naïve adult patients with mild to moderate CTS. Found through electro diagnostic testing; mean age: Group 1 48.5±10.5; Group 2 – 53.6±7.65.	Acupuncture group given treatment during 6 weekly sessions for 20 minutes. Group asked to feel a de-qi sensation; heaviness (n = 21) vs. Placebo acupuncture group acupuncturists stopped manipulate needle for 2 seconds. Both groups given wrist splints for sleeping (n = 20). Follow-up baseline, immediately after 6 weeks treatment, 2 weeks and 3 months after last treatment.	Comparing baseline to three months after the last treatment carpal Tunnel Self-Assessment Questionnaire (CTSAQ) scores improved in both groups. Group 1, 0.58 improvement (p = 0.03), Group 2 improved by 0.81 (p = 0.001). Analyzing CTSAQ hand function 3 months after last treatment group 1, improvement by 0.45 (p = 0.17) and group 2, improvement by 0.48 (p = 0.02) both improved significantly.	“Both treatment and placebo groups demonstrated improvements from baseline.”	Splints given to all participants. Small sample size with 20% dropout in 1 arm. Acupuncture not superior to placebo acupuncture.
Yang 2009 RCT	5.5	N = 77 (63 females/14 males) consecutive and	Acupuncture 8 sessions of 30 minutes duration for 4 weeks (2x a week) (n = 38) vs. Steroid treatment group: 20mg daily of prednisolone for 2 weeks and 10mg daily for following 2 weeks. 4 weeks total (n = 39). Follow-up baseline, 2 weeks, 4 weeks for Global Symptom Score and nerve conduction study (NCS) scores at baseline and 4 weeks.	At study end, there was a high percentage of improvement in both acupuncture and steroid groups at 2 weeks and 4 weeks (p < 0.01). Although there was no statistical significance	“Despite the limitations, this randomized, controlled study indicates that short-term acupuncture treatment is as effective as short-term low-	Minimal differences between groups observed. Population poorly described.

Sponsored by Kuang Tien General Hospital grant. No COI.		prospective patients with mild to moderate CTS and naïve to acupuncture treatment (confirmed by NCS); mean age: Group 1 – 9.3±8.9; Group 2 – 49.9±10.3.		between the two group at these follow ups. Nocturnal awakening week 4, acu group 3.5 ± 3.8 vs steroid group 1.5 ± 1.9, (p < 0.03).	dose steroid for mild-to-moderate CTS.”	
Yang 2011 RCT Sponsoredby Kuang Tien General Hospital grant. No COI.	5.0	N = 70 whom had not done any other type of intervention since the other study. (Yang 2009); Mean age: Group 1 – 49.3±8.9; Group 2 – 49.9±10.3.	Acupuncture consisted of 8 sessions of 30 minute duration administered for 4 weeks (twice a week) (n = 38) vs. Steroid treatment group prescribed 20mg daily of prednisolone for 2 weeks and given 10mg daily for following 2 weeks. 4 weeks total (n = 39). Follow-up at 7 months and 13 months after treatment.	Global Symptom Score (GSS) month 7, group 1 3.4±5.8 vs group 2 7.2±5.4 (p <0.01). GSS at month 13 group 1, 4.5±7.7 vs group 2, 11±8.6 (p <0.01). Month 13 – Baseline improvement in GSS group 1, -11.53±7.63 vs group 2, 3.-28±10.64 (p <0.01). Distal Motor Latency (DML) Month 13 – Baseline improvement; group 1, -1.44±1.07 vs group 2 -0.18±1.04 (p <0.01). Compound Muscle Action Potential (CMAP) group 1 improvement 0.56 ±1.25 (p <0.01). Motor Nerve Conduction Velocity (MNVC) at Month 13, group 52.7±4.0 vs group 2 49.7±4.6. Month 13 – Baseline group 1, -0.47±4.00. Sensory Nerve Action Potential (SNAP) Month 13 – Baseline, acupuncture improvement 2.75±6.15 (p<0.01). Distal Sensory Latency (DSL) Month 13 – Baseline acupuncture vs steroids, -0.36±0.62 vs 0.23±0.71 (p <0.01). Both groups improved significantly Month 13 – Baseline in Wrist Palm Sensory nerve conduction velocity, (p <0.01).	“[T]herefore, we conclude that acupuncture treatment can be considered as an alternative therapy to other conservative treatments for those who do not opt for early surgical decompression.”	Long term follow up of prior study. No statistical difference between groups at any time point.
Kummerdee 2010 RCT Sponsoredby Pramonkutklao Hospital’s	4.0	N = 61 with mild to moderate CTS who have not participated in surgical treatment,	Acupuncture group, 10 sessions 2x a week, needles placed around median nerve and received 1 Hz current for 30 minutes (n =30) vs. Night Splinting group for 5 weeks, use of metal bar splint to restrict wrist flexion during sleep (n = 30). Follow-up at baseline and immediately after treatment period (5 weeks).	Boston Carpal Tunnel Outcome Scale (BCTS) decreased significantly, 1.92± 0.54 (baseline) to 1.53±0.34 (treatment end) Acu group (p <0.001) vs. 1.88±0.48 (baseline) to 1.61±0.43 (end) (p <0.007) splint group. Acu group Symptom Severity Scale (SSS) 2.03±0.61(baseline)	“Electro-acupuncture provides more pain attenuating effect than night splinting in mild-to-moderate degree CTS.”	Comparable efficacy, but pain symptoms relieved slightly better with acupuncture group. Study susceptible to

Foundation under Princess Maha Chakri Sirindhorn's Patronage		steroid injections, or were pregnant, all patients asked to discontinue use of NSAIDs during study; age: Group 1: 50.37±9.01; Group 2: 51.73±8.92		to 1.57±0.39 (end), Functional Status Scale (FSS) 1.76±0.63 (baseline) to 1.50±0.39 (end) and VAS 22.57±22.67 (baseline) to 7.97±14.99 (end) scores all decreased significantly (p <0.05) vs. night splinting for which only SSS decreased significantly (p = 0.008) at 5 weeks. Comparing groups: VAS reduction Acu group 14.60±19.31 vs 4.97±24.37 NS group (p = 0.028).		significant contact time bias.
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Evidence for the Use of Low-Level Laser Therapy for CTS

There are 11 moderate-quality RCTs and 1 moderate-quality crossover trial incorporated into this analysis.(779, 799, 802-811) There is 1 low-quality RCT in Appendix 2.(812)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: laser or low-level laser therapy, carpal tunnel, medial nerve, median carpal, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, or tingling; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 41 articles in PubMed, 541 in Scopus, 29 in CINAHL, 38 in Cochrane Library and. We considered for inclusion 9 from PubMed, 5 from Scopus, 0 from CINAHL, and Cochrane Library. Of the 14 articles considered for inclusion, 13 randomized trials and 0 systematic review met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Irvine 2004 RCT Double-blind No mention of sponsorship. One of the authors (K. M. C.) funded by Alberta Heritage Foundation for Medical Research as clinical investigator.	7.5	N = 15 (12 female/3 male) with CTS. Ranging in age from 34 to 67 years, (46 ± 11).	Gallium/aluminum/ arsenide laser treatment (n = 8) vs. Control group or treatment with a sham laser (n = 7). Follow-up for 4 weeks.	Improvement in sham laser (p = 0.034) and LLLT treatment groups, (p = 0.043). NS between group differences, (p = 0.69).	“[L]LLT is no more effective in the reduction of symptoms of CTS than is sham treatment.”	No difference between groups.
Tascioglu 2012 RCT	7.5	N = 60 (46 female/14 male) with	First group received Ga-Al-As laser irradiation at each point, once daily, 5 days a week (N = 20) vs. Second group treated with same low-power laser, but painful points irradiated with duration of 1 minute, once daily, 5 days a week (n = 20) vs. Third group	Pain scores decreased significantly in all groups at Study end for group I, II and III, (p < 0.001, p <0.001, and p < 0.01).	“In conclusion, the results of this study indicate that low level laser, given at two	Comparable results showing LLL not superior to placebo.

Placebo-controlled No mention of sponsorship or COI.		CTS symptoms shorter than 6 months. Aged between 28 and 68 years.	received placebo laser, with duration of 2 minutes irradiation, 1x daily, 5 days a week (n = 20). Follow-up for 15 days.	FSS scores improved in all groups, (p <0.05).	different dosages, was no more effective than placebo in the treatment of CTS.”	
Bakhtiary 2004 RCT Sponsored by a grant from Semnan Medical Sciences University. No mention of COI.	7.0	N = 40 and 10 (gender not specified) with bilateral and unilateral CTS confirmed by electromyography or 90 wrists. Age means for laser/ultrasound groups: 48 (13.4) / 45 (17.1).	Ultrasound, 15 minute sessions with frequency of 1 MHz and intensity of 1.0W/cm ² , pulsed mode duty cycle of 1:4 and transducer area 5cm ² (N = 45) vs. Low-level laser therapy, applied low intensity 9J, infrared laser diode, 830nm at 5 points, 1.8J/point, daily 15 minute sessions 5 times a week (n = 45). Follow-up for 3 weeks.	Thumb sensory latencies favored ultrasound: -0.7 vs -0.2, (p = 0.003). Other electrodiagnostic measures all favored ultrasound. VAS pain scores - 6.3 in the ultrasound group vs. -2.0 in laser group, (p < 0.001) at 4 weeks after completion of treatment.	“[U]ltrasound treatment is more effective than low level laser therapy in patients with mild to moderate carpal tunnel syndrome.”	Suggests laser not effective compared with ultrasound.
Naeser 2002 RCT Double-blind Crossover Sponsored in part by the American Society for Lasers in Surgery and Medicine’s 16th Annual Meeting. No COI.	6.5	N = 11 (2 female/9 male) with mild to moderate CTS, EDS confirmed. Age range from 40 to 68 years (mean 53.5 y).	Device 1: Red-beam laser, continuous 15-mW, applied to shallow acupuncture points located on the fingers and hand, 3 times weekly (n = 11) vs. Device 2: Infrared pulsed laser, 180ns, 9.4W, located on the elbow, shoulder, upper back, and cervical paraspinal areas, 3 times weekly (n = 11) Device 3: Microamps TENS 580µA-3.5mA device, applied to the affected wrist, 3 times weekly (n = 11). Follow-up for 3 to 4 weeks.	McGill Pain Questionnaire scores were significantly lower with real treatment, (p = 0.0035). Sensory latencies were improved with real treatment, (p = 0.009), but not motor latencies, (p = 0.27).	“[LLLT] appears to be an affective substitute for surgery...especially when this new conservative treatment is applied in the early stages of CTS (preferably within 1y of symptom onset) and with middle to moderate cases (as defined with NCSs and where there is no abnormality on needle electromyography).”	Small sample size. Combined therapy precludes assessment of value of laser. Variable numbers treatments. 27% incomplete data.
Evcik 2007 RCT Placebo-controlled Double-blind No mention of sponsorship or COI.	6.5	N = 81 (70 female/11 male) with CTS diagnosis, on both clinical examination and electromyographic (EMG) study. Age range, 26-78.	Group 1 or laser group received 7 joules/point over carpal tunnel area at wrist (n = 41) vs. Group 2 or placebo received placebo laser therapy (n = 40). Follow-up at 4 and 12 weeks.	VAS scores for day and night showed significant decrease in both groups at end of therapy, (p < 0.001). Statistically significant improvement in sensory nerve velocity, and sensory and motor distal latencies in laser group, (p <0.001), and sensory nerve velocity meaningful in placebo group, (p <0.05).	“In using LLLT, (1) there was no difference relative to pain relief and functional capacity during the follow-up in CTS patients; (2) there were positive effects on hand and pinch grip strengths.”	Comparable results for pain relief. Although LLLT group showed some improvement in hand and pinch grip strength over placebo.

Ekim 2007 RCT No mention of sponsorship or COI.	6.5	N = 19 (18 female/1 male) with clinical and electrophysiological evidence of CTS with RA. Age 33-72 years.	Group 1 or LLLT with dosage 1.5J / per point once daily for 10 days (n = 10 hands) vs. Group 2 or placebo laser therapy group once daily for 10 days (n = 9 hands). Follow-up at 3 months.	Mean differences at 3 months significant; 95% CI, (-15 – (-5)) and placebo (-5 – (-2)). No other statistically significant improvements in the other clinical symptoms and electrophysiological assessments.	“CTS only add to the suffering of RA patients with disorganized hand functions.”	Small sample size. Rheumatoid arthritis population, with utility for occupational or general populations unclear.
Yagci 2009 RCT Masked-controlled No mention of sponsorship or COI.	6.0	N = 45 (hands) with symptoms and signs of suspected CTS over 3 months. Mean age for S/ and SLLLT groups: 51.75±12.09/ 49.47±6.32.	Splinting or S group splinted in neutral position with standard cotton–polyester splints (n = 24) vs. splinting plus low-level laser therapy SLLLT an infrared Ga–Al–As diode laser device wavelength 830nm (n = 21). Follow-up for 3 months.	No differences at baseline and third month, (p >0.05). Symptom severity score of SLLLT group statistically lower than S group, (p = 0.03). S group had improvement in only BQ symptom severity score, (p = 0.001), and there was a significant decrease in grip strength (p = 0.016).	“As a conclusion, both SLLLT and splinting provided improvements in clinical parameters but SLLLT is electrophysiologically superior to splinting.”	Comparable efficacy.
Chang 2008 RCT Placebo-controlled Double-blind Sponsored by the National Science Council of the Republic of China. No COI.	5.5	N = 36 with mild to moderate degree of CTS. Age mean for laser/ and placebo groups; 46.01 ± 11.65 / 49.07 ± 11.28.	Laser group received laser treatment (10 Hz, 50% duty cycle, 60 mW, once daily for two weeks (N = 20 wrists) vs. Placebo group received sham laser treatment (N = 20 wrists). Follow-up after 2 weeks of treatment for 18 week.	No significant differences seen in motor latency and sensory peak latency between groups, (p >0.05). Statistically significant reduction in VAS scores in laser group after treatment and at 2-week, (p <0.05 and 0.051). At 2 weeks, statistically significant differences in reductions in Symptom Severity Scale and Functional Status Scales scores between groups, (p <0.05).	“LLLT was effective in alleviating pain and symptoms, and in improving functional ability, as well as finger and hand strength, in those with mild to moderate CTS, and the therapy had no side effects.”	Small sample size and short follow up period. CTS diagnosis not standardized. Trends of longer duration disease and less nocturnal awakening in placebo group. Unusual finding of increases in symptoms in placebo group.
Saeed 2012 RCT No mention of sponsorship or COI.	5.5	N = 100 with unilateral CTS diagnosed clinically and electrophysiologically. The mean age was 35.59 ± 6.1.	Group A, treated by Ultrasound therapy 1MHz, 1.0 Watt/cm2, 5x a week for 4 weeks (n = 50) vs. Group B, treated with LLLT or 830 nm infrared, 5x a week for 4 weeks (n = 50). Follow-up for 4 weeks.	Distal motor latency and sensory latencies were found to be statistically improved in ultrasound treated group, (p <0.001). Change from baseline for pain/symptom severity scale/functional status scale, (p <0.001).	“Ultrasound treatment proved to be more effective than Laser treatment.”	Ultrasound group better than laser at 4 weeks. Unclear compliance and dropouts.

<p>Fusakul 2014</p> <p>RCT</p> <p>Double-blind</p> <p>Sponsored by grant from Research Support Funding of the Faculty of Medicine at Vajira Hospital, Navamindradhiraj University, Thailand. No COI.</p>	<p>5.5</p>	<p>N = 66 with mild to moderate carpal tunnel syndrome (CTS). Mean age for group I / II: 50.70 ± 1.39 / 50.79 ± 1.38.</p>	<p>Group I, LLLT with a splint of 15 sessions, 3 times weekly for 5 weeks (n = 63 hands) vs. Group II, placebo treatment with splint for 15 sessions, 3x a week for 5 weeks (n = 63 hands). Follow-up for 5 weeks.</p>	<p>At 5 and 12 week follow-up significantly better improvements in LLLT-treated group compared to placebo, especially for grip strength, T0/T5/T12; (p = 0.414/0.313 / 0.554). Distal motor latency of median nerve significantly improved in LLLT vs placebo group. (p < 0.05).</p>	<p>“[B]oth LLLT and splints improved the clinical parameters of our study, but LLLT was electro-neurophysiologically superior to splints with regard to the conduction of the median motor nerve fibers.”</p>	<p>LLLT significantly better than sham at 3 months for median nerve distal motor latency and better for grip strength.</p>
<p>Shoostari 2008</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>4.0</p>	<p>N = 80 with CTS based on clinical examination and electromyographic (EMG) findings. Age range 30-70.</p>	<p>Group A received low power laser waves by physiolaser Olympic with multiple probe five times weekly (n = 40) vs. Group B received flash laser (n = 40).</p>	<p>Median transcarpal sensory NCV after/before treatment, (p <0.001). Hand grip power increased 15.39% Group A with no meaningful improvements in Group B. NCV of median nerve in Group A improved about 3.25% ms, 1.99% ms, 6.43 m/s, with no meaningful changes in Group B.</p>	<p>“Laser therapy as a new conservative treatment is effective in treating CTS paresthesia and numbness and improved the subjects’ power of hand grip and electrophysiological parameters.”</p>	<p>Sparse methodological details. Hand grip improved in LPL group.</p>
<p>Raeissadat 2010</p> <p>RCT</p> <p>Single-blind</p> <p>No mention of sponsorship or COI.</p>	<p>4.0</p>	<p>N = 65 (hands) with mild or moderate CTS. The mean age of patients was 43.9 years.</p>	<p>Group I received local corticosteroid injection or Hydrocortisone 50mg (n = unknown) vs. Group II, received low level laser therapy or 20J/cm² in 11 seconds/session for each of 5 points, 775nm, 10 sessions and 3sessions / week (n = unknown). Follow-up for 10 months.</p>	<p>Severity of disease in injection group based on electrodiagnostic findings; mild in 41.2%, moderate in others. After 10 months, electrodiagnostic studies normal in 32.4% (38.7% before treatment), mild in 23.5% (22.6%), moderate in 41.2% (35.5%), severe in 2.9% (3.2%). Median nerve distal sensory latency before (DSL1) and 10 months after accomplishing treatment and comparison of 2 groups: injection therapy vs laser therapy: 4.28±0.36 vs 4.25±0.43 DSL1, and 3.9±0.5 vs 4±0.6, DSL2, (p >0.05). Distal motor latency: 4.3±0.6 vs 4.33±0.65 (MDL1) and 4.2±0.7 vs 4.17±0.8 (DML2), (p <0.05). Before vs. 10 months after treatment severity of disease: mild 45.2% vs 22.6%.</p>	<p>“Low level laser therapy can be as effective as local injection in reducing pain and severity of disease (based on electrodiagnostic medicine classification) in patients with mild and moderate CTS even in long term (after 10 months).”</p>	<p>Comparable efficacy. Patient blinding not possible due to different treatments (injection vs. laser).</p>

Evidence for the Use of Manipulation and Mobilization for CTS

There are 2 moderate-quality RCTs incorporated into this analysis.(637, 819) There are 3 low-quality RCTs in Appendix 2.(625, 820, 821)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: manipulation or mobilization / carpal tunnel, median nerve, median, carpal, disease, entrapment, neuropathy, syndrome, compression, CTS, burning, itching, numbness, tingling, hand, palm, finger, wrist, and pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 38 articles in PubMed, 172 in Scopus, 26 in CINAHL, and 10 in Cochrane Library. We considered for inclusion 3 from PubMed, 8 from Scopus, 3 from CINAHL, 1 from Cochrane Library and 0 from other sources. Of the 15 articles considered for inclusion, 3 randomized trials and 8 systematic studies met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Davis 1998 RCT Sponsored by a grant from the National Chiropractic Mutual Insurance Company. No mention of COI.	5.0	N = 91 (gender not specified) age 21-45 years with self-reported symptoms of CTS and EDS confirmed CTS. Mean age ibuprofen group 38±5 year, manipulation group 36±6 years.	Ibuprofen (800mg 3x a day for 1 week, then 2x a day for 1week, then PRN 7 weeks) and nocturnal cock-up wrist supports (n = 46) vs. high velocity, low amplitude manual thrust procedures: manipulation to upper extremity and spine (3 treatments a week for 2 weeks; 2 treatments a week for 3weeks; 1 treatment a week for 4 weeks) plus ultrasound applied over carpal tunnel for half chiropractic treatment visits, 1 MHz and 1.0-1.5 W/cm at 50% duty cycle 5 minutes plus nocturnal wrist supports (n = 45). Study 9 weeks. Assessments at baseline, end of study.	CTS outcome assessment physical distress (mean±SD) baseline to end of study: IBU and splint 14.66±9.89 to 5.74± 6.28 vs. ultrasound and manipulation 12.47±8.07 to 9.25±8.14 (p = 0.0132). CTS outcome assessment mental distress (mean±SD) baseline to end of study: IBU and splint 33.61±12.02 to 14.94±11.33 vs. ultrasound and manipulation 28.94±11.69 to 17.29±13.24 (p = 0.0085). No significance between group difference in EDS.	“Carpal tunnel syndrome associated with median nerve demyelination but not axonal degeneration may be treated with commonly used components of conservative medical or chiropractic care.”	Baseline did not exclude prior ibuprofen use or manipulation, but prior use of these treatments is likely differential between the 2 groups and is a potentially fatal study flaw. Ibuprofen use PRN after 2 weeks and subject contact differed between groups, providing bias in favor of manipulation/ultrasound. High dropout rates. Study mainly compares variable dose ibuprofen vs. manipulation plus ultrasound as both splinted. Since ibuprofen not effective and evidence that ultrasound is, results suggest manipulation is not effective.
Burke 2007 RCT Sponsored by the TherapyCare Resources, Inc. No COI.	5.0	N = 24 with clinically suspected CTS. Mean age TISTM 39.8±8.75 years, STM 43.4±5.32 years.	Graston Instrument-assisted soft tissue mobilization surgery (GISTM) (N=14) vs. soft tissue mobilization (STM) surgery administered with clinician hands (N=12). 6 week treatment (2 times a week for 4 weeks, then once a week for 2 weeks). Follow-up at 3 months.	VAS pain ratings (baseline/post-treatment/3months): CISTM 61.5±26.6/9.8±12.5/9.2±11.0 vs. STM 60.5±17.9/ 15.4±19.6/33.7±28.8 (p <0.05).	“Although the clinical improvements were not different between the 2 manual therapy techniques, which were compared prospectively, the data substantiated the clinical efficacy of conservative treatment options for mild to moderate CTS.”	This study’s two arms are both active treatment, precluding ability to address efficacy of manual therapy.

Evidence for the Use of Massage

There is 1 moderate-quality RCT incorporated into this analysis.(822) There are 2 low-quality RCTs in Appendix 2.(823, 824)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Massage, soft tissue massage and carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, and pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 22 articles in PubMed, 209 in Scopus, 13 in CINAHL, 128 in Cochrane Library and 0 in other sources. We considered for inclusion 3 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 3 articles considered for inclusion, 3 randomized trials and 0 systematic studies met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Madenci 2012 RCT No mention of sponsorship or COI.	4.5	N = 80 (76 females/4 males) with CTS with symptoms for longer than 6 weeks and at least 1 positive test of following: Tinel, Phalen, Buda, and Carpal compression test. Between the ages of 31 and 65	Group I, splint plus massage; Madenci hand massage technique (MHMT) self-applied for 6 weeks with weekly follow-up visits (n = 40) vs. Group II, splint (n = 40). Both groups received tendon and nerve gliding exercises and analgesic drugs. All wore wrist-hand resting splint during sleep at night for 6 months.	Patient global assessment (PGA, pre-treatment/post-treatment, mean±SD): Group I (8.5±1.1/2.3±0.8) v. Group II (8.2±1.2/4.1±0.7), p = 0.001. Physician global assessment (MDPGA, pre-treatment/post-treatment, mean±SD): Group I (5.9±0.8/1.2±0.5) v. Group II (5.1±0.9/2.7±0.8), p = 0.002. Grip strength right: Group I (25.4±6.3/30.3±5.2) vs. Group II (25.7±5.9/28.2±3.2), p = 0.042. Grip strength left: Group I (21.2±3.2/26.9±2.6) vs. Group II (20.5±3.3/24.1±2.3), p = 0.041. Boston symptom severity scale: Group I (3.9±1.1/1.8±0.4) v. Group II (3.7±1.0/2.5±0.5), p = 0.001. Boston functional capacity scale: Group I (3.2±0.8/2.0±0.4) v. Group II (3.2±0.6/2.6±0.6), p = 0.001.	“Statistically more significant improvement was observed in PGA, MDPGA, hand grip strength scores, and electrophysiological parameters in the group applied MHMT as compared to the group applied splint therapy only.”	Data suggest “splint+massage” treatment superior to splint along for global score outcome but not for any other outcomes including objective electrodiagnostic measures. Study susceptible to significant contact time bias. Both groups also provided exercises and analgesics.

Evidence for the Use of Therapeutic Touch for CTS

There are no quality studies. There is 1 low-quality RCT in Appendix 2.(825)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Therapeutic touch and carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, and pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 22 articles in PubMed, 209 in Scopus, 13 in CINAHL, 128 in Cochrane Library and 0 in other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.*

Evidence for the Use of Ice

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: ice; self-applied ice, cold therapy, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling,

hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 19 articles in PubMed, 7 in Scopus, 0 in CINAHL, 0 in Cochrane Library and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Heat

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Self applied heat, heat therapy, electrical induced heat, dielectric heating, self-applied heat therapy, carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, tingling, and pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 44 articles in PubMed, 34 in Scopus, 2 in CINAHL, and 38 in Cochrane Library. We considered for inclusion 1 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 2 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Evidence for the Use of Diathermy

There are 2 moderate-quality RCTs incorporated into this analysis.(829, 830)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: diathermy; carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 33 articles in PubMed, 153 in Scopus, 0 in CINAHL, and 3 in Cochrane Library. We considered for inclusion 0 from PubMed, 2 from Scopus, 0 from CINAHL, 1 from Cochrane Library and 0 from other sources. Of the 3 articles considered for inclusion, 2 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Frasca 2011 RCT Double-blind No sponsorship or COI	5.0	N = 22 (19 females/3 males) with idiopathic unilateral or bilateral, mild to moderate carpal tunnel syndrome (CTS). Mean age HT group 50.8±13.8 and for SC group 56.4±13.8	Hyperthermia treatment or HTG for 8 sessions, 20 minutes each (n = 11) vs. sham-controlled groups or SCG for 8 sessions, 20 minutes each (n = 11). Follow-up at baseline and 3 weeks.	At final visit of HTG improvement in pain severity vs. baseline (VAS: p = 0.002, Levine-Boston I p <0.0001) and functional impairment (Levine-Boston II p = 0.002) No significant difference in SCG vs. baseline value (VAS p = 0.713 Levine-Boston I p = 0.14). Comparisons of changes in outcome measures for HTG pain severity (VAS p = 0.004, Levine-Boston I p = 0.009) No significant difference for SCG. VAS for HTG 17.9mm.	“Hyperthermia produced short-term improvements in pain and function in patients with mild to moderate carpal tunnel syndrome in the absence of any sizeable change in neurophysiological parameters.”	Small sample size. Study represented as double blinded, but cannot blind this type of study design using heat.
Incebiyik 2014 RCT Double-blind	4.5	N = 31 females with mild and moderate CTS. Mean age for Group 1 51±10.07 and for Group 2 44.92±10.84.	Group 1 hot pack, Short-wave diathermy or SWD, and gliding exercises for 15 sessions, 5 times weekly (n = 15) vs. Group 2 hot pack, placebo for SWD, and	At baseline vs. 3 weeks, between-group comparison: Tinel test/ Phalen test/Reverse Phalen test/Carpal compression test/VAS/ Levine-Boston Symptom Severity Scale or SSS/ Functional Status Scale or FSS; p <0.001 group 1 vs. p = 0.500 group 2/p <0.001 vs p = 1.000/ p< 0.001 vs p=1.000/p < 0.001 vs p =	“SWD provided short-term improvements in pain, clinical symptoms, and hand function in patients with mild and moderate CTS.”	Data suggest treatment superior to placebo. Many cointerventions poorly tracked. Trial susceptible to contact time bias.

No mention of sponsorship or COI.			gliding exercises for 15 sessions, 5 times weekly (n = 13). Follow-up at baseline and at 3 weeks.	1.000/p < 0.001 vs p = 1.105/p < 0.001 vs p = 0.234/p < 0.001 vs p = 0.204.		
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Evidence for the Use of Ultrasound for CTS

There are 1 high-(640) and 7 moderate-quality(611, 637, 805, 831, 833, 835, 836) RCTs incorporated into this analysis. There are 4 low-quality RCTs in Appendix 2.(785, 832, 837, 838)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: ultrasound therapy, carpal tunnel syndrome, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 56 articles in PubMed, 6329 in Scopus, 8 in CINAHL, 43 in Cochrane Library and 0 in other sources. We considered for inclusion 11 from PubMed, 0 from Scopus, 2 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 18 articles considered for inclusion, 13 randomized trials and 1 systematic review met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Ultrasound vs. Placebo						
Yildiz 2011 RCT No mention of sponsorship or COI.	8.0	N = 51 (25 median nerves; 43 female/8 male) with signs and symptoms of CTS for more than a month and mild-to-moderate CTS after electrodiagnostic test confirmation. Age range 39-66 years.	Group 1: sham ultrasound (US), ultrasound system in off mode 15 minute sessions once a day 5 times a week for 2 weeks plus splinting with a neutral custom-molded thermoplastic volar wrist splint at night and during the day for 8 weeks (n = 17, 25 median nerves) vs. Group 2: US, pulse mode (1:4) with gel without medication at 1 MHz frequency and 1 W/cm ² intensity plus splinting (n = 17, 26 median nerves) vs. Group 3: ketoprofen phonophoresis (PH), US pulse mode (1:4) with 2.5% ketoprofen gel at 1 MHz frequency and 1 W/cm ² intensity plus splinting (n = 17, 25 median nerves). Follow-up for 8 weeks.	Mean±SD VAS (baseline/2 week/8 week): Group 1, 5.76±2.45/2.72±2.07/3.28±2.74 vs. Group 2, 4.96±2.50/2.41±2.43/2.77±2.74 vs. Group 3, 6.04±2.40/3.03±1.96/0.98±1.65 (p = 0.002, Group 3> Group 1; p = 0.004, Group 3 > Group 2).	“Our results suggest that ketoprofen PH in addition to splinting is superior to the combination of US and splinting with respect to pain only in middle term patients with CTS.”	Ultrasound plus splinting not superior to splinting alone. Ketoprofen plus splinting was associated with a reduction in pain at 8 weeks.

Ebenbichler 1998 RCT No mention of sponsorship. No COI.	6.5	N = 45 (gender not specified) with mild to moderate CTS. Mean age 51.	Ultrasound daily 15 minute sessions, 5x a week for 2 weeks then twice a week for 5 more weeks, 1MHz with intensity 1.0W/cm ² , pulsed mode duty cycle of 1:4 and transducer area of 5cm ² (n = 45 wrists) vs. sham ultrasound (n = 45 wrists). Follow-up period 6 months.	Main changes in symptom complaints were (active/sham): Week 2 (-1.05/0.05, p = 0.015), end of therapy (-0.17/-2.14, p = 0.001) and 6 months (-0.08/-2.76, p <0.0005). Grip strength measures improved (p <0.0005). EDS measures improved (p <0.05).	“There are satisfying short to intermediate term effects due to ultrasound treatment in patients with mild to moderate idiopathic carpal tunnel syndrome.”	Suggests ultrasound efficacious. High numbers of treatments (20). No assessment of blinding provided.
Ultrasound vs. Injection						
Bilgici 2010 RCT No mention of sponsorship or COI.	5.5	N = 34 (22 female/9 male) with CTS. Mean age for Groups A and B; 47.33 (7.44) and 44.15 (9.30).	Group A, ultrasound treatment given under water, 5x a week, for 4 weeks, intensity of 1.5 watt/cm ² for 5 minutes, with 2.5 cm ² soundhead, frequency 3 MHz (n = 16) vs. Group B, local corticosteroid injection (single 4mg dexamethasone without lidocaine) plus splinting (n = 18). Follow-up for 8 weeks.	VAS pain / severity of symptoms / functional status / grip strength, (p < 0.001) and two point discrimination (p <0.016). Group A, improved for all clinical outcomes, (p <0.001), except the grip strength.	“Both ultrasound treatment and corticosteroid injection plus splinting were effective on the clinical symptoms and the electrophysiological findings of CTS.”	Both groups improved meaningfully over time, but differences between groups minimal with only one significant difference.
Ultrasound vs. Other Treatments or in Combination(s)						
Bakhtiary 2004 RCT Sponsored by grant from Semnan Medical Sciences University. No mention of COI.	7.0	N = 40 (age not specified) and 10 with bilateral and unilateral CTS confirmed by electromyography or 90 wrists. Age means for laser/ultrasound groups: 48 (13.4)/45 (17.1).	Ultrasound, 15 minute sessions with frequency of 1 MHz and intensity of 1.0W/cm ² , pulsed mode duty cycle of 1:4 and transducer area 5cm ² (N = 45) vs. low-level laser therapy, applied low intensity 9J, infrared laser diode, 830nm at 5 points, 1.8J/point, daily 15 minute sessions 5 times a week (n = 45). Follow-up for 3 weeks.	Thumb sensory latencies favored ultrasound: -0.7 vs. -0.2, p = 0.003. Other electrodiagnostic measures all favored ultrasound. VAS pain scores were -6.3 vs. -2.0, p <0.001 at 4 weeks after treatment completion.	“Ultrasound was more effective than laser therapy for treatment of carpal tunnel syndrome.”	Suggests ultrasound efficacious. Numbers of treatments (15) in protocol is high.
Baysal 2006 RCT No mention of sponsorship and COI.	5.5	N = 36 (72 wrists) females with bilateral CTS, EDS confirmed. Mean age Group 1 47.8±5.5 years, Group 2 50.1±7.3, Group 3, 51.4±5.2 years.	Group 1: tendon- and nerve-gliding exercises 5 daily sessions, each exercise repeated 10 times at each session for 3 weeks plus splinting with custom made neutral volar splint for 3 weeks all night and during the day (n = 12) vs Group 2: ultrasound administered 15 minutes per session to the palmar carpal tunnel area at frequency of 1 MHz and intensity of 1.0 W/cm ² , 15 treatments once a day, five time a week for 3 weeks plus	Pain score before treatment/after treatment /after 8 weeks follow-up: Group I: 4.8±2.3/3.3±2.9/ 2.6±2.8; Group II: 5.7±2.7/2.2±1.9/ 2.5±2.8; Group III: 5.6±3.5/1.3±1.8/ 0.8±0.9. Functional status score: Group I: 20.6±7.8/14.8±7.5/ 14.9±6.6; Group II: 21.9±9.1/16.1±8.5/ 16.1±8.7; Group III: 20.5±7.1/11.7±3.6/ 12.6± 3.4. NS between groups for study outcomes.	“The result of this study emphasizes the efficacy of conservative treatment in CTS. In all patient groups, the treatment combinations were significantly effective immediately and 8 weeks after the treatment.”	Results suggest ultrasound may have some benefits, although it was not compared to a sham, placebo or no treatment. All groups were splinted.

			splinting (n = 12) vs. Group 3: ultrasound, splinting and exercises (n = 12). Full-time splint use; 8 week treatment. Assessments at first treatment, end of therapy, and after 8 weeks follow-up.			
Davis 1998 RCT Sponsored by a grant from the National Chiropractic Mutual Insurance Company. No mention of COI.	5.0	N = 91 with self-reported symptoms of CTS and EDS confirmed CTS. Mean age ibuprofen group 38±5 year, manipulation group 36±6 years.	Ibuprofen (800mg 3x a day for 1 week, then 2x a day for 1 week, then PRN 7 weeks) and nocturnal cock-up wrist supports (n = 46) vs. high velocity, low amplitude manual thrust procedures: manipulation to upper extremity and spine (3 treatments a week for 2 weeks; 2 treatments a week for 3weeks; 1 treatment a week for 4 weeks) plus ultrasound applied over the carpal tunnel for half of chiropractic treatment visits, 1 MHz and 1.0-1.5 W/cm at 50% duty cycle for 5 minutes plus nocturnal wrist supports (n = 45). Study duration: 9 weeks. Assessments at baseline and end of study.	CTS outcome assessment physical distress (mean±SD) baseline to end of study: IBU and splint 14.66±9.89 to 5.74± 6.28 vs. ultrasound and manipulation 12.47±8.07 to 9.25±8.14 (p = 0.0132). CTS outcome assessment mental distress (mean±SD) baseline to end of study: IBU and splint 33.61±12.02 to 14.94±11.33 vs. ultrasound and manipulation 28.94±11.69 to 17.29±13.24 (p = 0.0085). No significance between group difference in EDS.	“Carpal tunnel syndrome associated with median nerve demyelination but not axonal degeneration may be treated with commonly used components of conservative medical or chiropractic care.”	Baseline did not exclude prior ibuprofen use or manipulation, but prior use of these treatments is likely differential between 2 groups and potentially fatal study flaw. Ibuprofen use PRN after 2 weeks and subject contact differed between groups bias in favor of manipulation/ultrasound. High dropout rates. Study mainly compares variable dose ibuprofen vs. manipulation plus ultrasound as both splinted. Since ibuprofen not effective and evidence that ultrasound is suggest manipulation not effective.
Chang 2014 RCT Sponsored by grant of Taipei Tzuchi Hospital, Buddhist Tzuchi Medical Foundation (TCRD-TPE-99-25) and partially supported by grant from National Science Council, Executive Yuan, Taiwan (NSC102-2314-	4.0	N = 60 diagnosed with CTS. Mean age: Group1: 51.9 years. Group 2: 48.8 years	Group1: Paraffin therapy, Twice per week. (N = 30) vs. Group 2: ultrasound +splint only, twice per week. (n = 30) Follow up period: 8 weeks after treatment.	Significant improvements in symptom severity scores seen in both groups. The effect size (ES) of the symptom severity scores was 0.63 for both groups. However, significant improvements in functional status scores (ES 0.38) and pain scales (ES 0.74) only seen in US therapy group. An effect size of 0.3 to 0.8 is considered a “moderate” effect.	“To improve the functional status of CTS patients, a combination of ultrasound therapy and a wrist orthosis may be more effective than a combination of paraffin therapy and a wrist orthosis. Since this is an exploratory trial, further confirmatory testing is suggested to justify the efficacy of these two treatments.”	Minimal differences seen between groups. Data suggests ultrasound and splint not superior to paraffin and splint.

B-303-001) No COI.						
Ultrasound vs. Ultrasound plus NSAID						
Piravej 2004 RCT Sponsored by Asahi Glass Foundation, Japan and Faculty of Engineering, Chulalongkorn University. No mention of COI.	4.5	N = 18 females (30 hands) with mild to moderate CTS for less than 12 months (mean 6.53±4.33 months), no treatment for at least 1 month and no steroid injections in last 3 months. Age range 33-68 years, mean age 46.97±8.37 years.	Ultrasound 0.5 W/cm ² for 10 minutes, 5 days a week for 4 weeks plus placebo (n = 15 hands) vs ultrasound 0.0 W/cm ² plus diclofenac 75mg a day (n =15 hands). Follow-up within 5 days after 4 weeks of treatment.	Night pain/paresthesias (pre/post): US 1.47±0.83/0.53±0.64 vs. placebo US/NSAID 1.53±0.92/0.60±0.63 (p = 0.89). Frequency of awakening US 0.80±1.15/0.27±0.80 vs. placebo US/NSAID 1.07±1.22/0.20±0.56 (p = 0.36).	“The therapeutic efficacy of low intensity ultrasound thermotherapy was satisfied for mild to moderate CTS. However, the electrophysiological changes after ultrasound treatment need further investigation.”	Low sample size. Blinding unclear. Diagnostic criteria unclear, including NCS and 9 other criteria that seem unlikely fulfilled for all. No non-treatment comparison. No between group differences. Conclusion regarding ultrasound not clearly supported. If bilateral CTS (12/30), both treated the same and double-counted in results, weakening conclusions.

Evidence for the Use of Phonophoresis

There is 1 high-(640) and 2 moderate-quality(783, 840) RCTs incorporated into this analysis. There are 2 low-quality RCT in Appendix 2.(786, 839)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Phonophoresis or phonophoresis, carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 19 articles in PubMed, 6 in Scopus, 11 in CINAHL, 43 in Cochrane Library and 0 in other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 0 systematic studies met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Yildiz 2011 RCT No mention of sponsorship or COI.	8.0	N = 51 (25 median nerves; 43 female/8 male) with signs and symptoms of CTS for more than a month and mild-to-moderate CTS after electrodiagnostic test confirmation. Age range 39-66 years.	Group 1: sham ultrasound or US, ultrasound in off mode 15 minute sessions once a day 5x a week for 2 weeks plus splinting with neutral custom-molded thermoplastic volar wrist splint at night and during day (n = 17) vs. Group 2: US, pulse mode (1:4) with gel without medication at 1 MHz frequency and 1 W/cm ² intensity plus splinting (n = 17) vs. Group 3: ketoprofen phonophoresis (PH), US pulse mode (1:4) 2.5% ketoprofen gel at 1 MHz frequency and 1 W/cm ² intensity	Mean±SD VAS (baseline/2 week/8 week): Group 1, 5.76 ±2.45/2.72 ± 2.07/3.28 ± 2.74 vs. Group 2, 4.96 ± 2.50/2.41 ± 2.43/2.77 ± 2.74 vs. Group 3, 6.04 ± 2.40/3.03 ± 1.96/0.98 ± 1.65 (p = 0.002, Group 3 > Group 1; p = 0.004, Group 3 > Group 2). Pain score significantly lower in Group 3 at 8th week compared to other treatment groups (Group 1 and Group 2) (p = 0.002, p = 0.004 and p = 0.001, p = 0.001).	“Ketoprofen PH as adjuvant therapy on splinting is effective with respect to reduction of pain.”	Ultrasound plus splinting not superior to splinting alone. Ketoprofen plus splinting was associated with a reduction in pain at 8 weeks.

			plus splinting (n = 17). Follow-up for 8 weeks.			
Bakhtiary 2013 RCT Sponsored by Research Deputy of Semnan University of Medical Sciences. No COI.	7.0	N = 34 (gender not specified) with mild to moderate CTS confirmed by electromyography. Mean age for Iontophoresis and Phonophoresis; 48.2 (14.5) and 44.6 (12.8).	Iontophoresis of Dex-P 0.4% (n = 26) vs. Phonophoresis of Dex-P 0.4%, plus applied over wrist chin, and pulsed (20%) ultrasound waves (n = 26). Follow-up for 4 weeks.	Pain at end of treatment and 4 weeks later significantly favored phonophoresis vs. iontophoresis of Dex-P intervention, (p <0.01). Motor latency/motor action potential amplitude/finger pinch strength/hand grip strength/and pain relief: [mean difference 0.8 m/s; 95% (CI), 0.5-1.1]/(4.1 mV; 95% CI, 3.0 - 5.2)/(31.6 N; 95% CI, 15.9-47.3)/(27.1 N; 95% CI, 13.5-40.5)/and 2.1 points on 10-point scale; 95% CI, 1.3-2.9.	“Our clinical trials showed that phonophoresis of Dex-P is more effective than iontophoresis of Dex-p treatment in patients with mild to moderate CTS.”	Data suggest phonophoresis superior to iontophoresis
Soyupek 2012 RCT No mention of sponsorship or COI.	4.5	N = 52 with CTS, EDS confirmed. Mean age splinting, PCS, PNSAI: 47.95±6.93 years, 50.50±8.71 years, 53.79±10.40 years.	Phonophoresis with corticosteroid (betamethasone valerate %0.1 cream), CS (PCS) over carpal tunnel for 10 min/session at frequency of 3 MHz and intensity of 1.5 W/cm ² 5 times a week for 3 weeks (n = 28) vs. phonophoresis with non-steroidal anti-inflammatory drug (diclofenac diethylammonium gel), NSAI (PNSAI) over carpal tunnel for 10 min/session at frequency of 3 MHz and intensity of 1.5 W/cm ² 5x a week for 3 weeks (n = 23) vs. wrist splinting in neutral position during the day and at night for the first 15 days and then when CTS was symptomatic (n = 23). Follow-up 3 months after treatment.	VAS difference baseline to after 3 months, mean±SD (baseline/after 3 months): splinting group 50.69±23.45/37.91±23.94 (NS); PCS 60.35±18.95/30.35±18.15 (p <0.017); PNSAI 69.13±16.21/45.65±23.65 (p <0.017). Boston Questionnaire total difference from baseline to after 3 months, mean±SD (baseline/after 3 months): splinting group 43.34±10.89/39.26±10.03 (NS); PCS 54.21±11.34/39.14±10.33 (p <0.017); PNSAI 53.69±41.86/41.86±10.03 (p <0.017). Tinel’s sign, %, difference from baseline to after 3 months (baseline/after 3 months): splinting group 65.2/60.9 (NS); PCS 82.1/50.0 (p <0.017); PNSAI 82.6/65.2 (NS). Phalen’s sign, %, difference from baseline to after 3 months (baseline/after 3 months): splinting group 60.9/52.2 (NS); 89.3/50.0 (p <0.017); PNSAI 78.3/39.1 (p <0.017).	“[T]he most effective treatment modality for CTS was P-CS according to ultrasonographic investigations and other findings.”	PCS group better than splinting or PNSAI groups.

Evidence for the Use of Iontophoresis for CTS

There are 2 moderate-quality RCTs incorporated into this analysis.(841, 842) There are 2 low-quality RCT in Appendix 2.(786, 839)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Iontophoresis or phonophoresis, carpal tunnel syndrome, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 19 articles in PubMed, 6 in Scopus, 11 in CINAHL, 43 in Cochrane Library and 0 in other sources. We considered for inclusion 2 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 2 articles considered for inclusion, 2 randomized trials and 0 systematic studies met the inclusion criteria.*

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Amirjani 2009 RCT No mention of sponsorship or COI.	7.5	N = 20 (19 female/1 male) with mild to moderate NCS confirmed (19 females; 1 male). Mean age: 54 ±10 years	Dexamethasone sodium phosphate in distilled water 0.4% (n = 10) vs. distilled water iontophoresis 80mA a minute continuous DC current at 2mA a minute over carpal tunnel, 6 treatments QOD over 2 week (n = 10). Follow-up for 6 months.	Levine Self-Assessment Questionnaire scores median (25 th -75 th % CI) (baseline/post first treatment/post 6 treatments): Dex [38 (31-40)/33 (30-48), 26 (24-31)] vs. water controls (36 (33-54)/38 (27-44)/34 (22-41)), (p = 0.73, p = 0.91, p = 0.25))	“Although corticosteroid iontophoresis is feasible in clinical settings and is well-tolerated by patients, iontophoresis of 0.4% dexamethasone was not effective in the treatment of mild to moderate CTS.”	Small sample size. Stratified baseline data not provided. Appears underpowered, although magnitude of a potential benefit also not likely high or moderate.
Gökoğlu 2005 RCT No mention of sponsorship or COI.	4.0	N = 27 with clinical and electro physiologic evidence of CTS. Mean age: 46.2 ±8.0 years; group 2: 49.2±8.2 years.	40mg methylprednisolone acetate (1ml) injected into carpal tunnel (n = 15) vs. iontophoresis of DXM-P (n = 15). Follow up at 2 and 8 weeks.	Symptoms severity scores (baseline/Week 2/Week 8): injection 2.7±0.8/1.9±0.7/1.6 ±0.6 vs. iontophoresis 3.1±0.8/2.5±0.9/2.2±1.0 (p <0.05) weeks 2 and 8 favor injection. Functional status scale and VAS scores similarly favored injection.	“Success of both iontophoresis of dexamethasone sodium phosphate and injection of corticosteroids, but symptom relief was greater at 2 and 8 wks with injection of corticosteroids.”	Suggests injection superior to iontophoresis of dexamethasone.

Evidence for the Use of Glucocorticosteroids (Oral and Injection) for CTS

There are 8 high-(646, 648, 843-845, 851, 855, 860) and 19 moderate-quality(631, 636, 643, 644, 647, 777, 835, 840, 842, 848, 849, 852-854, 863-868) RCTs (one with two reports) incorporated into this analysis. There are 5 low-quality RCT and 1 prospective randomized blinded trial in Appendix 2.(786, 789, 839, 869-871)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: glucocorticoids, glucocorticosteroids, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 109 articles in PubMed, 268 in Scopus, 5 in CINAHL, and 46 in Cochrane Library. We considered for inclusion 30 from PubMed, 0 from Scopus, CINAHL, Cochrane Library and other sources. Of the 30 articles considered for inclusion, 30 randomized trials and 0 systematic studies met the inclusion criteria.*

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: glucocorticoids, glucocorticosteroids, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial,

randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies; Carpal Tunnel Syndrome to find 53 articles. Of the 53 articles, we considered for inclusion 12. Of the 12 considered for inclusion, 12 are randomized controlled trials and 0 systematic reviews.

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Armstrong 2004 (Score=9.5)	Intracarpal Glucocorticoid Injections	RCT	Sponsored by Southern California Kaiser Permanente Department of Research and Evaluation. No mention of COI.	N = 81 with typical symptoms of CTS and EDS confirmed. Age 18-80.	Mean Age: 51.67±11.95 years; 18 males, 63 females.	Group 1, received Steroid injection consisting of Betamethasone 6mg (n = 43) vs. Group 2, received a saline injection (Placebo group) (n = 36)	Baseline, 2 weeks, 3 months, 6 months, 18 months.	Changes in median sensory latencies -0.19 ± 0.27 vs. -0.04 ± 0.14 ($p = 0.01$). Changes in symptoms scores also favored corticosteroid injections -0.78 ± 0.80 vs. -0.19 ± 0.62 ($p < 0.01$). Satisfaction rates 70% vs. 34% ($p = 0.001$). In subsequent open label follow-up, additional injections performed per patient requests (up to 7 injections for a few); 18 (39.1%) referred for surgery, 37.0% reported adequate symptom relief.	“Steroid injections are a safe and effective treatment for temporary relief of CTS symptoms for patients who did not improve with splinting and activity modification.”	Unblinded after 2 weeks.
Dammers 2006 (Score=9.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 136 EDS confirmed diagnosis of CTS.	Mean age: 51.3 years; 30 males, 102 females.	Group 1, received 20mg methylprednisolone injections (n = 45) vs. Group 2, received 40mg methylprednisolone injections (n = 43) vs. Group 3, received 60mg methylprednisolone injections (n = 44)	Baseline, 3 months, 6 months, 1 year.	73% of 60mg, 53% of 40mg and 56% of 20mg groups symptom free or requiring no further treatment at 6 months. Only 22% treated with 1-2 injections methylprednisolone during first year referred to surgery ($p < 0.05$).	“One injection of methylprednisolone close to the carpal tunnel reduces the number of patients requiring surgery.” 60mg dose more effective than lower doses, with 2nd injection possibly increasing recurrence of symptom-free patients.	Injection site 4cm proximal to distal wrist crease.
Wong 2001 (Score=9.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 62 with newly diagnosed CTS >3 months.	Mean age: 49 years; 7 males, 53 females.	Group 1, received Steroid injection of prednisolone 25mg and a placebo oral pill (n = 30) vs.	Baseline, 2 weeks, 8 weeks, 12 weeks.	Global symptom scores (injection/oral): baseline ($25.0 \pm 6.4 / 25.7 \pm 8.3$), 2 weeks ($13.6 \pm 7.5 / 17.8 \pm 10.0$), 8 weeks ($13.7 \pm 8.3 / 20.8 \pm 8.7$), and 12 weeks ($14.3 \pm 8.4 / 21.4 \pm 9.6$). GSS scores borderline	“Local steroid injection was superior to oral corticosteroids over a 3-month period in patients with CTS.”	Suggests injections superior to oral glucocorticosteroids.

						Group 2, received Oral steroid of prednisolone acetate 15mg and placebo injection (n = 30)		significant at 2 weeks (p = 0.07), but significant at 8 and 12 week follow-ups (p = 0.002 and p = 0.004).		
Wong 2005 (Score=9.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 40 with newly diagnosed CTS and NCS confirmed.	Mean age: 46.9±7.8 years; 6 males, 24 females.	Single injection group or methylprednisolone 15 mg injection (n = 20) vs. Double-injection group at 8 weeks of steroid or placebo (n = 20). 40 week follow-up.	Baseline, 8, 24, & 40 weeks.	Global Symptom Score Single vs. Double injections (pre/8/24/40 weeks): Single 26.7±10.1/15.2±9.9/15.9±10.6/12.6±9.1 vs. Double 25.6±11.6/11.4±7.6/13.0±9.7/14.1±11.0 (p>0.19) all times. No differences in grip strengths or in NCS other than right hand which was borderline different at baseline (p = 0.08).	“The results suggest that an additional steroid injection confers no added benefit to a single injection in terms of symptoms relief.”	Both arms had active treatment
Atroshi 2013 (Score=8.5)	Intracarpal Glucocorticoid Injections	RCT	Sponsored by grant from Region of Scania Research and Development Foundation and Hässleholm Hospital Organization. No COI.	N = 111 with idiopathic CTS not previously treated with steroid injections.	Mean age: 46.67±11.42 years; 30 males, 81 females.	80mg methylprednisolone (n = 37) vs. 40mg methylprednisolone (n = 37) vs. placebo (n = 37).	Baseline, 10 weeks, 1 year.	At baseline CTS symptom severity score at 10 weeks improved those who received methylprednisolone vs. placebo (p = 0.003 for 80mg; p = 0.001 for 40mg methylprednisolone). At 1-year rates of surgery 73%, 81%, and 92% in 80mg methylprednisolone, 40mg methylprednisolone, and placebo groups. Those who received 80mg methylprednisolone less likely to have surgery (OR, 0.24 [CI, 0.06 to 0.95], (p = 0.042).	“Methylprednisolone injections for CTS have significant benefits in relieving symptoms at 10 weeks and reducing the rate of surgery 1 year after treatment, but 3 out of 4 patients had surgery within 1 year.”	Data suggest both active treatments superior to placebo, no statistical differences between 80 mg and 40 mg steroid
Dammers 1999 (Score=8.0)	Intracarpal Glucocorticoid Injections	RCT	No sponsorship and no COI.	N = 60 with carpal tunnel symptoms >3 months and NCS confirmed.	Mean age: 52 years; 10 males, 50 females.	Intervention group or methylprednisolone 40mg plus 10mg lidocaine (n = 30) vs. Control group or lidocaine alone (n = 30).	Baseline, 1, 3, 6, 9, 12 months.	Percentage not needing 2nd treatment (1/3/6/9/12 month): steroid (77/63/57/53/50%) vs. placebo (20/7/7/7/7%), significant but no p-value reported. In open phase, 24 of 28 crossed over from controls and 50% of those had surgery, no p-value reported.	“A single injection with steroids close to the carpal tunnel may result in long term improvement and should be considered before surgical decompression.”	Data suggest injection effective and 50% need no treatment for 1 year.

Hui 2005 (Score=8.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 50 with EDS confirmed idiopathic CTS.	Mean age: 49.5±9.4 years; 2 males, 48 females.	Steroid injection or methylprednisolone acetate 15mg (n = 25) vs. Decompression or open CTR (n = 25).	Baseline, 6, and 20 weeks.	Mean improvements in global symptoms scale: 24.2±11.0 vs. 8.7±13.0 (p <0.001). Grip strengths were: surgery 23.4±8.2 to 21.8±7.9 vs. injection 24.2±7.0 to 26.6±7.4 (p = 0.009). Sensory nerve conduction velocities: surgery 34.2±7.9 to 42.2±8.0 m/s vs. injection 37.3±8.0 to 40.5±6.3 (p = 0.003).	“Open carpal tunnel release resulted in better symptomatic and neurophysiologic outcome but not grip strength in patients with idiopathic carpal tunnel syndrome over a 20-week period.”	Suggests surgery superior.
Peters-Velutha maningal 2010 (Score=7.5)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship. No COI.	N = 69 with clinical diagnosis of CTS. Mean age: NaCl group = 57.6 years, TCA group = 56.5 years.	Mean age: 47.0±29.7 years; 16 males, 53 females.	1ml triamcinolone acetate (TCA) 10mg/ml (n = 36) vs. 1ml saline (NaCl) 0.9%, placebo 1-2 injections (n = 33).	Follow-up 1, 3, 6 and 12 months.	Steroid-group showed better direct treatment response (p = 0.013), perceived improvement (p = 0.01) and more improvement than NaCl-group in outcomes SSS BCTQ score (from 2.872 to 1.948 in TCA group vs. from 2.815 to 2.529 in NaCl group) and FSS BCTQ score (2.456 to 1.881 in TCA group vs. 2.353 to 2.366 in NaCl group). Mean difference in change score 0.637 (95% CI: 0.320, 0.960; (p <0.001)) for SSS BCTQ and mean difference in change score 0.588 (95% CI: 0.232, 0.944; p = 0.02) for FSS BCTQ. Number Needed to Treat to achieve satisfactory partial treatment response or complete resolution of symptoms and signs 3 (95% CI: 1.83, 9.72).	“Corticosteroid injections for CTS provided by general practitioners are effective regarding short-term outcomes when compared to placebo injections.”	Multiple injections given if patient result was “not satisfactory” Data suggest steroid injections superior to NaCl for short term outcomes.
Babaei-Ghazani 2017 (Score=7.0)	Intracarpal Glucocorticoid Injections	RCT	No sponsorship or COI.	N = 44 patients with signs/symptoms of mild to moderate CTS.	Mean age: 56.1±6.6 years; 4 males, 40 females.	Ultrasound-guided injections above the median nerve group (n=22) vs ultrasound-guided injections below the median	Follow up 6 and 12 weeks.	Mean VAS pain score for above the median nerve group was 6.04 at baseline vs 2.90 at 6 weeks (p<.05) and 2.77 at 12 weeks (p<.05). VAS for below the median nerve group was 6.86 at baseline vs 2.81 at 6 weeks (p<.05) and 2.90 at 12 weeks (p<.05). No significant between group findings.	“Both above and under median nerve ultrasound-guided steroid injection techniques were effective in reducing the symptoms, improving the function and electrodiagnostic and sonographic findings of CTS. However the amount of improvement in the outcomes did not differ between groups, implying that none of technique has the superiority over another.”	No meaningful differences between treatment groups. Both treatment groups improved over time. No assessment for equality.

						nerve group (n=22). Both injections were conducted using ulnar side approach				
Bakhtiar y 2013 (Score=7.0)	Intracarpal Glucocorticoid Injections	RCT	Sponsored by Research Deputy of Semnan University of Medical Sciences. No COI.	N = 34 mild to moderate CTS confirmed by electromyography. Mean age for Iontophoresis and Phonophoresis; 48.2 (14.5) and 44.6 (12.8).	Mean age: 46.4±13.7 years; no mention of sex.	Iontophoresis of Dex-P 0.4% (n = 26) vs. Phonophoresis of Dex-P 0.4%, plus applied over wrist chin and pulsed (20%) ultrasound waves (n = 26).	Baseline, 2 weeks, 6 weeks.	Pain at end of treatment and 4 weeks later significantly favored phonophoresis vs iontophoresis of Dex-P intervention, (p <0.01). Motor latency/motor action potential amplitude/finger pinch strength/hand grip strength/pain relief: [mean difference 0.8 m/s; 95% (CI), 0.5-1.1]/(4.1 mV; 95% CI, 3.0 -5.2)/(31.6 N; 95% CI, 15.9-47.3)/(27.1 N; 95% CI, 13.5-40.5)/ and 2.1 points on 10-point scale; 95% CI, 1.3 - 2.9.	“Our clinical trials showed that phonophoresis of Dex-P is more effective than iontophoresis of Dex-p treatment in patients with mild to moderate CTS.”	Data suggest phonophoresis superior to iontophoresis
Ly-Pen 2005 (Score=6.5)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 123 (163 wrists) with CTS.	Mean age: 51.9±12.6 years; no mention of sex.	Betamethasone 6.4mg, 2 injections 2 weeks apart (n = 83 wrists) vs. Open Carpal Tunnel Release (n = 80).	Follow-up at 3, 6, and 12 months.	70% improvements in nocturnal paresthasias present (3/6/12 months): injection 86.7/69.9/61.4% vs. surgery 61.3/68.8/ 73.8% (p = 0.001/p = 1.0/p = 0.098).	“Over the short term, local steroid injection is better than surgical decompression for the symptomatic relief of CTS. At 1 year, local steroid injection is as effective as surgical decompression for the symptomatic relief of CTS.”	Details sparse. Most patients had 2 injections. No clear surgical benefit vs. injection.
Roghani 2018 (Score=6.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship. No COI.	N = 94 patients with a clinical diagnosis of CTS and electrodiagnostic confirmation of moderate CTS.	Mean age: 65.2 years; 17 males, 77 females.	80 mg triamcinolone (2 mL) and 1 mL of 2% lidocaine group (group 1) (n=32) vs 40 triamcinolone (1 mL) 1 mL of 2% lidocaine and 1 mL normal saline group (group 2) (n=32) vs 1 mL 2% lidocaine and 2 mL normal	Follow up at baseline, 2 weeks, 3 months, and 6 months.	Mean VAS pain score at baseline for group 1 was 7.29 vs 2.43 at 6 months (p<0.001). Mean VAS at baseline for group 2 was 6.22 vs 2.00 at 6 months (p<0.001). Mean VAS at baseline for group 3 was 5.8 vs 2.75 at 6 months (p<0.001).	“Hydrodissection with lidocaine and normal saline is as effective as hydrodissection with low- and high-dose steroid medication in elderly patients with CTS in this study, but further studies with matched baseline measures and also a sham group are suggested for definitive recommendation.”	All three treatment groups, including lidocaine only, had significant improvements over the 6 month study period. Only significant between group finding was for median distal motor latency, slightly favoring steroid tx.

						saline group (group 3) (n=30).				
Bahrami 2015 (Score=6.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship. No COI.	N = 60 hands of 30 female patients with mild and moderate CTS	Mean age: 50.07±9.7 years; 0 males, 30 females.	Single local injection of 40 mg/ml triamcinolone acetate and 0.5 ml lidocaine (2%) group (n=30 hands) vs single local injection of 0.5 ml 17-alpha hydroxyl progesterone and 0.5 ml lidocaine (2%) group (n=24 hands)	Follow up at baseline and 10 weeks.	Mean VAS pain score for triamcinolone group at baseline was 5.00 vs 2.23 at 10 weeks (p=0.0001). Mean VAS for progesterone group at baseline was 4.80 vs 2.29 at 10 weeks (p=0.0001). No significant between group differences.	“Both treatments were effective in the short-term management of mild and moderate disease, clinically and electrophysiologically. There were no significant differences in therapeutic effects between two groups.”	All groups had significant improvements in outcomes but no differences between groups.
Özdoğan 1984 (Score=6.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 37 with idiopathic CTS.	Mean age: 45.8±8.7 years; 0 males, 37 females.	Steroid injection, 1.5mg betamethasone disodium phosphate and acetate suspension (n = 18) vs. Placebo into deltoid double dummy (N = 19). Follow-up for 10-12 months.	Baseline, 1 week, 1 month, recall at 10 months.	7 from carpal injection group and 6 from IM injection group returned with symptoms after 1 month and required second shot. One from first group and 2 from second group required third shot after 7.3±3.7 months. Response rate 50% in hand injections vs. 15.8% IM.	“Steroid injected at the site of entrapment is effective and suggest superiority to the intramuscular route in the management of ICTS.”	Carpal injections appear superior to intramuscular steroids.
Ly-Pen 2012 (Score=6.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 101 with clinical diagnosis and neuro-physiological confirmation of CTS.	Mean age: 51.9±12.6 years; no mention of sex.	Surgical decompression (n = 83 wrists) vs. Local steroid injection (n = 83 wrists).	Baseline, 3, 6, 12, 24 months.	56 underwent surgery, 24 had CTS in both hands. 84% required 2 injections. At 24-months follow-up, 60.2% of wrists in injection group and 68.8% in surgery group achieved 20% response in nocturnal paraesthesias, (p = 0.256). Surgery more effective than injection for self-perceived functional impairment, with	“Our findings suggest that both local steroid injection and surgical decompression are effective treatments in alleviating symptoms in primary CTS at 2-year follow-up.”	High drop out at 24 months. Injection superior at 3 months’ time point but release superior at 12 months and 24 months.

								mean VAS score of 6.21 (8.81) in injection group vs. 2.02 (7.23) in surgery group, (p = 0.008).		
Celiker 2002 (Score=5.5)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 23 with bilateral or unilateral CTS, EDS confirmed.	Mean age: 48.2±12.6 years; 1 male, 22 females.	Group A: acetaminophen 120mg a day with splints at night (n=11). Group B: 40mg methylprednisolone acetate (1ml) (n=12)	Baseline, 2 weeks, 8 weeks.	VAS pain scores (baseline/2 nd week/8 th week): NSAID plus splint 7.9±1.4/4.3±0.9/1.7±1.0 vs. injection 7.0±2.2/3.1±2.5/1.8±1.9 (P>0.05). Symptom severity scale results similar (p>0.05).	“Both splinting combined with the use of a nonsteroidal anti-inflammatory drug and steroid injection into the carpal tunnel resulted in significant improvement in carpal tunnel syndrome.”	No placebo controlled. Suggests splinting and NSAID may be as effective as injection.
Bilgici 2010 (Score=5.5)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 34 with CTS.	Mean age: 45.7±8.5 years; 9 males, 22 females.	Group A, ultrasound treatment (n = 16) vs. Group B, local corticosteroid injection plus splinting (n = 18). Follow-up for 8 weeks.	Baseline, 4 weeks, 8 weeks.	VAS pain/severity of symptoms/functional status / grip strength, (p <0.001) and two point discrimination (p <0.016). Group A, improved for all clinical outcomes, (p <0.001), except grip strength.	“Both ultrasound treatment and corticosteroid injection plus splinting were effective on the clinical symptoms and the electrophysiological findings of CTS.”	Both groups improved meaningfully over time, but differences between groups minimal; one statistically significant difference.
Habib 2006 (Score=5.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 42 with symptoms of CTS and EDS confirmed. Age >18 years old.	Mean age: 42.15±11.9 years; 9 males, 23 females.	Local corticosteroid classic injection (n = 21) vs. 2-3cm distal to the wrist crease. Both with 12mg methylprednisolone acetate with 0.15ml lidocaine (n = 21). Follow-up for 12 months.	1, 3, 6, and 12 weeks.	81 % of classical injection and 71% new method injection patients had favorable response rate after 3 weeks (p = 0.468). Procedure time 8.48±1.123 seconds in new method group vs. 26.71±32.83 in classical group (p = 0.021). Mean±SD grade of pain: new method 4.38±1.523 vs. classic method 3.62±1.071 (p = 0.065).	“Local corticosteroid injection using the novel approach for the treatment of carpal tunnel syndrome is helpful, and the favorable response rates are comparable to those using the classic approach after 1, 3, 6, and 12 weeks.”	Suggests traditional injection technique may be superior.
O’Gradaigh 2000 (Score=5.0)	Intracarpal Glucocorticoid	RCT	No mention of sponsorship or COI.	N = 32 with suspected CTS and EDS confirmed. Age not reported.	No mention of age or sex.	Hydrocortisone 25mg or 100mg (A), hexacetonide 20mg (B), plus phase II;	Baseline, post treatment, 6 weeks, 6 months.	Results from Phase 1 (25mg/100mg/no injection) 66% vs. 63% vs. 5% better or much better (NS between injected groups’ differences).	“As low dose steroid is as effective, and potentially less toxic, this should be the recommended dose for injection of carpal tunnel syndrome.”	Two studies in one report with the first finding benefits of injection. Second trial found minimal incremental gain for higher dose.

	Injections					Triamcinolone 20mg or Hydrocortisone 100mg (n = 33) vs. Control no injection (n = 20).		Symptoms improved in Phase 2 in 72% vs. 67% (NS).		
Ucan 2006 (Score=5.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 57 with CTS diagnosis.	Mean age: 44.63±8.96 years; 4 males, 53 females.	Group A or Splinted (S) hands splinted in neutral position with standard cotton polyester splint (n = 23) vs. Group B or single steroid injection (20mg triamcinolone acetate plus 20mg lidocaine) and splinted (SLSI) (n = 23) vs. Group C: Surgery (OCTR) (N = 11).	Baseline, 3 and 6 months.	Boston Questionnaire scores (baseline/3rd month/6th month): splinting 2.66±0.35/1.39±0.37/1.54±0.31 vs. splint plus steroid 2.79±0.63/1.41±0.32/1.96±0.63 vs. CTR 3.09±0.5/1.86±0.6/1.41±0.31 (p = 0.004). Palm-wrist median sensory nerve velocities: splint 27.26±5.3/29.6±7.16/29.56±4.83 vs. splint plus steroid 26.35±4.12/31.57±4.33/28.74±6.19 vs. CTR 23.98±4.28/32.20±4.17/33.15±4.1 (NS between groups). Those completely/almost satisfied 3rd/6th months splinting 69.6%/34.8% vs. splint plus steroid 100%/82.6% vs. CTR 45.5%/90.9%.	“All treatment methods were found to be effective, but despite the complications and the relatively long period to return to work, OCTR was superior to conservative methods in long term.”	Baseline differences present. Appears to have targeted lower enrollment for surgery without stating such.
Lee 2014 (Score=4.5)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 44 patients with mild to moderate idiopathic CTW with a neurophysiological confirmation consisting of N = 75 hands.	Mean age: 52.7 years; 3 males, 41 females.	In-plane ulnar approach carpal tunnel injection group (n = 24) vs out-plane carpal tunnel injection group (n = 26) vs blind injection group (n = 25). All three were injections of 40 mg of triamcinolone.	Follow up at baseline, 4 and 12 weeks.	Mean baseline SSS for the blind group was 30.21 vs 20.18 at 12 weeks (p<0.05). Mean baseline SSS for the out-plane group was 28.30 vs 17.41 at 12 weeks (p<0.05). Mean baseline SSS for the in-plane group was 29.55 vs 12.18 at 12 weeks (p<0.05). No significant between group differences. Number of posttreatment complications for the blind group was 15 vs 7 for the out-plane group vs 4 for the in-plane group.	“US-guided local steroid injection using an in-plane ulnar approach in the CTS may be more effective than out-plane or blind injection.”	Methodological details sparse. Baseline differences in symptoms duration. No meaningful differences between groups for most outcomes. Blind injection had more complications.

Atthakomol 2018 (Score=4.5)	Intracarpal Glucocorticoid Injections	RCT	Sponsored by the Faculty of Medicine, Chiang Mai University. No COI.	N = 25 CTS patients diagnosed based on guidelines of the American Academy of Neurology for CTS.	Mean age: 49.4 years; 6 males, 19 females.	Radial extracorporeal shock wave therapy (rESWT) group – 15 Hz frequency, 5000 shocks, BTL-6000 SWT, for 3-7 minutes (n = 13) vs local corticosteroid injection (LCsI) group – 1 ml of triamcinolone (acetanide) 10 mg mixed with 1 ml of 1% lidocaine (n = 12).	Follow up at baseline, 1, 4, 12, and 24 weeks.	Mean VAS pain score for the rESWT group at baseline was 2.4 vs 0.35 at 24 weeks (p = 0.0075). Mean VAS pain score for the LCsI group at baseline was 2.6 vs 1.7 at 24 weeks (p = 0.19). Mean difference of SSS at 12 to 24 weeks between rESWT and LCsI groups was -5.1 (p = 0.036)	“Treatment of CTS using single-dose rESWT has a carry-over effect lasting up to 24 weeks suggesting that single-dose rESWT is appropriate for treatment of mild to moderate CTS and provides longer-lasting benefits than LCsI.”	Small sample size (n=25). Methodological details sparse.
Karadas 2011 (Score=4.5)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship. No COI.	N = 99 with clinical and electrophysiologic evidence of CTS, older than 18 years.	Mean age: 47.1±10.7 years; 13 males, 86 females.	Group 1 40mg triamcinolone acetanide (n = 34) vs. Group 2 4ml 1% procaine HCl (n = 32) vs. Group 3 both 40mg triamcinolone acetanide and 4ml 1% procaine HCl (n = 33).	Follow-up at baseline, 2, and 6 months after injection.	VAS scores improved significantly in each group at 2 and 6 months after treatment, (p <0.05). No significant differences shown for electrophysiologic findings at baseline, 2, and 6 months, (p >0.05).	“Local procaine HCl injection and steroid injection effectively reduced the symptoms of CTS and equally improved electrophysiologic findings.”	Combined triamcinolone acetanide and procaine HCL may be superior to individual medications alone.
Karadas 2012 (Score=4.5)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 57 with clinically suspected primary CTS. Age >18 years.	Mean age: 47.2±10.2 years; 7 males, 50 females.	Group 1 injected with 1ml 0.09% saline (n = 19) vs. Group 2 injected with 40mg triamcinolone acetanide (n = 20) vs. Group 3 injected with 4ml 1%		Clinical/electrophysiological evaluations improved significantly in groups 2 and 3 at post-treatment, (p <0.05). No significant changes in group 1, (p >0.05). Groups 2 and 3 better scores vs. group 1 at 2, 6 months, (p <0.05). No difference between groups 2 and 3 in terms of change scores	“Triamcinolone acetanide and procaine HCl injections are effective regarding short- and long-term outcomes compared with placebo injections, and procaine HCl injection was as effective as steroid injection.”	Both active interventions superior to saline injection.

						procaine HCl (N = 18).		of any terms at post-treatment, (p >0.05).		
Seok 2012 (Score=4.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship. No COI.	N = 31 patients with positive Tinel sign or Phalen test that had numbness and tingling in at least two of the first, second and third digits. All patients were diagnosed with mild to moderately severe CTS using electrophysiologic studies	Mean age: 50.3 years; 5 males, 26 females.	One session of extracorporeal shock wave therapy (ESWT) with 1000 shocks at a frequency of 360 shocks per minute group (n = 15) vs local corticosteroid (CS) injection of 40 mg triamcinolone acetonide group (n = 16)	Follow up at baseline, 1 and 3 months.	No significant in group differences were seen in the ESWT group. Baseline NCV of median sensory nerve for the injection group was 34.35 vs 40.06 at 3 months (p<0.05). No significant between group difference.	“ESWT can be as useful as CS injection for relieving symptoms of carpal tunnel syndrome. Furthermore, in contrast to CS injection, it has the merit of being noninvasive”	No meaningful differences between groups. Methodological details sparse. Data suggest trend favoring injection at 3mo., which may be underpowered.
Eslamian 2017 (Score=4.0)	Intracarpal Glucocorticoid Injections	RCT	No sponsorship or COI.	N = 47 patients with a primary idiopathic CTS with a clinical and electrodiagnostic confirmation of CTS. N = 60 hands.	Mean age: 52.4 years; 2 males, 45 females.	Ultrasound guided (US) steroid injections (n = 30 hands) vs landmark (LM) guided steroid injections (n = 30 hands). Both steroid injections were 40 mg of methylprednisolone without local anesthetic.	Follow up at baseline and 12 weeks.	Boston Carpal Tunnel Questionnaire (BCTQ) total score at baseline for the US group was 2.86 vs 1.58 at 12 weeks (p<0.001). BCTQ total score at baseline for the LM group was 3.08 vs 1.80 at 12 weeks (p<0.001). No significant between group differences.	“Both US-guided and LM-guided steroid injections were effective in reducing the symptoms, improving the function and electrodiagnostic findings of CTS. Although there was better symptomatic improvement with US-guided injections and better increase in sensory nerve action potential amplitude with LM-guided injection, a significant difference was not generally observed between US-guided and LM-guided CTS injections.”	Methodological details sparse. Both groups had improvements for most outcomes but no meaningful difference between groups.
Khosrawi 2015 (Score=4.0)	Intracarpal Glucocorticoid	RCT	No sponsorship or COI.	N = 43 patients with a diagnosis of severe CTS based on the clinical signs	Mean age: 51.4 years; 6 males, 37 females.	Full-time neutral wrist splint for 12 weeks group (n = 22; Group A) vs injections of 40 mg Depo-	Follow up at baseline, 4 and 12 weeks.	Median nerve distal motor latency at baseline for group A was 5.76 vs 5.04 at 12 weeks (p<0.001). Median nerve distal motor latency at baseline for group A was 6.55 vs 4.88 at 12	“considering some findings regarding the superior effect of splinting plus local steroid injection on functional status scale and median nerve distal motor latency, it seems that using combination therapy could be more	Methodological details sparse. No significant difference between groups.

	Injections			and symptoms of CTS and electrodiagnostic evidence of severe CTS.		Medrol 1cc and full time neutral wrist splint for 12 weeks.		weeks (p<0.001). No significant between group differences.	effective for long-term period specially in the field of functional improvement of CTS.”	
Gökoğlu 2005 (Score=4.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 30 with clinical and EDS evidence of CTS.	Mean age: 48.0 ± 8.2 years; 3 males, 27 females.	Group 1: 40mg methylprednisolone acetate injected (n = 15) vs. Group 2: iontophoresis of dexamethasone sodium phosphate (n = 15).	Follow-up for 2 and 8 weeks.	Symptoms severity scores (baseline/week 2/week 8): injection 2.7±0.8/1.9±0.7/ 1.6±0.6 vs. iontophoresis 3.1±0.8/2.5±0.9/ 2.2±1.0 (p <0.05) for Weeks 2 and 8 favoring injection. Functional status scale and VAS scores similarly favored injection.	“Success of both iontophoresis of dexamethasone sodium phosphate and injection of corticosteroids, but symptom relief was greater at 2 and 8 weeks with injection of corticosteroids.”	Suggests injection superior to iontophoresis of dexamethasone.
Üstün 2013 (Score=4.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship. No COI.	N = 46 with idiopathic CTS.	Mean age: 44.3±10.9 years; 5 males, 41 females.	US-guided device of 20mg methylprednisolone (n = 23) vs. Palpation-guided approach or blind injection group of 20mg methylprednisolone using ulnar side approach (n = 23).	Follow-up at 6 and 12 weeks.	Scores for symptom severity and functional status improved at 6 and 12 weeks after the treatment, (p < 0.05). Boston Carpal Tunnel Questionnaire (BCTQ) symptoms / function: 6 weeks; 1.33±0.55 and 12 weeks; 1.30±0.45 vs 1.41± 0.59 and 1.67±0.73 Palpation group, (p <0.001)/1.33±0.46 and 1.36±0.49 vs 1.52±0.87 and 1.86±1.09, (p <0.001).	“[B]oth US-guided and blind steroid injections were effective in reducing the symptoms of CTS and improving the function, an earlier onset/better improvement of symptom relief suggests that US-guided steroid injection may be more effective than are blind injections in CTS.”	Data suggest ultrasound guided injection superior to blind for providers with this level of experience.
Girlanda 1993 (Score=4.0)	Intracarpal Glucocorticoid Injections	RCT	No mention of sponsorship or COI.	N = 32 with clinical and EDS evidence of CTS. Age 36-60 years.	Mean age: 45.48±13.3 years; 6 males, 26 females.	Methylprednisolone acetate 15mg acetate injection locally (n = 9) vs. saline solution same amount as treatment group (n = 8). Study on long-term effects (n = 8).	Baseline, 1 week, 2 weeks, 1 month, 2 months.	Paresthesias significantly improved from baseline in both groups, but more improved in steroid group (p <0.0001 vs. p <0.01); statistical significance of improvements in saline disappeared at 1 month; persisted through 2 months in steroid. 50% of nerves worse within 6 months; 90% within 18 months; 8% of nerves remained improved at 2-year.	“Only a small percentage (8%) of the nerves remained improved at the 2-years follow-up.”	Methods details sparse, especially for long duration components of study. Patients had symptoms over 4 years.

Glucocorticosteroids vs. NSAIDs

Celiker 2002 (score=5.5)	NSAID /Corticosteroid Injection	RCT	No mention of sponsorship or COI.	N = 23 with bilateral or unilateral CTS, EDS confirmed.	Mean age: 48.2 years; 1 male, 22 females	Group A: acetaminophen 120mg a day with splints at night. Group B: 40mg methylprednisolone acetate (1ml)	8 weeks	VAS pain scores (baseline/2 nd week/8 th week): NSAID plus splint 7.9±1.4/4.3±0.9/1.7±1.0 vs. injection 7.0±2.2/3.1±2.5/1.8±1.9 (P>0.05). Symptom severity scale results similar (p>0.05).	“Both splinting combined with the use of a nonsteroidal anti-inflammatory drug and steroid injection into the carpal tunnel resulted in significant improvement in carpal tunnel syndrome.”	No placebo controlled. Suggests splinting and NSAID may be as effective as injection.
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Glucocorticosteroids vs. Anesthetics

Karadas 2011 (score=4.5)	Corticosteroid/ Anesthetic Injection	RCT	No mention of sponsorship. No COI.	N = 99 with clinical and electrophysiologic evidence of CTS	Mean age: 47.1 years; 13 males, 86 females	Group 1 40mg triamcinolone acetonide (n = 34) vs. Group 2 4ml 1% procaine HCl (n = 32) vs. Group 3 both 40mg triamcinolone acetonide and 4ml 1% procaine HCl (n = 33).	Follow-up at baseline, 2 and 6 months after injection.	VAS scores improved significantly in each group at 2 and 6 months after treatment, (p <0.05). No significant differences shown for electrophysiologic findings at baseline, 2, and 6 months, (p >0.05).	“Local procaine HCl injection and steroid injection effectively reduced the symptoms of CTS and equally improved electrophysiologic findings.”	Combined triamcinolone acetonide and procaine HCl may be superior to individual medications alone.
Karadas 2012 (score=4.5)	Corticosteroid/ Anesthetic Injection	RCT	No mention of sponsorship or COI.	N = 57 with clinically suspected primary CTS.	Mean age: 47.2 years; 7 males, 50 females	Group 1 injected with 1ml 0.09% saline (n=19) vs. Group 2 injected with 40mg triamcinolone acetonide (n = 20) vs. Group 3 injected with 4ml 1% procaine HCl (n=18).	Follow-up at 1, 2 and 6 months.	Clinical/electrophysiological evaluations improved significantly in groups 2 and 3 at post-treatment, (p <0.05). No significant changes in group 1, (p >0.05). Groups 2 and 3 better scores vs. group 1 at 2, 6 months, (p <0.05). No difference between groups 2 and 3 in terms of change scores of any terms at post-treatment, (p >0.05).	“Triamcinolone acetonide and procaine HCl injections are effective regarding short- and long-term outcomes compared with placebo injections, and procaine HCl injection was as effective as steroid injection.”	Both active interventions superior to saline injection.

Glucocorticosteroids vs. Iontophoresis

Bakhtiar y 2013	Corticosteroid/	RCT	Sponsored by Research Deputy of Semnan	N = 34 mild to moderate CTS confirmed by	Mean age: 46.4 years;	Iontophoresis of Dex-P 0.4% (n = 26) vs.	2, 4 weeks.	Pain at end of treatment and 4 weeks later significantly favored phonophoresis vs	“Our clinical trials showed that phonophoresis of Dex-P is more effective	Data suggest phonophoresis superior to iontophoresis
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(score=7.0)	Iontophoresis		University of Medical Sciences. No COI.	electromyography.	no mention of sex.	Phonophoresis of Dex-P 0.4%, plus applied over wrist chin and pulsed (20%) ultrasound waves (n = 26).		iontophoresis of Dex-P intervention, (p <0.01). Motor latency/motor action potential amplitude/finger pinch strength/hand grip strength/pain relief: [mean difference 0.8 m/s; 95% (CI), 0.5-1.1]/ (4.1 mV; 95% CI, 3.0 -5.2)/ (31.6 N; 95% CI, 15.9-47.3)/ (27.1 N; 95% CI, 13.5-40.5)/ and 2.1 points on 10-point scale; 95% CI, 1.3 - 2.9.	than iontophoresis of Dex-p treatment in patients with mild to moderate CTS.”	
Gökoğlu 2005 (score=4.0)	Corticosteroid/Iontophoresis	RCT	No mention of sponsorship or COI.	N = 30 with clinical and EDS evidence of CTS.	Mean age 48.0 ± 8.2 years; 3 males, 27 females	Group 1: 40mg methylprednisolone acetate injected (n = 15) vs. Group 2: iontophoresis of dexamethasone sodium phosphate (n = 15).	Follow-up for 2 and 8 weeks.	Symptoms severity scores (baseline/week 2/week 8): injection 2.7±0.8/1.9±0.7/ 1.6±0.6 vs. iontophoresis 3.1±0.8/2.5±0.9/ 2.2±1.0 (p <0.05) for Weeks 2 and 8 favoring injection. Functional status scale and VAS scores similarly favored injection.	“Success of both iontophoresis of dexamethasone sodium phosphate and injection of corticosteroids, but symptom relief was greater at 2 and 8 weeks with injection of corticosteroids.”	Suggests injection superior to iontophoresis of dexamethasone.
Injection vs. Ultrasound										
Bilgici 2010 (score=5.5)	Ultrasound/Steroid Injection	RCT	No mention of sponsorship or COI.	N = 34 with CTS.	Mean age: 45.7 years; 9 males, 22 females	Group A, ultrasound treatment (n=16) vs. Group B, local corticosteroid injection plus splinting (n=18).	Follow-up for 8 weeks	VAS pain/severity of symptoms/functional status / grip strength, (p <0.001) and two point discrimination (p <0.016). Group A, improved for all clinical outcomes, (p <0.001), except grip strength.	“Both ultrasound treatment and corticosteroid injection plus splinting were effective on the clinical symptoms and the electrophysiological findings of CTS.”	Both groups improved meaningfully over time, but differences between groups minimal; one statistically significant difference.
Glucocorticosteroids vs. Range of Doses										
Dammers 2006 (score=9.0)	Glucocorticosteroids	RCT	No mention of sponsorship or COI.	N = 136 EDS confirmed diagnosis of CTS.	Mean age 51.3 years; 30 males, 102 females	20mg methylprednisolone injections (n = 45) vs. 40mg methylprednisolone injections (n=43) vs. 60mg methyl-	Follow-up for 3 months.	73% of 60mg, 53% of 40mg and 56% of 20mg groups symptom free or requiring no further treatment at 6 months. Only 22% treated with 1-2 injections methylprednisolone during first year referred to surgery (p <0.05).	“One injection of methylprednisolone close to the carpal tunnel reduces the number of patients requiring surgery.” 60mg dose more effective than lower doses, with 2nd injection possibly increasing recurrence of symptom-free patients.	Injection site 4cm proximal to distal wrist crease.

						prednisolone injections (n=44).				
Injection Method										
Üstün 2013 (score=4.0)	Ultrasound/Blind Injections	RCT	No mention of sponsorship. No COI.	N = 46 with idiopathic CTS.	Mean age: 44 years; 5 males, 41 females	US-guided device of 20mg methylprednisolone (n = 23) vs. Palpation-guided approach or blind injection group of 20mg methylprednisolone using ulnar side approach (n = 23).	Follow-up at 6 and 12 weeks.	Scores for symptom severity and functional status improved at 6 and 12 weeks after the treatment, (p < 0.05). Boston Carpal Tunnel Questionnaire (BCTQ) symptoms / function: 6 weeks; 1.33±0.55 and 12 weeks; 1.30±0.45 vs 1.41± 0.59 and 1.67±0.73 Palpation group, (p <0.001)/1.33±0.46 and 1.36±0.49 vs 1.52±0.87 and 1.86±1.09, (p <0.001).	“[B]oth US-guided and blind steroid injections were effective in reducing the symptoms of CTS and improving the function, an earlier onset/better improvement of symptom relief suggests that US-guided steroid injection may be more effective than are blind injections in CTS.”	Data suggest ultrasound guided injection superior to blind for providers with this level of experience.
Glucocorticosteroids (Injection vs. Oral or by Injection Sites)										
Wong 2001 (score=9.0)	Steroid/Oral Injection	RCT	No mention of sponsorship or COI.	N = 62 with newly diagnosed CTS >3 months.	Mean age: 49 years; 7 males, 53 females	Steroid or prednisolone 25mg PO QD for 10 days (n = 30) vs. Oral steroid or prednisolone acetate 15mg injection (n = 30).	Follow-up for 12 weeks.	Global symptom scores (injection/oral): baseline (25.0±6.4/25.7±8.3), 2 weeks (13.6±7.5/17.8±10.0), 8 weeks (13.7±8.3/20.8±8.7), and 12 weeks (14.3±8.4/ 21.4±9.6). GSS scores borderline significant at 2 weeks (p = 0.07), but significant at 8 and 12 week follow-ups (p = 0.002 and p = 0.004).	“Local steroid injection was superior to oral corticosteroids over a 3-month period in patients with CTS.”	Suggests injections superior to oral glucocorticosteroids.
Habib 2006 (score=5.0)	Corticosteroid Injection	RCT	No mention of sponsorship or COI.	N = 42 with symptoms of CTS and EDS confirmed. Age >18 years old.	Mean age: 42.2 years; 9 males, 33 females	Local corticosteroid classic injection (n = 21) vs. 2-3cm distal to the wrist crease. Both with 12mg methyl-prednisolone acetate with 0.15ml lidocaine (n = 21).	Follow-up for 1, 3, 6 12 weeks	81 % of classical injection and 71% new method injection patients had favorable response rate after 3 weeks (p = 0.468). Procedure time 8.48±1.123 seconds in new method group vs. 26.71±32.83 in classical group (p = 0.021). Mean±SD grade of pain: new method 4.38±1.523 vs. classic method 3.62±1.071 (p = 0.065).	“Local corticosteroid injection using the novel approach for the treatment of carpal tunnel syndrome is helpful, and the favorable response rates are comparable to those using the classic approach after 1, 3, 6, and 12 weeks.”	Suggests traditional injection technique may be superior.

Glucocorticosteroids vs. Intramuscular Injection

Özdoğan 1984 (score=6.0)	Corticosteroid/ Intra muscular Injections	RCT	No mention of sponsorship or COI.	N = 37 with idiopathic CTS.	Mean age 45.8±8.7 years; 0 males, 37 females	Steroid injection, 1.5mg betamethasone disodium phosphate and acetate suspension (n=18) vs. Placebo into deltoid double dummy (n=19).	Follow-up for 10-12 months.	7 from carpal injection group and 6 from IM injection group returned with symptoms after 1 month and required second shot. One from first group and 2 from second group required third shot after 7.3±3.7 months. Response rate 50% in hand injections vs. 15.8% IM.	“Steroid injected at the site of entrapment is effective and suggest superiority to the intramuscular route in the management of ICTS.”	Carpal injections appear superior to intramuscular steroids.
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Intracarpal Tunnel Injection with Glucocorticosteroids vs. Saline or No Injection

Armstrong 2004 (score=9.5)	Corticosteroid/ Placebo	RCT	Sponsored by Southern California Kaiser Permanente Department of Research and Evaluation. No mention of COI.	N = 81 with typical symptoms of CTS and EDS confirmed.	Mean age: 51.6 years; 18 males, 63 females	Steroid injections or Betamethasone 6mg (n = 43) vs. Placebo group or saline (n = 36).	Follow-up for 18 months.	Changes in median sensory latencies -0.19±0.27 vs. -0.04±0.14 (p = 0.01). Changes in symptoms scores also favored corticosteroid injections -0.78 ±0.80 vs. -0.19 ±0.62 (p <0.01). Satisfaction rates 70% vs. 34% (p = 0.001). In subsequent open label follow-up, additional injections performed per patient requests (up to 7 injections for a few); 18 (39.1%) referred for surgery, 37.0% reported adequate symptom relief.	“Steroid injections are a safe and effective treatment for temporary relief of CTS symptoms for patients who did not improve with splinting and activity modification.”	Unblinded after 2 weeks.
Peters-Veluthamalingal 2010 (score=7.5)	Corticosteroid/ Placebo	RCT	No mention of sponsorship. No COI.	N = 69 with clinical diagnosis of CTS.	Mean age: 54.6 years; 16 males, 53 females	1ml triamcinolonacet onide (TCA) 10mg/ml (n=36) vs. 1ml saline (NaCl) 0.9%, placebo 1-2 injections (n=33).	Follow-up 1, 3, 6 and 12 months	Steroid-group showed better direct treatment response (p = 0.013), perceived improvement (p = 0.01) and more improvement than NaCl-group in outcomes SSS BCTQ score (from 2.872 to 1.948 in TCA group vs. from 2.815 to 2.529 in NaCl group) and FSS BCTQ score (2.456 to 1.881 in TCA group vs. 2.353 to 2.366 in NaCl group). Mean difference in change score 0.637 (95% CI:	“Corticosteroid injections for CTS provided by general practitioners are effective regarding short-term outcomes when compared to placebo injections.”	Multiple injections given if patient result was “not satisfactory” Data suggest steroid injections superior to NaCl for short term outcomes.

								0.320, 0.960; (p <0.001)) for SSS BCTQ and mean difference in change score 0.588 (95% CI: 0.232, 0.944; p = 0.02) for FSS BCTQ. Number Needed to Treat to achieve satisfactory partial treatment response or complete resolution of symptoms and signs 3 (95% CI: 1.83, 9.72).		
O'Gradaigh 2000 (score=5.0)	Cortico steroid/ Placebo	RCT	No mention of sponsorship or COI.	N = 32 with suspected CTS and EDS confirmed.	No mention of mean age or sex.	Hydrocortisone 25mg or 100mg (A), hexacetonide 20mg (B), plus phase II; Triamcinolone 20mg or Hydrocortisone 100mg (n = 33) vs. Control no injection (n = 20).	Follow-up 6 weeks and 6 months.	Results from Phase 1 (25mg/100mg/no injection) 66% vs. 63% vs. 5% better or much better (NS between injected groups' differences). Symptoms improved in Phase 2 in 72% vs. 67% (NS).	"As low dose steroid is as effective, and potentially less toxic, this should be the recommended dose for injection of carpal tunnel syndrome."	Two studies in one report with the first finding benefits of injection. Second trial found minimal incremental gain for higher dose.
Girlanda 1993 (score=4.0)	Cortico steroid/ Placebo	RCT	No mention of sponsorship or COI.	N = 32 with clinical and EDS evidence of CTS.	Mean age: 45.5 years; 6 males, 26 females	Methylprednisolone acetate injection locally (n = 9) vs. saline solution same amount as treatment group (n = 8). Study on long-term effects (n = 8).	Follow-up every 2 months for 2 years.	Paresthesias significantly improved from baseline in both groups, but more improved in steroid group (p <0.0001 vs. p <0.01); statistical significance of improvements in saline disappeared at 1 month; persisted through 2 months in steroid. 50% of nerves worse within 6 months; 90% within 18 months; 8% of nerves remained improved at 2-year.	"Only a small percentage (8%) of the nerves remained improved at the 2-years follow-up."	Methods details sparse, especially for long duration components of study. Patients had symptoms over 4 years.
One vs. Two Injections										
Wong 2005 (score=9.0)	Steroid Injections	RCT	No mention of sponsorship or COI.	N = 40 with newly diagnosed CTS and NCS confirmed	Mean age: 46.9 years; 6 males, 24 females	Single injection group or methylprednisolone 15 mg injection (n=20) vs. Double-	40 week follow-up	Global Symptom Score Single vs. Double injections (pre/8/24/40 weeks): Single 26.7±10.1/15.2±9.9/15.9±10.6/12.6±9.1 vs. Double 25.6±11.6/11.4±7.6/13.0±9.7/14.1±11.0 (p>	"The results suggest that an additional steroid injection confers no added benefit to a single injection in terms of symptoms relief."	Both arms had active treatment

						injection group at 8 weeks of steroid or placebo (n=20)		0.19) all times. No differences in grip strengths or in NCS other than right hand which was borderline different at baseline (p = 0.08).		
Steroid vs. Placebo										
Atroshi 2013 (score=8.5)	Steroid Injections	RCT	Sponsored by grant from Region of Scania Research and Development Foundation and Ha'ssleholm Hospital Organization. No COI.	N = 111 with idiopathic CTS not previously treated with steroid injections.	Mean age: 46.7 years; 30 males, 81 females	80mg methylprednisolone (n=37) vs. 40mg methylprednisolone (n=37) vs. placebo (n=37).	10 weeks	At baseline CTS symptom severity score at 10 weeks improved those who received methylprednisolone vs. placebo (p = 0.003 for 80mg; p = 0.001 for 40mg methylprednisolone). At 1-year rates of surgery 73%, 81%, and 92% in 80mg methylprednisolone, 40mg methylprednisolone, and placebo groups. Those who received 80mg methylprednisolone less likely to have surgery (OR, 0.24 [CI, 0.06 to 0.95], (p = 0.042).	"Methylprednisolone injections for CTS have significant benefits in relieving symptoms at 10 weeks and reducing the rate of surgery 1 year after treatment, but 3 out of 4 patients had surgery within 1 year."	Data suggest both active treatments superior to placebo, no statistical differences between 80 mg and 40 mg steroid
Dammers 1999 (score=8.0)	Steroid Injection	RCT	No sponsorship and no COI.	N = 60 with carpal tunnel symptoms >3 months and NCS confirmed.	Mean age: 52 years; 10 males, 50 females	Intervention group or methylprednisolone 40mg plus 10mg lidocaine (n = 30) vs. Control group or lidocaine alone (n = 30).	Follow-up 3, 6, 9, 12 months	Percentage not needing 2nd treatment (1/3/6/9/12 month): steroid (77/63/57/53/50%) vs. placebo (20/7/7/7/7%), significant but no p-value reported. In open phase, 24 of 28 crossed over from controls and 50% of those had surgery, no p-value reported.	"A single injection with steroids close to the carpal tunnel may result in long term improvement and should be considered before surgical decompression."	Data suggest injection effective and 50% need no treatment for 1 year.
Splinting vs. Steroid vs. Surgery										
Wang 2017 (Score=5.5)	Splint/Steroid	RCT	No mention of sponsorship or COI.	N = 52 patients with typical symptoms of CTS persisting for at least 3 months. CTS diagnosis were	Mean age: 55.05 years; 11 males, 41 females.	Steroid injection (SI) group (n=26) or SI plus splinting group (n=26). SI for both groups was ultrasound guided with 1 mL of 10 mg (10mg/mL)	Follow up at baseline 6 and 12 weeks.	Mean Symptom Severity Scale (SSS) for SI only group was 1.96 at baseline vs 1.28 at 6 weeks (p<0.05) and 1.49 at 12 weeks (p<0.05). Mean SSS for SI plus splint group was 2.27 at baseline vs 1.30 at 6 weeks (p<0.05) and 1.32 at 12 weeks (p<0.05). The between group difference in SSS was -0.048	"In people with CTS, steroid injection combined with splinting resulted in modestly greater reduction of symptoms, superior functional recovery, and greater improvement in nerve function at 12-week follow-up as compared with steroid injection alone. However, these small differences are of unclear clinical significance."	Trends toward differences at baseline between groups for outcomes variables makes interpretation more challenging. Many incongruities within tables and text. Data suggest steroid injection (SI) + splint superior to SI alone at 12 weeks but not 6 weeks.

				confirmed using motor and sensory nerve conduction studies.		triamcinolone acetonide and 1 mL of 2% lidocaine hydrochloride.		(p=0.032) with SI plus splint being superior.		
Ucan 2006 (score=5.0)	Splint/Steroid/Surgery	RCT	No mention of sponsorship or COI.	N = 57 with CTS diagnosis	Mean age: 44.6 years; 4 males, 53 females	Group A or Splinted (S) hands splinted in neutral position with standard cotton polyester splint (n = 23) vs. Group B or single steroid injection (20mg triamcinolone acetate plus 20mg lidocaine) and splinted (SLSI) (n = 23) vs. Group C: Surgery (OCTR) (n=11).	Follow-up for 3 and 6 months.	Boston Questionnaire scores (baseline/3rd month/6th month): splinting 2.66±0.35/1.39±0.37/1.54±0.31 vs. splint plus steroid 2.79±0.63/1.41±0.32/1.96±0.63 vs. CTR 3.09±0.5/1.86±0.6/1.41±0.31 (p = 0.004). Palm-wrist median sensory nerve velocities: splint 27.26±5.3/29.6±7.16/29.56±4.83 vs. splint plus steroid 26.35±4.12/31.57±4.33/28.74±6.19 vs. CTR 23.98±4.28/32.20±4.17/33.15±4.1 (NS between groups). Those completely/almost satisfied 3rd/6th months splinting 69.6%/34.8% vs. splint plus steroid 100%/82.6% vs. CTR 45.5%/90.9%.	“All treatment methods were found to be effective, but despite the complications and the relatively long period to return to work, OCTR was superior to conservative methods in long term.”	Baseline differences present. Appears to have targeted lower enrollment for surgery without stating such.
Glucocorticosteroid vs. Surgery										
Hui 2005 (score=8.0)	Injection/Decompression	RCT	No mention of sponsorship or COI.	N = 50 with EDS confirmed idiopathic CTS.	Mean age: 49.5 years; 2 males, 48 females	Steroid injection or methylprednisolone acetate 15mg (n=25) vs. Decompression or open CTR (n=25).	Follow-up at 6 and 20 weeks.	Mean improvements in global symptoms scale: 24.2±11.0 vs. 8.7±13.0 (p <0.001). Grip strengths were: surgery 23.4±8.2 to 21.8±7.9 vs. injection 24.2±7.0 to 26.6±7.4 (p = 0.009). Sensory nerve conduction velocities: surgery 34.2±7.9 to 42.2±8.0 m/s vs. injection 37.3±8.0 to 40.5±6.3 (p = 0.003).	“Open carpal tunnel release resulted in better symptomatic and neurophysiologic outcome but not grip strength in patients with idiopathic carpal tunnel syndrome over a 20-week period.”	Suggests surgery superior.
Ly-Pen 2005 (score=6.5)	Injection/Decompression	RCT	No mention of sponsorship or COI.	N = 123 (163 wrists) with CTS.	Mean age 51.9 years; 8 males, 93 females	Betamethasone 6.4mg, 2 injections 2 weeks apart	Follow-up at 3, 6, and 12 months.	70% improvements in nocturnal paresthesias present (3/6/12 months): injection 86.7/69.9/61.4% vs. surgery	“Over the short term, local steroid injection is better than surgical decompression for the symptomatic relief of CTS. At 1 year, local steroid injection	Details sparse. Most patients had 2 injections. No clear surgical benefit vs. injection.

						(n=83 wrists) vs. Open Carpal Tunnel Release (n=80).		61.3/68.8/ 73.8% (p = 0.001/p = 1.0/p = 0.098).	is as effective as surgical decompression for the symptomatic relief of CTS.”	
Ly-Pen 2012 (score=6.0)	Injection/Decompression	RCT	No mention of sponsorship or COI.	N = 101 with clinical diagnosis and neuro-physiological confirmation of CTS.	Mean age: 51.5 years; 8 males, 93 females	Surgical decompression (n=83 wrists) vs. Local steroid injection (n=83 wrists).	Follow-up of 2 years.	56 underwent surgery, 24 had CTS in both hands. 84% required 2 injections. At 24-months follow-up, 60.2% of wrists in injection group and 68.8% in surgery group achieved 20% response in nocturnal paraesthesias, (p = 0.256). Surgery more effective than injection for self-perceived functional impairment, with mean VAS score of 6.21 (8.81) in injection group vs. 2.02 (7.23) in surgery group, (p = 0.008).	“Our findings suggest that both local steroid injection and surgical decompression are effective treatments in alleviating symptoms in primary CTS at 2-year follow-up.”	High drop out at 24 months. Injection superior at 3 months’ time point but release superior at 12 months and 24 months.

Evidence for the Use of Intramuscular Injections for CTS

There is 1 moderate-quality RCT incorporated into this analysis.(854)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: intramuscular injections, carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, tingling, wrist, hand, palm, finger, pain, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 36 articles in PubMed, 722 in Scopus, 3 in CINAHL, 40 in Cochrane Library and 0 in other sources. We considered for inclusion 8 from PubMed, 0 from Scopus, 1 from CINAHL, 2 from Cochrane Library and 0 from other sources. Of the 11 articles considered for inclusion, 3 randomized trials and 1 systematic study met the inclusion criteria.*

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: intramuscular injections, carpal tunnel syndrome, median nerve neuropathy, median neuropathy, median nerve disease, entrapment, neuropathy, nerve compression, burning, itching, numbness, tingling, wrist, hand, palm, finger, and pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 1 articles. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Özdoğan 1984 (Score=6.0)	Intramuscular Glucocorticosteroid Injections	RCT	No mention of sponsorship or COI.	N = 37 females: symptoms: burning pain, tingling, numbness in thumb, index and long fingers and palm.	Mean age: 45.8±8.7; 0 males, 37 females.	Group 1, received 1.5mg betamethasone disodium phosphate and acetate suspension into carpal tunnel and same volume of placebo (0.5 ml saline) into the deltoid muscle on same side (n = 18) vs.	1 week, 1 month, and 10 months after study completion.	Seven patients from carpal injection group and 6 patients from IM injection group returned with symptoms after 1 month and required 2nd shot. One from 1st group and 2 from 2nd group required 3rd shot after 7.3±3.7 months. Response rate 50% in hand injections	“Steroid injected at the site of entrapment is effective and suggest superiority to the intramuscular route in the management of ICTS.”	Data suggest intracarpal tunnel injections much more effective.

						Group 2, received 1.5mg betamethasone disodium phosphate and acetate suspension into deltoid muscle and same volume of placebo into carpal tunnel (n=19)		compared to 15.8% IM.		
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Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Özdoğan 1984 (Score=6.0)	Intramuscular Glucocorticosteroid Injections	RCT	No mention of sponsorship or COI.	N = 37 females: symptoms: burning pain, tingling, numbness in thumb, index and long fingers and palm.	Mean age: 45.8±8.7; 0 males, 37 females.	Group 1, received 1.5mg betamethasone disodium phosphate and acetate suspension into carpal tunnel and same volume of placebo (0.5 ml saline) into the deltoid muscle on same side (n = 18) vs. Group 2, received 1.5mg betamethasone disodium phosphate and acetate suspension into	1 week, 1 month, and 10 months after study completion.	Seven patients from carpal injection group and 6 patients from IM injection group returned with symptoms after 1 month and required 2nd shot. One from 1st group and 2 from 2nd group required 3rd shot after 7.3±3.7 months. Response rate 50% in hand injections compared to 15.8% IM.	“Steroid injected at the site of entrapment is effective and suggest superiority to the intramuscular route in the management of ICTS.”	Data suggest intracarpal tunnel injections much more effective.

						deltoid muscle and same volume of placebo into carpal tunnel (n=19)				
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Evidence for the Use of Insulin Injections for CTS

There are 2 moderate-quality RCT incorporated into this analysis.(872, 873)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Insulin injections and carpal tunnel syndrome, CTS, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 6 articles in PubMed, 836 in Scopus, 1 in CINAHL, 39 in Cochrane Library and 0 in other sources. We considered for inclusion 3 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 3 articles considered for inclusion, 2 randomized trials and 1 systematic studies met the inclusion criteria.*

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: insulin injections and carpal tunnel syndrome, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, and pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 403 articles. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Ozkul 2001 (Score=6.0)	Insulin Injections	RCT	No mention of sponsorship or COI.	N = 43 with non-insulin-dependent diabetes mellitus (NIDDM) with mild to moderate CTS.	Mean age: 47.7±1.3; 0 males, 50 females.	Group 1, received 0.3 mL-12 U of NPH insulin one time a week for 7 weeks (n=22) vs. Group 2, received placebo (0.3 mL-0.9% saline	Follow up at baseline, 1, 2, 3, 4, 5, 6, 7, 15, and 23 weeks.	Mean±SD median nerve motor distal latency (MNMDL): decrease 5 weeks insulin group 4.52±0.12 vs. placebo 4.80±0.03ms (p <0.05) and continued to 23	“[L]ocal insulin injections more significantly decreased MNMDL [median nerve motor distal latency], increase MNSV [median nerve sensory velocity] and reduces GSS [global symptom score] than the placebo in NIDDM patients with CTS.”	All had gluco-corticosteroid injection. Suggestive results that need confirmation.

						solution) injected into carpal tunnel weekly for 7 week (n=21)		weeks (p <0.01). Mean±SD median nerve sensory velocity (MNSV): difference more significant insulin group vs placebo over whole study (p <0.01).		
Ashraf 2009 (Score=4.0)	Insulin Injections	RCT	No mention of sponsorship or COI.	N = 50 with non-insulin dependent diabetes mellitus; 20 had bilateral involvement, had symptoms and signs of CTS confirmed by standard electro diagnosis.	Mean age: 51.3±4.5; 15 males, 35 females.	Group 1, received injection into carpal tunnel (10IU of NPH insulin) (n=30 hands) vs. Group 2, received Physiotherapy (2 periods with 10 sessions) (n=32 hands)	Follow up at baseline, 2, 4, and 6 weeks.	In both groups decrement of distal motor latency (DML) of median nerves statistically significant. In both groups the increment of sensory nerve conduction velocity was statistically significant. Also, decrement of pain, paresthesia, numbness, weakness/ clumsiness and nocturnal awaking was statistically significant in both groups. But no significant	“In conclusion, in the present study, local insulin injections significantly reduced symptoms as the physiotherapy in NIDDM patients with CTS. But clinical significant difference in compare with physiotherapy was not seen. In summary two local insulin injections had no significant difference with compare to 20 sessions physiotherapy. Although these findings are promising, further studies with insulin are needed to verify its effectiveness as a treatment for CTS and other degenerative nerve diseases.”	No differences between groups

								difference between two groups.		
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Evidence for the Use of Botulinum Injections for CTS

There is 1 moderate-quality RCT incorporated into this analysis.(874)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: botulinum toxin, botox or botulinum Injection, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, and pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 11 articles in PubMed, 201 in Scopus, 2 in CINAHL, and 1 in Cochrane Library. We considered for inclusion 1 from PubMed, 0 from Scopus, CINAHL, and Cochrane Library. Of the 1 article considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.*

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: Botulinum toxin, Botox or Botulinum Injection, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 5 articles. Of the 5 articles we considered for inclusion 0. Of the 0 considered for inclusion,0 are randomized controlled trials and 0 systematic reviews.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Breuer 2006 (score=7.5)	Botulinum Injections	RCT	Sponsored by Elan Pharmaceuticals, San Francisco, California. No mention of COI.	N = 20 with hand pain and discomfort associated with CTS.	No mention of mean age; no mention of sex.	Group 1, received 2,500 units of botulinum toxin B injection into carpal tunnel (N=11) vs. Group 2, received injections of placebo	Follow up at baseline, 5, 9, and 13 weeks.	Response rates for botulinum toxin B and placebo groups: 126/143 (88.1%) vs. 117/117 (100%).	“Botulinum toxin B is not dramatically superior to placebo for the relief of CTS symptoms.”	Small sample size. Few screened (20/388) randomized. Suggests not effective.

						(Normal saline solution) (N=9)				
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Evidence for the Use of Carpal Tunnel Surgical Release

There are 7 high-(763, 851, 931, 937, 938, 955, 956) and 36 moderate-quality (one with two reports)(641, 777, 778, 852, 853, 907, 911, 914-918, 921-925, 928, 929, 932, 935, 936, 939-941, 945, 946, 948-954, 957, 959, 960) RCTs and crossover trials incorporated into this analysis. There are 13 low-quality RCTs(407, 846, 913, 930, 961-969) in Appendix 2.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: carpal tunnel surgical release, Knifelight, open release, endoscopic, epineurotomy, neurolysis, flexor retinacular, ulnar bursal preservation, mini palmer incision, flexor tenosynovectomy, biopsy of abnormal tenosynovium and carpal tunnel syndrome, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective studies, prospective studies, epidemiological studies, epidemiological research, and Nonexperimental Studies. We found and reviewed 179 articles in PubMed, 84 in Scopus, 17 in CINAHL, 45 in Cochrane Library and 0 in other sources. We considered for inclusion 56 articles from PubMed, 2 from Scopus, 2 from CINAHL, 1 from Cochrane Library and 3 from other sources. Of the 64 articles considered for inclusion, 51 randomized trials and 12 systematic studies met the inclusion criteria.*

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: carpal tunnel surgical release, Knifelight, open release, endoscopic, epineurotomy, neurolysis, flexor retinacular, ulnar bursal preservation, mini palmer incision, flexor tenosynovectomy, biopsy of abnormal tenosynovium and carpal tunnel syndrome, median nerve neuropathy, median neuropathy, median nerve disease entrapment, neuropathy nerve compression, burning, itching, numbness, tingling, and pain. ; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies; Carpal Tunnel Syndrome to find 77 articles. Of the 77 articles we considered for inclusion 28. Of the 28 considered for inclusion, 18 are randomized controlled trials and 10 systematic reviews.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Carpal Tunnel Release vs. Non-surgical Therapy										
Gerritsen 2002 (score=8.5)	Carpal Tunnel Release Surgery	RCT	Sponsored by a grant from the Health Care Insurance Council of the Netherlands. No mention of COI.	N = 176 EDS confirmed.	Mean age: 49 years; 33 males, 143 females	Open release (n = 87) vs Splinting for 12 months (n = 89).	Follow-up at 1, 3, 6, 12 and 18 months.	Overall success rates statistically superior for all 5 measurements other than 1st month (1/3/6/12/18 months): 29 vs. 42% (p = 0.07)/80 vs. 54% (p	“Treatment with open carpal tunnel release surgery resulted in better outcomes than treatment with wrist splinting for patients with CTS.”	Duration of symptoms was somewhat worse in splinting group (median 52 vs. 40 weeks, NS). Both treatment arms document

								<p><0.001)/94 vs. 68% (p<0.001)/92 vs. 72% (p = 0.002) / 90 vs. 75% (p = 0.02). Nights awakening with symptoms and paresthesias not significantly different at 12 or 18 months. Five (5.7%) in surgery group had wound infection; CRPS/RSD in one. Median-ulnar latency differences borderline favored splinting (baseline: 1.7 vs. 1.8 months; 12 months: 1.1 vs. 0.7months), as did other measures.</p>		substantial improvement, which may reflect a good natural history.
Jarvik 2009 (score=7.0)	Open Surgery/Endoscopic Decompression	RCT	Sponsored by the Intramural Research Program of the NIH Clinical Center. No COI.	N = 116 patients considering surgery for diagnosed CTS.	Mean age 50.7 years; 54 males, 62 females	Surgery Group: Open surgery or Endoscopic surgery depending on surgeon's preference. (n = 57) vs. non-Surgical therapy group: 6 visits with physical therapy and	Follow-up 3, 6, 9 and 12 months.	<p>Primary outcome Carpal Tunnel Syndrome Assessment Questionnaire (CTSAQ). Surgical group significantly lower CTSAQ function score vs. non-surgical group at 6 months; 1.91 vs. 2.44 (p = 0.0006) and at 12 months;</p>	“Overall, these data indicate that, in patients with carpal tunnel syndrome without denervation, surgery modestly improves hand function and symptoms by 3 months compared with a multimodality	At 12 months, surgical group was statistically significant for improved symptoms and function.

						prescribed NSAIDS. (n = 59).		1.74 vs. 2.17 (p = 0.0081). Secondary outcome of CTSAQ symptoms also significantly lower in surgery vs. non-surgery at 6 months; 2.02 vs. 2.42 (p = 0.018) and 12 months; 1.74 vs. 2.07 (p = 0.036).	non-surgical treatment regimen, and this benefit is sustained through 1 year.”	
Fernández-De-Las-Peñas 2016 (score=6.0)	Carpal Tunnel Release Surgery/Manual Physical Therapy	RCT	Sponsored by 2 research project grants from the Health Institute Carlos III. No COI.	N=120 females with carpal tunnel syndrome	Mean age: 47±9 years; 0 males, 120 females	Physical Therapy Group: received 3 treatment sessions of manual physical therapy (desensitization maneuvers of central nervous system 30 min once per week) (n=60) vs Surgery Group: received open or endoscopic decompression and release of the carpal tunnel and education of	Follow up at 1, 3, 6, and 12 months	Time-by-prediction rule status showed effect for hand pain (F=0.200, p=0.657), worst pain during last week (F=0.03, p=0.863), function (F=0.001, p=0.990), symptom severity (f=0.034, p=0.854). Secondary analysis showed effects of hand pain (F=0.024, p=.878), worst pain experience (f=0.013, p=0.918), function (F=0.265, p=0.608), symptom severity	“The results of this study did not support the validity of the previously developed clinical prediction rule for manual physical therapy in women with CTS.”	Physical therapy treatment poorly defined and included median nerve from shoulder to hand. . No significant differences at 1 year, however PT was superior to surgery for most outcomes at 1, 3 months.

						physical therapy (n=60)		(F=0.265, p=0.662).		
Korthals-de Bos 2006 (score=4.0)	Carpal Tunnel Release Surgery	RCT	Sponsored by grant from Health Care Insurance Council of the Netherlands. No COI.	N = 13 patients with electrophysiologically confirmed idiopathic carpal tunnel syndrome.	No mention of mean age or sex.	Open release: Incision size not specified. Numerous specialists performed (n = 73) vs. Nocturnal splinting plus daytime “if they wished to.”	Follow-up 3, 6, 12 months.	Success rates higher at 12 months for surgery group, 92% vs. 72%, difference is 20% (8-31 95% CI). Night awakening due to complaints not different (3.6±2.9 vs. 2.9±3.0). Severity of main complaint higher in surgery group (6.4±2.7 vs. 5.1±3.1). Mean aggregate costs 2,126€ surgery vs. 2,111€ splint. Absenteeism comparable (50 vs. 52 days).	“In the Netherlands, surgery is more cost-effective compared with splinting, and recommended as the preferred method of treatment for patients with CTS.”	Population-based study with likely relatively suboptimal control over treatments. Small sample size. Applicability of cost data to US is questionable.
Carpal Tunnel Release vs. Injections										
Hui 2005 (score=8.0)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship or COI.	N = 50 patients with electrophysiologically confirmed idiopathic carpal tunnel syndrome.	Mean age 49.5 years; 2 males, 48 females	Injection Group- Methylprednisolone acetate 15mg (n = 25) vs. Open carpal tunnel release (n = 25).	Follow-up at 6 and 20 weeks.	Mean improvements in the global symptoms scale 24.2±11.0 vs. 8.7±13.0 (p <0.001). Grip strengths: surgery 23.4 ±8.2 to 21.8±7.9 vs. injection 24.2±7.0 to 26.6±7.4 (p = 0.009). Sensory	“Open carpal tunnel release resulted in between symptomatic and neurophysiologic outcome but not grip strength in patients with idiopathic carpal tunnel syndrome over a 20-week period.”	Suggests surgery superior.

								nerve conduction velocities: surgery 34.2±7.9 to 42.2±8.0 m/s vs. injection 37.3±8.0 to 40.5±6.3 (p = 0.003).		
Ly-Pen 2005 (score=6.5)	Surgical Decompression/Injections	RCT	No mention of sponsorship or COI.	N = 123 (163 wrists) with carpal tunnel syndrome (CTS).	Mean age 51.9 years; 8 males, 93 females	Bethamethasone 6.4mg, 2 injections 2 weeks apart (n = 83 wrists) vs. Open Carpal Tunnel Release (n = 80). 1 year study.	Follow-up 3, 6, and 12 months.	70% improvements in nocturnal paresthesias present (3/6/12 months): injection 86.7/69.9/61.4% vs. surgery 61.3/68.8/ 73.8% (p = 0.001/p = 1.0/p = 0.098).	“Over the short term, local steroid injection is better than surgical decompression for the symptomatic relief of CTS. At 1 year, local steroid injection is as effective as surgical decompression for the symptomatic relief of CTS.”	Details sparse. Most patients had 2 injections. No clear surgical benefit.
Ucan 2006 (Score=5.0)	Carpal Tunnel Release Surgery/Injections	RCT	No mention of sponsorship or COI.	N = 57 (57 hands) with mild or moderate idiopathic carpal tunnel syndrome.	Mean age 44.6 years; 4 males, 53 females	Group A: splinted for 3 months (n = 23 Hands) vs. Group B: Single steroid injection (20mg triamcinolone acetate with 20mg lidocaine) and splinted for 3 months (n = 23 Hands) vs.	Follow-up assessments 3 and 6 months.	Boston Questionnaire scores (baseline/ 3rd month/6th month): splinting 2.66±0.35/1.39±0.37/ 1.54±0.31 vs. splint plus steroid 2.79±0.63/1.41±0.32/1.96± 0.63 vs. CTR 3.09±0.5/1.86±0.6 /1.41± 0.31 (p = 0.004 at 6	“All treatment methods were found to be effective, but despite the complications and the relatively long period to return to work, OCTR was superior to conservative methods in long term.”	Baseline differences present. Appears to have targeted lower enrollment for surgery without stating.

						Group C: surgery (n = 11 Hands).		months). Palm-wrist median sensory nerve velocities: splint 27.26±5.3/29.6±7.16/29.56±4.83 vs. splint plus steroid 26.35±4.12/31.57 ± 4.33/28.74± 6.19 vs. CTR 23.98±4.28/ 32.20 ±4.17/33.15 ±4.1 (NS). Completely satisfied/ almost satisfied (3rd/6th months): splinting 69.6%/34.8% vs. splint plus steroid 100%/82.6% vs. CTR 45.5%/90.9%.		
Endoscopic vs. Open Release										
Saw 2003 (score=7.5)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship or COI.	N = 150 patients with carpal tunnel syndrome.	Mean age 51.9 years; 40 males, 110 females	Open Carpal Tunnel Release Group: Open incision 2cm (n = 76) vs. 1-portal endoscopic release (n = 74).	Follow-up at 1, 3, 6 and 12 weeks.	Anterior carpal tenderness not significantly different 22±7 vs. 24±6 (p = 0.18). Grip strength was also not different, but favored endoscopic (p = 0.21). Endoscopic group returned to work average 8 days (95% CI 2-13, (p = 0.005)) sooner than open. Lost time offset	“On the basis of these findings, we recommend that endoscopic carpal tunnel release should be considered in the employed as a cost-effective procedure, but perhaps not in the general population as a whole.”	Endoscopic recommended due to earlier return to work in employed.

								increased costs of endoscopic surgery, resulting in net savings of 438£ (\$661.63 USD 2009) per patient.		
Atroschi 2006 (score=7.0)	Carpal Tunnel Release surgery	RCT	Sponsored by research grants from Skane county council's research and development foundation, Kristianstad University, and Swedish Society of Medicine. No COI.	N = 128 with idiopathic CTS.	Mean age 44 years; 40 males, 88 females	Open Surgery Group-4cm open (n = 65) vs. 2-portal endoscopic release-1cm endoscopic (n = 63).	Follow-up at 3 and 6 weeks and 3 and 12 months.	Post-operative pain scores (3 weeks/6 weeks/ 3 months/12 months): open 60.5±23/51.3±23/36.2±20/13.9±22 vs. endoscopic 52.1±23/43.3±23/23.5±26/8.7 ±21 (p = 0.028, p = 0.03, p <0.001, p = 0.13 respectively). Lost time median 28 days in both groups (range 17-44).	"In carpal tunnel syndrome, endoscopic surgery was associated with less postoperative pain than open surgery, but the small size of the benefit and similarity in other outcomes make its cost effectiveness uncertain."	Minimal advantage to endoscopic of less pain, but not earlier return to work.
Atroschi 2009 (score=7.0)	Carpal Tunnel Release Surgery	RCT	Sponsored by research grants from Skane County Council's research and development foundation, Kristianstad University, and The Swedish Society of Medicine. No	N = 128 with idiopathic CTS.	Mean age 44 years; 40 males, 88 females	Open Surgery Group-4cm open (n = 65) vs. 2-portal endoscopic release-1cm endoscopic (n = 63).	Follow-up at 3 and 6 weeks and 3 and 12 months.	Symptom severity scores at 5 years were endoscopic 1.45±0.7 vs. open 1.42±0.7 (NS). 52/61 open vs. 53/63 endoscopic had "no pain" (NS). No differences in functional status scores, although both improved from pre-	"The improvements in symptoms of CTS and hand-related disability 5 years after open and 2-portal endoscopic carpal tunnel release were equivalent."	Very high response rate for 5-year study (only missing 2 who died). Suggests no long term differences. Same rates of palmar pain for both groups. No differences in

			mention of COI.					operative status (p <0.001). In 1st year, 1 open and 2 endoscopic required repeat surgery; between Years 1 and 5, 2 open and 1 endoscopic required repeat surgery.		reoperation rates.
Brown 1993 (score=6.5)	Carpal Tunnel Release Surgery	RCT	No sponsorship or COI.	N = 145 (169 hands) with CTS.	Mean age 56 years; 46 males, 99 females	Open Carpal Tunnel Release: Open incisions 3.5-4.5cm (n = 75, 85 hands) vs. 2-portal endoscopic release-endoscopic incisions 2cm and 1.5cm (n = 76, 84 Hands).	Follow-up at 21, 42, 84 days.	Symptoms relieved in 98-99% among each group. Open group more likely to have incisional tenderness (61% vs. 36%). Return-to-work occurred earlier for endoscopic group (p <0.05).	“Preliminary analysis suggests that functional outcomes are achieved more quickly when the endoscopic method is used. However, the greater rate of complications indicates that intraoperative safety must be improved before endoscopic carpal-tunnel release is performed on a widespread basis.”	Suggested endoscopic superior.
Ferdinand 2002 (score=6.5)	Carpal Tunnel Release Surgery	Crossover Trial	No mention of sponsorship. No COI.	N = 25 (50 hands) with bilateral CTS.	Mean age: 54.9 years; 5 males, 20 females	Open carpal tunnel release (n = 25) vs 1-portal endoscopic release (n = 25). Incision	Follow-up at 6, 12, 26, 62 weeks.	Data presented graphically. Persisting symptoms in 1 (4%) of open vs. 0% endoscopic. Persisting pain in	“In comparison with open release, single-portal endoscopic carpal tunnel release has a	No differences between groups in strength or return to hand function.

						sizes not specified.		1 in each group. No differences in grip strength. Mean operating time 10±2 minutes open group vs. 13±4 minutes endoscopic group. Difference significant (p<0.005).	similar incidence of complications and a similar return of hand function, but is a slightly slower technique to undertake.”	
Trumble 2002 (score=6.5)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship. COI, one or more authors received grants or outside funding from Orthopaedic Research and Education Foundation, American Society for Surgery of the Hand, and Boeing Foundation. No author received payments or other benefits or commitment or agreement to provide such benefits from a commercial entity.	N = 147 (192 hands) with idiopathic CTS.	Mean age 56 years; 52 males, 95 females	Open carpal tunnel release group: Open incision 3-4 cm (n = 72, 95 hands) vs. 1-portal endoscopic release (n = 75, 97 hands).	Follow-up assessments made at 2, 4, 8, 12, 26, and 52 weeks.	Symptom severity scores different for weeks 2; 3.1 vs. 2.3 (p <0.01), 4; 3.0 vs. 2.0 (p <0.01), 8; 2.7 vs. 1.9 (p <0.01), and 12; 2.5 vs. 1.8 (p <0.01) among open group vs. endoscopic group. Open group also showed significant increase in functional status score vs. endoscopic group at week 2; 3.0 vs. 2.2 (p<0.01), 4; 2.6 vs. 1.9 (p<0.01), 8; 2.5 vs. 1.9 (p <0.01), and 12; 2.4 vs. 1.7 (p <0.01). Median time to return to work 38 vs. 18	“Good clinical outcomes and patient satisfaction are achieved more quickly when the endoscopic method of carpal tunnel release is used. Single portal endoscopic surgery is a safe and effective method of treatment carpal tunnel syndrome.”	Data suggest the long-term outcomes were identical, although the benefits were short-term for the endoscopic technique.

								days, (p = 0.0086), favoring endoscopic group.		
Wong 2003 (score=6.5)	Carpal Tunnel Release Surgery	Crossover Trial	No sponsorship. No mention of COI.	N = 30 (60 hands) with bilateral idiopathic CTS.	Mean age 47 years; 2 males, 28 females	Open Group: using Strickland instrumentation. 1.5cm open incision (n = 15, 30 hands) vs. 2-portal endoscopic release (n = 15, 30 hands).	Follow-up 2, 4, 8, 16 weeks, 6 and 12 months.	At 1 year, 17 (57%) of endoscopic vs. 19 (63%) of limited open had complete resolution (p = 0.65). Trend toward increased strength in open group (NS). Pain scores lower in limited open group 2 weeks: 2.5 vs. 3.3 (p = 0.004) and 4 weeks: 1.5 vs. 2.5 (p = 0.008).	“The results showed that the outcome was similar at follow-up of one year using both techniques. However, the LOCTR group had significantly less tenderness of the scar at the second and fourth postoperative week. There was also less thenar and hypothenar (pillar) pain after LOCTR.”	Suggests limited open technique modestly beneficial compared with endoscopic.
Erdmann 1994 (score=6.0)	Endoscopic /Open Decompression	RCT	No mention of sponsorship or COI.	N = 105 with CTS.	Mean age 53.4 years; 28 males, 77 females	Open carpal tunnel release (n = 52) vs. 2-portal endoscopic release (n = 53). Incision sizes not specified.	Follow-up at 1 and 2 weeks; 1, 3, 6 and 12 months.	Symptoms relieved in 1.1 vs. 1.75 days. Return to work in 14 vs. 39 days (p <0.005) for the endoscopic group vs. the open group. Grip strength returned to preoperative values for the endoscopic group vs. the open group 28 vs. 90 days (p <0.005).	“This trial illustrates that endoscopic carpal tunnel release has distinct advantages over open surgery, in a select group of patients, particularly relating to earlier recovery of hand strength and return to work.”	Long incision likely used in 1994.

MacDermid 2003 (score=6.0)	Carpal Tunnel Release Surgery	RCT	Sponsored by physicians of Ontario through Physicians Services Incorporated Foundation. No COI.	N = 123 with CTS.	Mean age 47.1 years; 39 males, 84 females	Open carpal tunnel syndrome (n = 32) vs. 2-portal endoscopic release (n = 91). Incision sizes not specified.	Follow-up assessments at 1, 6 and 12 weeks.	McGill Pain Questionnaire scores favored endoscopic release, e.g., Week 1: 13 vs. 28 and Week 6:12 vs. 22, both (p <0.05). Symptom Severity Scale scores not significantly different. Grip strengths at 1 and 6 weeks favored endoscopic release (e.g., week 1, 11 vs. 15kg, (p <0.05)).	“No substantive difference in benefit was shown for these 2 methods of carpal tunnel release.”	The data indicate less pain and better grip strength at 1 to 6 weeks in the endoscopically treated group
Sennwald 1995 (score=5.5)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship or COI.	N = 47 with CTS.	Mean age 52.6 years; 10 males, 37 females	Open carpal tunnel release (n = 22) vs. 1-portal endoscopic release- Endoscopic incision 2cm (n = 25).	Follow-up at 4, 8 and 12 weeks.	Grip strength recovery significant at 4 weeks (p = 0.005), 8 weeks (p = 0.003) and 12 weeks (p = 0.0002) in favor of endoscopic group compared to open group. Endoscopic group could use operated hand normally after 24 days vs. 42 days after open procedure (p <0.001).	“The study is strongly in favour of endoscopic release. However, this technique does not allow any analysis of the pathology or structure to be treated.”	Baseline mean grip strength approximately 26 vs. 32 (p = 0.29). Appears to have contributed to post-operative differences.

Ejiri 2012 (score=5.5)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship or COI.	N = 79 with CTS with distal motor latency to abductor pollicis brevis muscle greater than 4.5ms.	Mean age 58.5 years; 8 males, 71 females	Endoscopic carpal tunnel release (ECTR group) (n = 40, 51 hands) vs. Open carpal tunnel release (OCTR) (n = 39, 50 hands).	Follow-up assessments at week 4 and 12.	At week 12, rate of improved cases higher in OCTR group vs. ECTR group (p = 0.08), however not significant. No significant differences between groups for improvement in ADL impairment. At week 4, mean improvement in grip strength significantly higher in ECTR group vs. OCTR; -4.6 vs. -8.1 (p = 0.04). But not significant at 12 weeks: -1.2 vs. -3.6 (p = 0.27).	“These results suggest that while no difference exists between ECTR and small incision methods in terms of improved subjective symptoms, sensation, or electrophysiological findings, recovery of muscle strength is superior with ECTR.”	At 4 weeks, ECTR was significantly better than OCTR for muscle strength, but ECTR may increase the risk of transient nerve dysfunction which resolved at 6 months.
Larsen 2013 (score=5.5)	Carpal Tunnel Release Surgery	RCT	No sponsorship or COI.	N = 90 with CTS.	Mean age: 51 years; 26 males, 64 females	Classic incision group 7cm curved incision (n = 30) vs. short incision group: incision 3cm in mid-palm (n = 30) vs. Endoscopic group- using Linvatec system (n = 30).	Follow-up at 1, 2, 3, 6, 12, 24 weeks.	No significant difference between groups for post-op pain at any time point (p >0.05). No significant difference for disappearance of paresthesia between treatment groups (p >0.05). Tendency for earlier return of	“These results are in accordance with the findings in the literature: faster rehabilitation and earlier return to work after ECTR... (Endoscopic Carpal Tunnel Release), few complications but a risk of	At 24 weeks, the endoscopic group had quicker return to work and faster rehabilitation.

								grip strength (significant at weeks 2 and 3 only (p >0.05)), as well as ROM (significant at weeks 1 and 3) in endoscopic groups vs. other two groups.	nerve branch neuropraxy with transient neurological problems.”	
Dumontier 1995 (score=5.0)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship or COI.	N = 96 with idiopathic CTS.	Mean age 52.3 years; 11 males, 85 females	Open carpal tunnel release group: Open incisions 3-4cm (n = 40) vs. 2-portal endoscopic release (n = 56).	Follow-up assessments made at 2 weeks, 1, 3, 6 months.	Loss of grip strength conventional group vs. endoscopic group (mean±SD): 2 W-pre-op: -15.02±10.27/-13.84±9.50 (p = 0.67); 1 M-pre-op.: -12.80± 9.84/-6.25±6.81 (p <0.01)3 M-pre-op: -8.26±6.37/-3.66±6.84 (p = 0.02).	“No statistically significant differences were found regarding pain, disappearing of paresthesiae or time to return to work. However, better recovery of grip strength was observed in the endoscopic group at 1 and 3 months.”	Possibly 2:1 assignment, not noted. Variable follow-ups with 45.3% dropout at 3 months.
Jacobsen 1996 (score=5.0)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship or COI.	N = 29 EDS confirmed (32 hands) with idiopathic CTS.	Mean age 46 years; 8 males, 21 females	Open carpal tunnel release group (n = 16 Hands) vs, 2-portal endoscopic release (n = 16 hands). Incision sizes not specified.	Follow-up at 2 and 6 weeks and 6 months.	Sick length average 17 days (0-31) in endoscopic group vs. 19 days (0-42 days) in open group. No significant difference between groups for average sick day length (p	No differences in surgical results were found, but three patients in the endoscopic group suffered transient numbness on the radial side of the ring finger.”	Higher risks in endoscopic group.

								>0.05). At final follow-up, 8 in endoscopic group returned to normal vs. 9 in open group (p >0.05).		
Kang 2013 (score=4.5)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship. No COI.	N = 59 with bilateral CTS. Each hand randomly assigned to different surgery.	Mean age 55 years; 4 males, 48 females	Endoscopic Group: carpal tunnel release surgery performed with Agee technique (n = 59 hands) vs. Mini-Open Group: release performed with small (1.5cm) incision. (n = 59 hands).	Follow-up at 3 months post-op.	Boston Carpal Tunnel Questionnaire symptom (BCTQ-S) and function (BCTQ-F) score main outcome. No significant differences between endoscopic vs. mini-open at 3 months for BQTC-S; 1.5 vs. 1.4 (p = 0.774) or for BQTC-F; 1.5 vs. 1.7 (p = 0.832). No significant difference in mean DASH (Disabilities of the Arm, Shoulder and Hand) score (p = 0.978).	“Endoscopic and mini-incision open carpal tunnel releases seem to have comparable early subjective outcomes after carpal tunnel release has been performed in patients who had idiopathic carpal tunnel syndrome.”	Sparse methodology. Comparable outcome efficacy at 3 months, but patient preference towards endoscopic procedure.
Gümüştas, 2015 (score=4.0)	Open Release/Endoscopic Release	RCT	No mention of sponsorship. No COI.	N=41 patients diagnosed with carpal tunnel syndrome	Mean age: 45.5 years; 2 males, 39 females	Endoscopic Group: received endoscopic surgery (n=21) vs Open Group: received open carpal tunnel release surgery (n=20)	6 months	Symptom severity improved from 3.35±0.65 to 1.26±0.48 for endoscopic group (p<0.001) compared to 3.51±0.54 to 1.41±0.46 in the open group	“It was shown both clinically and electrophysiologically that endoscopic carpal tunnel surgery was as effective as open surgery as a treatment method	Both treatment groups demonstrated statistically significant improvement; however, there were no statistically

								(p<0.001). Functional capacity improved from 3.11±0.82 to 1.2±0.35 in the endoscopic group (p<0.001) compared to 3.43±0.63 to 1.56±0.48 in the open group (p<0.001).	for carpal tunnel syndrome.”	significant differences between the 2 treatment groups.
Agee 1992 (score=4.0)	Carpal Tunnel Release Surgery	RCT	Sponsored in part by the 3M Orthopedic Products Division, St. Paul, Minn. No mention of COI.	N = 122 (147 hands) with CTS.	No mention of mean age or sex.	Open carpal tunnel release- Control Group (65 hands) vs. 1-portal endoscopic release- Endoscopic incision 2cm (n = 82 hands).	Follow-up at weeks 1, 2, 3, 6, 9, 13, and 26.	Median return to work 25 days vs. 46.5, (p <0.01). Stratified analyses 71 vs. 16.5 days for workers’ comp vs. non-WC treated with endoscopic technique vs. 78 vs. 45.5 days in open group (WC vs. non-WC). Less immediate postoperative scar tenderness.	“Improvement in most of the variables measured translated into earlier return to work and to ADL.”	Suggests endoscopic superior to open.
Open vs. Mini Incision										
Jugovac 2002 (score=4.5)	Carpal Tunnel Release Surgery	RCT	Sponsored by Croatian Ministry of Science and Technology grant No. 0062076 to Dr Marin F. Stanèiæ. No mention of COI.	N = 72 with NCS finding of CTS.	Mean age 53.4 years; 18 males, 54 females	Open carpal tunnel release group (n = 36) vs. mini-incision group- using an operating microscope (n = 36).	3 month follow-up.	Symptomatic relief open (31/36 complete relief) vs mini (31/36) (NS). Hand function return to daily activities in 5 days with limited incision vs. 10 days open (p = 0.001). RTW	“Limited palmar incision CTR is as effective and safe as traditional CTR technique, but with better postoperative recovery and cosmetic results.”	Some baseline differences. Follow-up timing unclear.

								15 vs. 30 days (p = 0.001).		
Tarallo 2014 (score=4.5)	Carpal Tunnel Release/Minimal	RCT	No sponsorship or COI.	N=120 patients with carpal tunnel syndrome	Mean age: 64 years; 60 males, 60 females	Group A: received carpal tunnel decompression by traditional open release (n=60) vs Group B: received carpal tunnel release by minimal access carpal tunnel release (n=60)	Follow up at 6 and 12 months	Patients in group B showed better results than group A at both 6 and 12 months (p<0.001).	“[M]ACTR showed statistically significant improvement compared to TOCTR. The patient tolerance is reasonably high and the procedure is compatible with the current minimal invasive trend in surgery.”	Data suggest minimal access CTR better than open CTR for scaring and return to work.
Aslani 2012 (score=4.0)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship. No COI.	N = 105 who qualified for carpal tunnel release surgery.	Mean age 54.2 years; 10 males, 95 females	Open surgery group (n = 36) vs. Endoscopic surgery group (n = 32) vs. Mini Palmer incision group (n = 28).	Follow-up at 2 weeks, 4 weeks and 4 months.	Endoscopic (2 wrists showed weakness at 4 months) and Mini Palmer incision (0 wrists weakness) groups showed significant improvement in weakness vs. open surgery (4 wrists showed weakness) (p <0.05). No other significant differences for other variables (p >0.05). 0 participants expressed pain in the open group at final follow-up	“Satisfactory results with all three surgery techniques of open, mini-incision or endoscopic and has a low chance of complications. Endoscopic treatment and mid-palmar mini incision have less pain and greater satisfaction among patients in the first weeks, however, overall results are the same and	Cross-sectional study shows early patient satisfaction with endoscopic and mini techniques, but at 4 months comparable satisfaction between all groups.

								and 4 participants expressed pain in both endoscopic and mini-palmer groups.	satisfactory in all three groups after 4 months.”	
Tarallo 2014 (score=4.0)	Carpal Tunnel Release Surgery	RCT	Sponsored by National Institutes of Health (NIH), Wellcome Trust, Howard Hughes Medical Institute (HHMI) and other(s). No COI.	N= 120 with CTS with moderate-to-severe symptoms.	Mean age 64 years; 60 males, 60 females	Group A: carpal tunnel release by traditional open carpal tunnel release (TOCTR) (n = 60) vs. Group B: carpal tunnel release by minimal-access carpal tunnel release (MACTR) (n = 60)	Follow-up at 7 days, 6 and 12 months.	At final follow-up mean static 2-point discrimination score difference not significant between Group A and B; 4.3 mm vs. 4.7mm (p >0.05). At final follow-up, 2 patients (3.6%) in Group A had evidence of recurrent disease vs. 1 (1.8%) in Group B (p <0.01). In each subsection of BCT questionnaire, Group B showed significantly better results than Group A at both 6 month follow-up 1.4 vs. 2.3 (p <0.001) and 12 month follow-up; 1.1 vs. 1.5 (p<0.001).	“In our opinion, median nerve release is strongly advocated by MACTR as a safe, easily reproducible, low-grade learning curve, low time and a low-cost surgery and it can be performed with standard surgical equipment. In our perspective randomised study, MACTR showed statistically significant improvement compared to TOCTR.”	MACTR group was significantly better than TOCTR group at 6 and 12 months.
1 vs. 2 Limited Open Incisions										

Zyluk 2006 (score=6.5)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship or COI.	N = 79 (82 hands) EDS confirmed CTS.	Mean age 48 years; 15 males, 50 females	1 limited incision group- Single (2cm) (n = 39, 44 hands) vs. 2 limited open incisions group 1 and 2cm incisions (n = 40, 40 hands).	Follow-up at 1, 3, 6, 12 months.	Functional scores not different. Total grip strength (kg) Method 1/Method 2: Pre-op: 16.6/18.1; at 1 month: 16.1/14.9; at 3 months: 20.3/18.9; at 12 months: 24.2/24.1. No significant differences between groups for grip strength (p >0.05).	“We found that the single incision method offers better results in respect of grip and pinch strengths: less weakness at 1 month after surgery and a faster improvement relative to pre-operative values which is statistically significant.”	Minor advantage to one small incision.
Zhang, 2016 (score=4.0)	Carpal Tunnel Release Surgery	RCT	No mention of sponsorship. No COI.	N=207 patients with a confirmed diagnosis of carpal tunnel syndrome	Mean age: 46.4 years; 70 males, 137 females	Group A: received double small incisions and under headlight and surgical loupes (n=73) vs Group B: received standard open incision (n=65) vs Group C: received Chow double-portal endoscopic release (n=69)	3 years, 46, 47 months	Mean severity of symptoms was changed from 3.7±0.58 to 1.2±0.45 for group A, 3.8±0.62 to 1.2±0.31 for group B, and 3.7±0.52 to 1.5±0.36 for group C after 3 year follow up (p>0.05). Mean functional status changed from 3.2±0.71 to 1.2±0.38 for group A, 3.2±0.71 to 1.2±0.41 for group B, and 3.5±0.64 to 1.5±0.42 for group C after 3 year follow up (p>0.05).	“Carpal tunnel release by means of double small approaches is a minimally invasive and less technically challenging procedure with good nerve visualization, resulting in good appearance.”	Minimally invasive CTR significantly different than open CTR. 2 different types of minimally are not statistically significantly different for most outcomes excepting cost and VAS.
Epineurotomy										

Crnkovic 2012 (score=9.0)	Epineurotomy	RCT	No mention of sponsorship. No COI.	N = 50 with CTS and verified narrowing of median nerve within tunnel.	Mean age 51.75 years; 17 males, 33 females	Epineurotomy Group: Open field surgical release followed by longitudinal epineurotomy of nerve (n = 25) vs. No epineurotomy Group- Control Group- Open-field release without an epineurotomy (n = 25).	Follow-up at 90 and 180 days.	At 90 days, mean nerve volume increase somewhat higher in epineurotomy group vs. no epineurotomy group; 10.5 mm ³ vs. 7.2 mm ³ (p = 0.056); not significant. No significant difference found at 180 day follow-up (p = 0.452). Both groups significantly increased in nerve volume size compared to baseline (p<0.001).	“In conclusion, in line with other reports, the results suggest that even in selected patients longitudinal epineurotomy of the median nerve does not confer any relevant electrophysiological or clinical benefit (nor harm), as compared to a simple dissection of the carpal ligament.”	Failure to provide superiority for epineurotomy after carpal tunnel release, but some pain relief in the control group compared to study group.
Leinberry 1997 (score=7.0)	Epineurotomy	RCT	No sponsorship or COI.	N = 44 with EDS confirmed (50 hands) with CTS.	Mean age 64.8 years; 18 males, 26 females	Group 1: Release of transverse carpal ligament. No epineurotomy (n = 22, 25 hands) vs. Group 2: carpal tunnel release and adjuvant epineurotomy of median nerve (n = 22, 25 hands).	Follow-up 1 and 6 weeks; 6 and 12 months.	At 12-months, 60% of non-epineurotomy group vs. 56% of epineurotomy group asymptomatic (p >0.05). Two-point discrimination, grip strength and sensory nerve latencies all not significantly different.	“This suggests that epineurotomy of the median nerve offers no benefit compared with sectioning of the transverse carpal ligament alone.”	Patient blinding unclear, but seems probable.

Blair 1996 (score=6.0)	Epineurotomy	RCT	No mention of sponsorship or COI.	N = 86 EDS confirmed (117 hands) with CTS.	Mean age 48.7 years; 13 males, 62 females	Open release group- 4cm incision (n = 48) vs. carpal tunnel release with epineurotomy. 4cm incision (n = 27).	Follow-up for minimum of 24 months.	Synovial hypertrophy graded as marked or moderate in 18.8% of epineurotomy group vs. 33.3% of non-epineurotomy group. Non-significant trends in favor of epineurotomy present for pain (epineurotomy: 87.5% pre-op pain decreased to 12.5% 2 years post-op vs. no epineurotomy: 92.6% decreased to 29.6%). Nerve conduction velocities increased in both groups and did not differ between (pre/post-op): epineurotomy 31.1/ 43.8ms vs. 30.0/40.4 (p = 0.32). Patients happy/very happy with results in 73% epineurotomy vs. 70%.	“The study data do not support the use of Epineurotomy as an adjunctive procedure during carpal tunnel release.”	The trial is described as a comparative trial, but appears to involve a randomization procedure based on hospital chart number. Demographic variables were balanced between the two groups; however, the group sizes were not.
Foulkes 1994 (score=4.0)	Epineurotomy	RCT	No sponsorship or COI.	N = 33 (36 hands) with CTS who had not had previous	Mean age: 45.4 years; 16 males, 17 females	Epineurotomy Group (n = 23, 26 hands) vs. Non-Epineurotomy Group- Non-	Follow-up 6, 12 months post-op.	Results for sensibility not significant between groups at 6 months (p = 0.64) and 12	“The addition of an adjunctive epineurotomy, although safe, offers no clinical benefit in the	Sparse methodological details. Operating surgeons cannot be

				surgery on same side.		treatment group (n = 10, 10 hands)		months (p = 0.99). No significant difference in grip strength between groups at 6 months (p = 0.79) or 12 months (p = 0.28).	surgical treatment of carpal tunnel syndrome in our series of patients.”	blinded. Epineurotomy not superior in carpal tunnel surgery.
Neurolysis										
Lowry 1988 (score=8.0)	Neurolysis	RCT	No mention of sponsorship or COI.	N = 50 hands EDS confirmed with CTS.	No mention of mean age or sex.	Standard ligament release Surgery alone group (n = 25) vs standard ligament release surgery with adjunctive interfascicular neurolysis (n = 25).	3 month follow-up after surgery.	Excellent or good results in 66.7% of neurolysis vs. 65.2% without. No electrodiagnostic parameters significantly different between 2 groups (e.g., distal sensory latencies baseline/3 months' post-op): neurolysis (5.5±0.3/4.5±0.5) vs. no neurolysis (5.8±0.6/4.5±0.7). No significant differences were found between groups at follow-up. (p>0.05).	“The results of this study indicate that standard surgical release of the transverse carpal ligament is frequently warranted and usually beneficial in patients with severe carpal tunnel syndrome.”	No benefit shown for severe CTS.
Mackinnon 1991 (score=8.0)	Neurolysis	RCT	No sponsorship. No mention of COI.	N = 79 with CTS.	Mean age 58.5 years; 11 males, 48 females	Open carpal tunnel release group with internal neurolysis (n =	Follow-up for 6 months.	Relief of symptoms 88% in release only group vs. 81% of neurolysis group.	“While the technique of internal neurolysis has been proven to be	No benefit

						29, 31 hands) vs. open carpal tunnel release without internal neurolysis (n = 30, 32 hands)		Among those with abnormal pre-op 2-point discrimination, 62% recovered normal sensation in open release group vs. 55% of neurolysis group. Grip strengths increase from 15-19kg in open release only group vs. from 14 to 17kg in neurolysis group.	safe and is essential in the surgical evaluation of in continuity and in peripheral nerve reconstruction using interfascicular nerve grafting, it would appear from this study that it does not confer improved sensory or motor outcome in patients with primary CTS.	
Flexor Tenosynovectomy										
Shum 2002 (score=4.5)	Carpal tunnel Release Surgery/Flexor Tenosynovectomy	RCT	No sponsorship or COI.	N = 87 EDS confirmed (88 wrists) with idiopathic CTS.	Mean age 58 years; 15 males, 72 females	Open carpal tunnel release with flexor tenosynovectomy (n = 44 wrists) vs. Open carpal tunnel release without flexor tenosynovectomy (n = 44 wrists).	Follow-up for 12 months.	Both groups' symptom severity scores improved after surgery (tenosynovectomy 3.0±0.88 to 1.6±0.68 vs. from 2.9±0.64 to 1.6±0.7, (p ≤0.0002)). No correlations between pre- or post-operative symptoms severity scores and the intraoperative tenosynovial ratings (r = 0.038)	“We observed neither an added benefit nor an increased rate of morbidity in association with the performance of a flexor tenosynovectomy at the time of carpal tunnel release. We identified no clinical correlations that might predict which individuals would benefit from flexor	No benefit. No relationship found with tenosynovial ratings of appearance.

									or subsequent pathological analyses (r = 0.004 to 0.032).	tenosynovectomy on the basis of either the gross (intraoperative) or histological evaluation of the flexor tenosynovium.”	
Superficial Nerve Sparing											
Siegmeth 2006 (score=6.5)	Decompression/Superficial Nerve Sparing	RCT	No mention of sponsorship. No COI.	N = 42 (84 hands) with bilateral idiopathic CTS.	No mention of mean age or sex.	Open carpal tunnel release with superficial nerve sparing (n = 42, 42 hands) vs. open carpal tunnel release without superficial nerve sparing (n = 42, 42 hands).	Follow-up at 6 weeks, 3 and 6 months after surgery.	No differences in pain scores at any follow-up interval (graphic presentations of data, 6 weeks; (p = 0.73), 3 months; (p = 0.59), and 6 months; (p = 0.13)). No differences found between groups in PEM scores at 6 weeks (p = 0.93), 3 months (p = 0.43), and 6 months (p = 0.38).	“Scar pain scores in this series of open carpal tunnel decompressions were similar, whether or not an attempt was made to identify and preserve superficial nerve branches crossing the wound.”	Small sample size. Comparable efficacy but the standard carpal tunnel decompression technique took less time to perform.	
Incisional and Other Intraoperative Techniques											
Forward 2006 (score=8.5)	Carpal Tunnel Decompression	RCT	No sponsorship or COI.	N = 118 with CTS.	Mean age: 57 years; 34 males, 84 females	Preservation of parietal layer of ulnar bursa beneath flexor retinaculum during open release (n = 57) vs. Bursal division (n = 61).	Final follow-up at 8-9 weeks.	Grip strengths at follow-up 79% of pre-op values in those with ulnar bursal preservation vs. 82% among other group (p >0.05). One surgeon operated without	“In this group of patients, preservation of the ulnar bursa around the median nerve during open carpal tunnel release produced no significant	Suggests no benefits of preserving the ulnar bursa.	

								<p>tourniquet and data indicated those patients had higher grip and thumb key pinch strengths as well as among men and younger patients.</p>	<p>difference in grip strength or self-rated symptoms.”</p>	
Dias 2004 (score=8.5)	Carpal Tunnel Decompression	RCT	No mention of sponsorship or COI.	N = 26 EDS confirmed (52 hands) with bilateral CTS.	Mean age 56 years; 7 males, 19 females	Lengthening of retinaculum (n = 26 hands) performed on one hand vs. simple division of flexor retinaculum standard release (n = 26 hands) performed on other hand.	Follow-up at 2, 6, 12, and 25 weeks.	Levine symptom scores (baseline/Weeks 2/6/12/25): open 3.1/1.3/1.4/1.2/1.3 vs. lengthen 2.8/1.4/1.3/1.2/1.3 (p = 0.63). Function scores were negative (p = 0.66). Grip strengths not different (p = 0.79).	“The study has failed to demonstrate any measurable benefit for this technique. Simple division of the retinaculum is adequate.”	No advantage to lengthening retinaculum.
Bolster 2013 (score=6.0)	Open Carpal Tunnel Release/Sutures	RCT	No mention of sponsorship. No COI.	N=89 hands in 88 patients with idiopathic carpal tunnel syndrome	Mean age: 55 years; 28 males, 60 females	Single Stitches: received a single stitch (n=34) vs Donati Stitches: received vertical mattress stitches (n=37)	Follow up at 8 weeks	Scar formation was nice in 94% for singles stitches compared to 97% in Donati stitches. Donati stitches showed 2-fold higher VAS score for pain (p=0.01) and DASH score (p=0.06) compared to single stitches. VAS score for pain was lower in	“In conclusion, both Donati and single stitches are related to excellent scar formation. The Donati sutures are related to more prolonged postoperative pain.”	Single stitches group had more improvement in pain. Scar rating was not significantly different.

								both groups at follow up (p<0.01 for both).		
Menovsky 2004 (score=5.0)	Nylon/Polyglactin/Stainless Steel Sutures	RCT	No mention of sponsorship or COI.	N = 61 EDS confirmed with CTS.	Mean age 50.4 years; 14 males, 47 females	Nylon sutures in open release (n = 17) vs. Polyglactin 910 sutures (n = 25) vs. 4-0 stainless steel 4-0 sutures (n = 19).	Follow-up at 10 days and 6 weeks.	Mean pain scores at 10 days (nylon, polyglactin and stainless steel): 1.7 (+/-2.2), 3.1 (+/-2.3) and 1.9 (+/-2.3). At 6 weeks, pain scores were 3.6 (+/-3.1), 3.4 (+/-2.6) and 2.7 (+/-2.1). Infection rates were 0%, 8% and 0%. Suture granulomas more likely in polyglactin group (p <0.05). No differences in redness or wound hypertrophy.	“Nylon and stainless steel sutures are both suitable for skin closure after carpal tunnel surgery. Based on this study, absorbable vicryl sutures should not be used, since the incidence of infections and the presence of suture granulomas was much higher than in the nylon and steel suture groups.”	Suggests nylon or steel sutures preferable to polyglactin.
Citron 1997 (score=4.0)	Carpal Tunnel Decompression	RCT	No mention of sponsorship or COI.	N = 47 with CTS.	Mean age 52.1 years; 9 males, 38 females	Standard incision parallel to thenar crease (n = 26) vs. Ulnar L-shaped incision (n = 21).	Follow-up at 6 weeks, 3, 6, 9 and 12 months	No differences in grip strength, pillar tenderness or scar sensitivity (p >0.05).	“No difference was found in pillar pain between the two incisions, but one had a lower incidence of scar sensitivity.”	No benefits.
Macaire 2008 (score=4.0)	Ultrasound /NSG Wrist Blocks	RCT	No mention of sponsorship or COI.	N = 60 undergoing ambulatory endoscopic carpal tunnel release.	Mean age: 47.5 years; 18 males, 41 females	Ultrasound Group-Nerve blocks guided using ultrasound (n = 30) vs. Nerve	Follow-up immediately after surgery.	Time to perform nerve block primary outcome. Ultrasound group took significantly less time (s) than	“The present study demonstrates that ultrasound-guided nerve blocks reduce the	Similar efficacy, but procedure times shorter in ultrasound

						Stimulation- Nerve blocks using sensory- motor stimulation. (n = 30).		nerve stimulation to perform median nerve block; 55 s vs. 100 s (p = 0.002) and time (s) to perform ulnar block; 58 s vs. 80 s (p = 0.02). Mean VAS pain score not significant between groups for venipuncture (p = 0.26) and block puncture (p = 0.72).	performance time while the total time until readiness for surgery remains unaltered compared with nerve stimulation.”	guided wrist blocks.
Open Release vs. Knifelight										
Bhattacharya 2004 (score=6.5)	Open Release/Kn ifelight	Crossove r Trial	No mention of sponsorship or COI.	N = 26 with bilateral CTS.	Mean age: 48 years; 9 males, 23 females	2.5cm open incision (n = 26, 26 hands) vs. 1-1.5cm Knifelight incision (n = 26, 26 hands).	Follow-up at 2 and 6 weeks.	Knifelight vs. Open release (Median): return to work (in weeks): 2.0 vs. 2.0 (p = 0.80); grip strength recovery (%): 89 vs. 84 (p = 0.25); scar tenderness: 1 vs. 10 (p = 0.01)	“There was little difference between the two techniques with regard to time taken to return to work, return of grip strength, symptom relief, complications, incidence of pillar pain and patient preference. However, the incidence of scar tenderness was significantly lower with the Knifelight technique.”	No significant differences, other than less tenderness associated with Knifelight.

Helm 2003 (score=6.5)	Open Release/Knifelight	RCT	No mention of sponsorship of COI.	N = 82 with CTS.	Mean age: 53 years; 32 males, 50 females	Open release vs. Knifelight. Incision sizes not specified	Follow up at 2 and 6 weeks	Post-op CTS symptoms and grip strengths not different between groups. Mild or moderate scar tenderness Knifelight (89.7%) vs. open (48.8%) (p <0.001). Return to work Knifelight vs. open CTR: 20 vs. 28 days, (p <0.001).	“We found no difference in discomfort reported during surgery, in the operative time, in the grip strength measured at 2 and 6 weeks post-operatively or in the proportion of patients cured of their pre-operative symptoms. Knifelight group had a statistically significant improvement in the time to return to work and in scar tenderness at 6 weeks post-operatively.”	Faster return to work and less scar tenderness with Knifelight.
Lorgelly 2005 (score=4.0)	Open Release/Minimally invasive decompression	RCT	No mention of sponsorship or COI.	N = 185 with CTS.	No mention of mean age or sex.	Knifelight (2cm incision) (n = 92) vs. Limited open (3-4cm) (n = 89).	Mean 30 month follow-up.	First section Boston CTS questionnaire (baseline/19/30 months): Knifelight (3.84/1.46/1.28) vs. open (3.66/2.04/1.39). (NS other than 19 month, p <0.001). RTW 16.6 vs. 25.4 days (p	“Minimally invasive carpal tunnel decompression appears to be more effective but more costly.”	Some details sparse. No workers’ compensation patients.

									<0.001). Recurrent disease in Knifelight 1% vs. 5% (p <0.01).	
Early vs. Delayed Surgery										
Chandra 2013 (score=5.0)	Early/Delayed Surgery	RCT	No sponsorship or COI.	N = 100 affected by CTS.	Mean age: 45.6 years; 17 males, 83 females	Early surgery group (<1 week after diagnosis) (n = 51) vs. delayed surgery group (>6 months after diagnosis) (n = 49). Delayed determined by wait-listing.	Follow-up after at least 6 months (range, 6-13.2 months; mean, 7.2 months).	Both groups improved in pre-op clinical score (p <0.0001). Mean post-op clinical score lower in early surgery group vs. late surgery group at final follow-up; 8.11 vs. 18.19 (p <0.001). Early group had 100% return to normal activity compared to the late group with 89% (43) with partial return of activity and 11% (6) with normal return to activity (p<0.001).	“On the basis of this study, we propose early surgical (1 week) intervention in patients with moderately severe (grade 3–4) CTS.”	Early surgical intervention group superior to late surgical intervention group. Study only involved moderately severe CTS. Susceptible to wait-listed control bias. Non-operative management was NSAIDs, pregabalin “with or without splint” and PT, thus did not appear to follow highest quality evidence for treatment.
Open Release vs Other										
Kanchanathepsak 2017 (score=6.0)	Open Release/Hypothenar Fat Pad	RCT	No mention of sponsorship. No COI.	N=41 patients with primary carpal tunnel syndrome	Mean age: 51.9 years; 2 males, 34 females	COR Group: received open carpal tunnel release(n=20) vs HTFPF Group: received	Follow up at 6 and 12 weeks	NCS showed improved DSL in HTFPF group at follow up compared to COR group (p<0.05). VAS score was	“There is no advantage outcome in primary CTS for having additional HTFPF procedure in	No statistically significant differences between groups for any outcome.

						hypothenar fat pad flap procedure (n=21)		decreased in both groups (p>0.05).	CTR. COR is still the standard treatment. Nevertheless, improvement of DSL and S-amp could be observed at 6 wk postoperatively.”	
Cho 2016 (score=5.5)	Open Release/Short Wrist Traverse Technique	RCT	No sponsorship or COI.	N=84 patients with idiopathic carpal tunnel syndrome	Mean age: 54.0 years; 6 males, 73 females	Group A: received limited open technique (n=40) vs Group B: (n=49) received short wrist transverse open technique group	Follow up at 6 weeks, 3 and 6 months	Improvement in BWCTQ symptom severity scale and Functional status scale were observed for both groups (p=0.023, p=0.031, respectively). Scar discomfort resolved at 4.4 months in group A compared to 4.1 months in group B (p=0.465).	“In conclusion, this study shows no difference in outcome between a standard open CTR and a CTR with a short transverse incision.”	Excluded B bilateral wrists but no definition of which were excluded. No significant differences between treatment groups for any outcome.
Mini-Incision vs Endoscopic Release										
Oh 2017 (score=4.5)	Mini-incision/Endoscopic Release	RCT	No sponsorship or COI.	N=67 patients with carpal tunnel syndrome	Mean age: 52.4 years; 10 males, 57 females	Mini-incision (n=32) vs Endoscopic Release: (n=35)	Follow up at 24 weeks	Mean BCTQ-S scores improved from 3.2±0.9 to 1.3±0.3 in mini-incision group compared to 3.1±0.8 to 1.2±0.2 in the endoscopic release group. Mean BCTQ-F scores and mean DASH scores	“Both mini-incision and endoscopic carpal tunnel release significantly reversed the pathological changes in the median nerve morphology of patients with	No meaningful differences between groups.

								similarly for both groups. Mean CSA-I was decreased in mini-incision group (13.2±4.6mm ² to 9.9±2.5 mm ²) in contrast to mean CSA-M (8.4±3.2 to 11.4±2.6) and CSA-O (7.0±2.3 to 10.8±2.4) scores that increased (p<0.001). The endoscopic release group mean CSA-I decreased from 13.0±6.0 to 10.1±2.4 mm ² (p<.001). Mean CSA-M and CSA-O were increased (p<0.001) for the endoscopic release group.	CTS, with no significant differences between techniques.”	
Non-Invasive Therapies										
Meems, 2017 (score=4.0)	Mechanical Wrist Traction	RCT	Sponsored by PAREL INVEST. No COI.	N=181 adult patients with EDX confirmed carpal tunnel syndrome	Mean age: 58.1 years; 60 males, 121 females	Intervention: received 12 treatment sessions (2 times per week for 6 weeks) of Phystrac mechanical traction device (used weights of 5 kg for session	3, 6 months	Patients receiving intervention showed longer time to surgery compared to care-as-usual group (90 days vs 41 days, respectively). More patients needed surgery in the care-as-usual group compared to	“Mechanical traction is associated with fewer surgical interventions compared to care as usual in CTS patients. Reductions in patient-reported symptoms at 6	Usual care bias. Quality of, and tracking of usual care unknown renders results uninterpretable. Statistically fewer surgeries among traction group but no difference in

						1 and increased 1 kg per session) (n=94) vs Care as Usual: received regular treatment from health care provider (splints, injections, or CTS surgery) (n=87)		intervention (43% vs 28%; HR=2.27, 95% CI 1.35-3.80). Symptom duration was longer in care-as-usual group compared to intervention (HR=1.89, 95% CI 1.11-3.24).	months' follow-up was similar in both groups. The long-term effects of mechanical traction require further evaluation.”	symptom scores between the 2 groups.
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Evidence for the Use of Perioperative Antibiotics

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: perioperative antibiotics or antibiotic prophylaxis, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 177 in Scopus, 0 in CINAHL, and 41 in Cochrane Library. We considered for inclusion 0 from PubMed, Scopus, CINAHL, and Cochrane Library and 0 from other sources. Zero articles met the inclusion criteria.*

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: perioperative antibiotics or antibiotic prophylaxis, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies; Carpal Tunnel Syndrome to find 3 articles. Zero articles met the inclusion criteria.*

Evidence for Use of Anesthesia during Carpal Tunnel Release

There is 1 high-(973) and 8 moderate-quality RCTs(974-981) incorporated into this analysis. There are 7 low-quality RCTs in Appendix 2.(982-988)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: anesthesia, local, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 15 articles in PubMed, 3165 in Scopus, 11 in CINAHL, and 44 in Cochrane Library. We considered for inclusion 15 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 15 articles considered for inclusion, 15 randomized trials and 0 systematic studies met the inclusion criteria.*

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: anesthesia, local, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 3 articles. Of the 3 articles we considered for inclusion 0. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Peng 2002 (score=9.5)	CTS/ Surgery/ Anesthesia	RCT	No mention of sponsorship or COI.	N = 40 patients undergoing hand surgery. Mean age for Lidocaine and Ropivacaine group: 43±19 and 42±13.	Mean age: 42.5 years; 24 females, 16 males	Group 1: Ropivacaine 0.375% injected over a period of 1 minute (n = 20) vs. Group 2: Lidocaine 0.5% forearm regional anesthesia (n = 20).	Follow-up for 15 minutes and at 24 hours post-op.	Onset of anesthesia 6.5±2.9 minutes for lidocaine vs. 8.0±4.1 minutes for ropivacaine. Pain ratings lower among ropivacaine group throughout first 90 minutes	“0.375% ropivacaine provides effective anesthesia and superior postoperative analgesia compared with 0.5% lidocaine when forearm IVRA is used.”	Study demonstrates ropivacaine provides superior anesthetic effect to lidocaine in IV regional anesthesia for hand surgery.
Bigat 2006 (score=7.5)	CTS/ Surgery/ Anesthesia	RCT	Sponsored by Akdeniz University Scientific Research Project Unit, Antalya / Turkey. No mention of COI.	N = 75 patients undergoing elective carpal tunnel release surgery	Mean age 41.5 years: 28 females, 22 males	Group L: received 3mg/kg lidocaine (n = 25) vs. Group LD: received 3mg/kg lidocaine plus 8mg dexamethasone (n = 25) vs. Group LDC: received 3mg/kg lidocaine for IVRA and 8 mg dexamethasone IV (n = 25).	Follow-up at 5, 10, 15, 30, 60, and 120 minutes	Duration of motor blockade 13 minutes LD group vs. 8 IVRA and 6 LDC, p = 0.04. LD requested less analgesics post-operatively (36% vs. 72% and 60%), p = 0.033. Mean analgesics consumed: IVRA 520± 390 vs. LD 200±285 vs. LDC 420±445mg (p = 0.016 between LD and IVRA).	“The addition of 8mg dexamethasone to lidocaine for IVRA in patients undergoing hand surgery improves postoperative analgesia during the first postoperative day.”	Baseline differences; blinding details sparse.
Alayurt 2004 (score=7.0)	CTS/ Surgery/ Anesthesia	RCT	No mention of sponsorship or COI.	N = 60 patients scheduled for surgery of hand or forearm	Mean age: 31.75 years; gender not specified	Group L: 35ml 0.5% lignocaine with 5ml saline (n = 15) vs. Group LS: sufentanil 25µg (n = 15)	Follow-up for 24 hours.	No difference between groups in intra-operative hemodynamic data, time to recovery of sensory block, onset and recovery of motor block, sedation scores or	“Addition of sufentanil, tramadol, or clonidine to lignocaine shortened the onset of the sensory block, delayed the onset time of the	Blinding details sparse.

						vs. Group LT: tramadol 100mg (n = 15) vs. Group LC: clonidine 1µg.kg-1 (n = 15).		postoperative pain. Group with saline had a longer delay of sensory block (p<0.001).	tourniquet pain and reduced the intraoperative consumption of opioid, but did not affect postoperative pain.”	
Bigat 2005 (score=7.0)	CTS/ Surgery/ Anesthesia	RCT	Sponsored by the Akdeniz University Scientific Research Project Unit, Antalya/Turkey. No COI.	N = 50 undergoing elective hand surgery for CTS	Mean age: 45.7 years; 22 Males, 28 Females	Group R: received 1% ropivacaine (n = 25) vs. Group L: received 2% lidocaine intravenous regional anesthesia (n = 25).	Follow-up for 24 hours after the surgery	Pain scores elevated from 30-120 minutes lidocaine vs. ropivacaine group (graphic data, p <0.05). Time to first analgesics lidocaine 226.4±237.1 for ropivacaine vs. 91.7±214.2 minutes (p <0.05). (Data appear reversed between groups for that outcome). Mean paracetamol consumption 550±390 vs. 175±335mg, p <0.05. Most lidocaine patients (60%) used analgesics vs. 20% ropivacaine.	“[R]opivacaine 1 mg/kg provided effective anaesthesia and long-lasting postoperative analgesia compared with lidocaine.”	Randomization, allocation details sparse. No assessor blinding.
Bernard 1997 (score=7.0)	CTS/ Surgery/ Anesthesia	RCT	No mention of sponsorship or COI.	N = 56 patients with CTS undergoing a release procedure	Mean age: 51 years; gender not specified	Group 1: 30µg clonidine in 400mg lidocaine group (n = 14) vs. Group 2: 90µg clonidine in 400mg lidocaine group (n = 14)	Follow-up at baseline, 20, 40, 60, 80, 140, 200 and 260 minutes post release.	Sensory blockage significantly more prominent at all assessments vs. saline group (p <0.01). At 20 and 30 minutes, all clonidine-dose groups significantly higher sedation rates vs. saline control	“[A] small dose of clonidine enhances the quality of the peripheral blocks from local anesthetics (lidocaine) and limits the α ₂ - agonist side effects to the sedation. The best dose to	Allocation unclear; blinding details sparse.

						vs. Group 3: 300µg clonidine in 400mg lidocaine (n = 14) vs. Group 4: saline control group in 400mg lidocaine (n = 14)		group, (p <0.01). Those in 30µg and 300µg clonidine groups exhibited significantly higher sedation rates at 20, 40, 140 minute assessments vs. those who received saline: 20 (p <0.05), 40 (p <0.01), 140 (p <0.05). At 40 minute assessment, 300µg group had higher sedation rate vs. 90µg group (p <0.05).	use clinically is between 30 µg and 90 µg.”	
Lawrence 2002 (score=7.0)	CTS/ Surgery/ Anesthesia	RCT	Sponsored by the Wishbone Trust. No mention of COI.	N = 56 patients undergoing carpal tunnel decompression.	Mean age: 53.6 years; 22 males, 34 females	Group 1: Eutectic mixture off local aesthetics (EMLA) 5ml (n = 29) at least 1 hour before surgery. vs. Group 2: placebo 5ml (n = 27) at least 1 hour before surgery. All then received 8ml 0.5% bupivacaine infiltrated over 60 second period	Follow-up post-op.	Lower pain scores with EMLA group, 23±10, vs placebo, 35±16 for both needle insertion (p = 0.0012) and anesthetic injection, EMLA 29±14 vs. placebo 46±19 (p = 0.0005).	“The results of this study show that EMLA is effective in reducing pain caused by the infiltration of local anesthetic prior to carpal tunnel release.”	Baseline details sparse.
Reuben 1996 (score=7.0)	CTS/ Surgery/ Anesthesia	RCT	No mention of sponsorship or COI.	N = 60 patients undergoing either elective carpal tunnel	Age and gender not specified.	Group 1 (control): no adjuvant (n = 20) vs.	Follow-up 24 hours post-op.	VAS scores lower in 2 groups who received ketorolac (p <0.05). Mean time from	“Ketorolac provides similar post-operative analgesia after ambulatory hand	Author with multiple fabricated and retracted research papers. Randomization, blinding, allocation details sparse.

				release or tenolysis performed by the same surgeon.		Group 2: 60mg ketorolac with IVRA n = 20) vs. Group 3: 60mg ketorolac infiltration to surgical site (n = 20). All groups: Given 40mL 0.5% lidocaine IV regional anesthesia and 1% lidocaine infiltration		tourniquet release to first medication 109+/-73 minutes for Group 1, 467+/-431 for Group 2, and 393+/-312 for Group 3 (p <0.05). Numbers of tablets taken: 4.1+/-1.3 Group 1; 1.8+/-1.2 Group 2; and 2.0+/-1.3 Group 3 (p <0.05).	surgery when administered with lidocaine either by IVRA or by wound infiltration.”	
Patil 2006 (score=5.5)	CTS/ Surgery/ Anesthesia	RCT	No sponsorship or COI.	N = 20 patients with bilateral carpal tunnel syndrome	Mean age: 54 years; 3 males, 17 females	Group 1: (Modified Gale) 6mL 2% lignocaine site infiltration (n = 9) vs. Group 2: (modified Altissimi and Mancini) 3.5mL 2% lignocaine infiltrated in incision line and 2.5mL 2% lignocaine infiltrated into carpal tunnel (n = 11).	Follow-up 24 hours after surgery.	Six patients experienced intra-operative pain with the Gale technique, versus none with the Altissimi and Mancini technique (p = 0.02).	“The postoperative pain was not significantly different between the two groups, although the patients anaesthetised by the Altissimi and Mancini technique required significantly lower numbers of analgesic tablets.”	Single blinding. Compliance rate unclear. Dropout rate high. Study described as crossover trial involving two surgical procedures of different hands at different times.
Nabhan 2011 (score=5.0)	CTS/ Surgery/ Anesthesia	RCT	No mention of sponsorship. No COI.	N = 44 with CTS confirmed by nerve conduction testing and physical exam	Mean age: 55 ±14 years; 18 males, 26 females	Group 1: received 20ml of pilocaine via 22 gauge needle (n = 22) vs Group 2: Received 30ml	Follow-up at baseline, 2 weeks and 6 months post-op.	Both groups showed significant improvement at 2 weeks and 6 months after procedure for hand function, ADLs, work	“In the current study, the application of subcutaneous LA for ECTR was more effective than IVRA.	Tourniquet and operating time were different between the 2 groups

				lasting >3 months with no prior surgery		of 1% prilocaine via 20 gauge cannula (n = 22).		performance, pain, and patient satisfaction values when compared to baseline. Mean tourniquet inflation time significantly higher in IVRA group compared to LA group: 27.5 (±2.3) vs. 13.0 (±2.8) minutes, (p = 0.01). Mean operating room time also higher in IVRA group vs. LA group: 45 (±3.9) vs. 28 (±3.5) minutes, (p = 0.01).	Furthermore, LA is less invasive and simpler in comparison to surgery under IVRA.”	
Lee 2013 (score=4.5)	Local Anesthesia	RCT	Sponsored by Seoul National University Hospital research fund. No COI.	N = 25 patients with bilateral carpal tunnel syndrome	Mean age: 57±10 years; 2 males, 23 females	Buffer Group: received 1% lidocaine buffered with 8.4% sodium bicarbonate (1mEq/mL) solution (1 mL bicarbonate to 9 mL 1% lidocaine) vs Non-buffered Group: received 1mL 0.9% sodium chloride to 9 mL 1% lidocaine non-buffered. All patients received both injections in random hands.	No mention of follow-up.	Mean VAS score for buffered group was 4.6±1.5 compared to the non-buffered group 6.5±1.5 (p<.001). Mean VAS score after adjusted for individual pain was 4.6±1.5 for the buffered group compared to 6.6±1.7 for the non-buffered group (p<.001).	“In open carpal tunnel surgery, the use of buffered lidocaine for local anesthesia reduces the anesthetic pain effectively.”	Blinding questionable, only bilateral CTS patients used. Data suggest buffered lidocaine superior.

Evidence for the Use of Initial Care

There are no quality studies incorporated into this analysis.

Rest

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Rest; relative rest / Triangular fibrocartilage complex (TFCC) tears ;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed zero articles in PubMed, zero in Scopus, zero in CINAHL, and 1 in Cochrane Library. We considered for inclusion zero from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the zero articles considered for inclusion, zero randomized trials and zero systematic studies met the inclusion criteria.

Splinting

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Splinting or Immobilization; Triangular fibrocartilage complex (TFCC) tears; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 6 articles in PubMed, 16 in Scopus, 1 in CINAHL, and 52 in Cochrane Library. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 1 from Cochrane Library and 2 from other sources. Of the 4 articles considered for inclusion, 0 randomized trials and 2 systematic studies met the inclusion criteria.

Ice

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Ice; Triangular fibrocartilage complex (TFCC) tears; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library and 0 in other sources. Zero articles met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Heat, Self-application of heat; Triangular fibrocartilage complex (TFCC) tears controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion zero articles in PubMed, zero in Scopus, zero in CINAHL, zero in Cochrane Library and zero in other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Exercise

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Exercise; triangular fibrocartilage, TFCC, triangular fibrocartilage complex, tears, injuries, lesions, triangular fibrocartilage injuries, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed zero articles in PubMed, zero in Scopus, zero in CINAHL, and 1 in Cochrane Library. We considered for inclusion zero from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the zero articles considered for inclusion, zero randomized trials and zero systematic studies met the inclusion criteria.

Evidence for the Use of Surgery

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Open surgical repair, triangular fibrocartilage, TFCC, triangular fibrocartilage complex, tears, injuries, lesions, tear, injury, triangular fibrocartilage injuries, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 7 articles in PubMed, 29 in Scopus, 0 in CINAHL, and 0 in Cochrane Library. We considered for inclusion 3 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Zero articles met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: arthroscopic, subchondral, arthroscopy, arthroscopic, arthroscopy, open surgery repair, ulna shortening or wafer procedures, triangular fibrocartilage, TFCC, triangular fibrocartilage complex, tears, injuries, lesions, tear, injury, triangular fibrocartilage injuries; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 55 articles. Of the 55 articles we considered for inclusion 2. Of the 2 considered for inclusion, 0 are randomized controlled trials and 2 systematic reviews.*

Evidence for the Use of MRI/CT

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: magnetic resonance imaging or MRI, CT, crush injury, upper extremity; diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency. We found and reviewed 5 articles in PubMed, 18 in Scopus, 6 in CINAHL, 1 in Cochrane Library, and 1490 from Google Scholar. Zero articles met the inclusion criteria.

Evidence for the Use of Initial Care

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: rest, bed rest, initial elevation, initial care, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion zero articles in PubMed, zero in Scopus, zero in CINAHL, 197 in Cochrane Library, 266 in Google Scholar and zero in other sources. Zero articles met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: splint, splints, nocturnal splint, splinting, upper extremity, wrist, wrist injury, crush injury, compartment syndrome, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 22 articles in PubMed, 11 in Scopus, 0 in CINAHL, 52 in Cochrane Library, and 1,929 in Google Scholar and zero in other sources. Zero articles met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: ice, self-application of ice, crush injuries, wrist injury, compartment syndrome, upper extremity, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 43 articles in PubMed, zero in Scopus, 2 in CINAHL, 4 in Cochrane Library and 5,690 in Google Scholar. We considered for inclusion 1 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library, zero from Google Scholar and zero from other sources. Of the 5,739 articles considered for inclusion, zero randomized trials and 1 systematic studies met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: heat, self-application of heat, crush injuries, wrist injury, compartment syndrome, upper extremity, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 4 articles in PubMed, 1 in Scopus, zero in CINAHL, 85 in Cochrane Library, 8252 in Google Scholar, and zero other sources. Zero articles met the inclusion criteria.

Evidence for the Use of NSAIDs/Acetaminophen

There is 1 moderate-quality RCT incorporated into this analysis.(1008) (Woo 05)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDs; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 0 in Scopus, 0 in CINAHL, 110 in Cochrane Library, 510 in Google Scholar, and 1 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 1 from Cochrane Library, 0 Google Scholar, and 1 from other sources. Of the 2 articles considered for inclusion, 1 randomized trials and 1 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Woo 2005 RCT Double-blind No mention of sponsorship or COI.	5.5	N = 300 (No mention of Gender) w/ painful isolated limb injuries. Mean Age: Paracetamol group 35.6±12.2; Diclofenac group 38.2±13.1; Indomethacin group 34.2±11.0; Diclofenac and Paracetamol group 38.3±12.7	Paracetamol and placebo group monitored every 30 minutes for 2 hours, same dosage for 3 days. (N =66) Vs Diclofenac and placebo group monitored every 30 minutes for 2 hours, same dosage for 3 days. (N =69). Vs	In stage 1 in the emergency department, analog pain scores and rest and with activity was >13 mm in all groups for the first hour. The diclofenac-paracetamol group achieved <13mm range at 90 minutes after ingestion as well as greatest pain reduction score in 2 hours. After 90 minutes all groups pain score was <13mm. No statistical difference between groups at any time. In stage 2, the diclofenac-paracetamol group was only group to achieve <13mm average pain reduction score within the first day. It also saw more abdominal pain than any other group. Median patient satisfaction scores (out of 10) with the oral analgesic treatment were 3.0 (3.0 to 4.0; P=.39) and with the study in general were 3.0 (3.0 to 4.0; P=.25).	“Analgesic benefit of oral paracetamol–nonsteroidal anti-inflammatory drug combinations over single nonsteroidal anti-inflammatory drugs or paracetamol treatment is small and of doubtful clinical significance.”	Baseline comparability questionable as diagnoses and distribution of group. No placebo group.

			<p>Indomethacin and placebo group monitored every 30 minutes for 2 hours, same dosage for 3 days. (N=71) Vs Diclofenac and paracetamol group monitored every 30 minutes for 2 hours, same dosage for 3 days. (N=94);</p> <p>Follow-up at baseline and at 5-8 days after initial presentation.</p>			
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Evidence for the Use of Exercise

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Exercise; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 43 in Scopus, 5 in CINAHL, 3 in Cochrane Library, 150 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Hyperbaric Oxygen for Crush Injuries or Compartment Syndrome

There is 1 moderate-quality RCT incorporated into this analysis.(1009)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Hyperbaric oxygen therapy, hyperbaric oxygenation, HBOT, crush syndrome, crush injury, compartment syndrome, compartment syndromes, upper extremity, hand, arm, forearm; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 15 articles in PubMed, 11 in Scopus, 15 in CINAHL, 5 in Cochrane Library, 1050 in Google Scholar, and 0 from other sources. We considered for inclusion 6 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 2 Google Scholar, and 0 from other sources. Of the 8 articles considered for inclusion, 1 randomized trial and 5 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
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Hyperbaric Oxygen vs. Placebo

Bouachour 1996 RCT Sponsored by research grants from the Centre Hospitalier Universitaire of Angers. No mention of COI.	6.5	N = 36 with Class II or III soft tissue injuries. Surgery in 6 hours. Mean age HBO group 45.8±16.1 years, placebo group 51.5±20.9 years.	HBO therapy 100% O2 at 2.5 atmospheres for 90 minutes, twice a day for 6 days (N=18) vs. placebo in hyperbaric chamber at pressure of 1.1 ata for 90 minutes, twice a day for 6 days (N=18). Assessments at the 1 st , 4 th , 8 th , and 12 th sessions.	Complete wound healing without tissue necrosis requiring surgical excision in 17 HBO patients vs. 10 placebo, (p <0.01). Tissue necrosis 1/18 HBO vs. 8/18 placebo. New surgical procedure = 2 (1 patient) vs. 8 (6 patients), p = 0.03 (p = 0.04).	“[T]his study shows the effectiveness of HBO in improving wound healing and reducing repetitive surgery. We believe that HBO is a useful adjunct in the management of severe (grade III) crush injuries of the limbs in patients more than 40 years old.”	Results suggest HBO beneficial for these more severe injuries with better healing and less repeat surgery required.
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Evidence for the Use of Surgery

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Surgery, surgical procedures, operative, general surgery, crush, wrist injuries, wrist injury, compartment syndrome, compartment syndromes, upper extremity, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 212 articles in PubMed, 250 in Scopus, 17 in CINAHL, and 0 in Cochrane Library. We considered for inclusion 5 from PubMed, 0 from Scopus, 2 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 7 articles considered for inclusion, 0 randomized trials and 1 systematic study met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: Surgery, surgical procedures, general surgery, crush, wrist injuries, wrist injury, compartment syndrome, compartment syndromes, and upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 82 articles. Zero articles met the inclusion criteria.*

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Emergency fasciotomy, crush injuries, crush, injury, injuries, compartment syndrome, upper extremities, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 44 in Scopus, 0 in CINAHL, and 1 in Cochrane Library. We considered for inclusion 0 from PubMed, 3 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 3 articles considered for inclusion, 0 randomized trials and 2 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: Emergency fasciotomy, crush, wrist injuries, wrist injury, compartment syndrome, compartment syndromes, and upper extremity; controlled clinical trial, controlled

trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.

Evidence for the Use of X-rays

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Kienböck’s disease, X-ray, radiography, radiograph; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 3 articles in PubMed, 347 in Scopus, 2 in CINAHL, 12 in Cochrane Library, 140 in Google Scholar and zero in other sources. Zero articles met the inclusion criteria.

Evidence for the Use of CT

There is 1 moderate-quality study incorporated into this analysis. (Nakamura 89)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: computed tomography or CT, Kienböck’s disease; diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 33 articles in PubMed, 3 in Scopus, 0 in CINAHL, 0 in Cochrane Library, and 295 from Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion 1 diagnostic study met the inclusion criteria.

Author/Year Study Type	Score	Number	Area of Spine	Diagnoses	Type of CT	X-ray used	MRI Used	More than one rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Nakamura 1989 Diagnostic No mention of sponsorship or COI.	4.5	N = 20 (3 female and 17 male) admitted for wrist problems; 3 with Kienbock’s disease, 14 with fractures or dislocations of the	Wrist	Wrist problems due to altered bony or joint structures.	High resolution CT scanner (Somatom DRH) and accompanying software (3D Display; Version B or C)	-	-	-	-	-	-	-	-	16/17 cases of fracture a three-dimensional CT image was believe to be useful to detect the fracture line. 3 had a flattened lunate due to Kienbock disease. 13 had deformity of the hamate body seen on plain radiography and CT, but the three-dimensional CT image. Presence and location of small fragments not detected by plain radiographs and CT, but distinctly observed in seven cases	“Three-dimensional CT imaging provides a great deal of information that cannot be obtained by conventional radiographs or CT images even at their present stage of technical development.”	Small sample (N=20). Data suggest 3-D CT provides more diagnostic information than either plain radiography or conventional CT.

		carpal bones													by using three dimensional CT images.		
		Age range from 18 to 64 years.															

Evidence for the Use of MRI

There are 2 moderate-quality studies incorporated into this analysis.(1020, 1021)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Magnetic Resonance Imaging, MRI, Kienböck’s disease or Kienbock disease, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 82 articles in PubMed, 68 in Scopus, 1 in CINAHL, 0 in Cochrane Library, and 523 from Google Scholar. We considered for inclusion 2 from PubMed, 0 from Scopus, CINAHL, Cochrane Library, Google Scholar, and from other sources. Of the 2 articles considered for inclusion 2 diagnostic studies met the inclusion criteria.

Author/Year Study Type	Score	Number	Area	Diagnoses	Type of MRI used	Type of CT used	T1 weighted images	T2 weighted images	X-ray	Myelography	More than one rater	Surgery Performed	Clinical outcomes assessed	Long term follow- up (mean when noted)	Results	Conclusion	Comments
Hashizume 1996 Diagnostic No mention of sponsorship or COI.	4.0	10 (2 female/ 8 male)	Wrist	Kienbock's Disease	1.5 Tesla signal, both T1 and T2 weighted images.	+	+	+	+	-	-	+	+	Mean follow- up 29.	Areas of collapse easily identified in x-ray, tomography, CT and microradiographic images. MRI showed complete loss of signal intensity in T1 images of lesion of lunate.	"MRI is at present unable to distinguish bone necrosis, the histological reactive interface or surrounding hyperaemia in detail."	Small sample size. Data suggest MRI unable to distinguish bone necrosis in detail.
Imaeda 1992 Diagnostic No mention of sponsorship or COI.	4.0	26 (7 female and 19 male)	Wrist	Kienbock's Disease	1.5 tesla signal with 3-inch surface coil. Both T1 and T2 weighted images.	-	+	+	-	-	-	+	+	-	For normal wrists, bone marrow showed high signal intensity on T1 and iso intensity on T2. For wrists with Kienbock's disease, T1 weighted images had decrease in signal intensity in all cases. After osteotomy of radius, signal intensity of lunate returned to normal in both T1 & T2.	"After osteotomy of the radius, the signal intensity of the lunate returned to normal and Lichtman's stage IL cases had better results than those in stage III. M.R. imaging is ideal for evaluating the lunate in Kienbock's disease."	Small sample. Data suggest a low signal intensity of lunate on T-1 weighted images is diagnostic of Kienböck's disease and signal intensity (if high) correlate to disease severity.

Evidence for the Use of Screening

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Screening for Systemic Disorders, steroid, trauma, Kienböck's disease or Kienbock disease, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 13 articles in PubMed, 0 in Scopus, 0 in CINAHL, Cochrane Library, and 127 from Google Scholar. We considered for inclusion 0 from PubMed, Scopus, CINAHL, Cochrane Library, Google Scholar, and from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Initial Care

There are no quality studies incorporated into this analysis.

Ice:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Kienböck's disease or Kienbock disease; Ice; Self Application; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 0 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Heat:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Kienböck's disease or Kienbock disease; HEAT/ Self-Application of Heat; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library and 0 in other sources. Zero articles met the inclusion criteria.

Splints:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Screening for Systemic Disorders, steroid, trauma, Kienböck's disease or Kienbock disease, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 13 articles in PubMed, 0 in Scopus, 0 in CINAHL, Cochrane Library, and 127 from Google Scholar. We considered for inclusion 0 from PubMed, Scopus, CINAHL, Cochrane Library, Google Scholar, and from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of NSAIDs/Acetaminophen

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDS, Acetaminophen, Kienböck's disease; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic,

systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 11 articles in PubMed, 2 in Scopus, zero in CINAHL, 3 in Cochrane Library, 132 in Google Scholar, and zero in other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Topical Medications

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Topical Cream, Topical Ointment, lidocaine patch, topical medication, Kienböck's disease, Kienbock disease; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 1 article in PubMed, 3 in Scopus, zero in CINAHL, 72 in Cochrane Library, 14 in Google Scholar and zero in other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Exercise

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, Kienböck's disease, Kienbock disease upper extremity, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 35 articles in PubMed, 5 in Scopus, zero in CINAHL, zero in Cochrane Library, 492 in Google Scholar, and zero other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Surgery

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: surgery, surgical fixation, surgical repair, kienbock's disease, Kienböck's disease, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 127 articles in PubMed, 17 in Scopus, 9 in CINAHL, 809 in Google Scholar and 1,348 in Cochrane Library. We considered for inclusion 4 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library, 4 in Google Scholar and zero from other sources. Of the 8 articles considered for inclusion, zero randomized trials and 8 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: surgical repairs, operative, Kienböck's disease or Kienbock disease; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 48 articles. Zero articles met the inclusion criteria.*

Evidence for the Use of X-rays

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: X-Ray, Wrist Sprain, Wrist Sprains, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 15 articles in PubMed, 0 in Scopus, 2 in CINAHL, Cochrane Library, and 55 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 57 articles considered for inclusion 0 diagnostic studies met the inclusion criteria.

Evidence for the Use of CT Scans

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Wrist Sprain, Wrist Sprain, Computed Tomography (CT), diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 13 articles in PubMed, 0 in Scopus, 0 in CINAHL, Cochrane Library, and 432 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 445 articles considered for inclusion 0 diagnostic studies met the inclusion criteria. Zero articles met the inclusion criteria.

Evidence for the Use of MR Arthrography

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: MR Arthrography, Wrist Sprain, Wrist Sprain, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 4 articles in PubMed, 0 in Scopus, 0 in CINAHL, Cochrane Library, and 244 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 248 articles considered for inclusion 0 diagnostic studies met the inclusion criteria.

Evidence for Initial Care

There is one moderate-quality RCT that shows heat is effective in reducing pain from wrist sprains.(1046) There are no quality studies evaluating relative rest, splints, or ice for wrist sprains. However, these treatments may help with symptomatic relief. Splints are recommended particularly for patients with moderate to severe sprains. (Physicians should be aware that as early mobilization of ankle sprains results in improved clinical outcomes and those results may be applicable to the wrist.) These interventions are not invasive, have no adverse effects, and are low cost, thus they are recommended.

Rest:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Rest, wrist sprains; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed zero articles in PubMed, 477 in Scopus, zero in CINAHL, zero in Cochrane Library, 1224 in Google Scholar, and zero from other sources. We considered for inclusion zero from PubMed, zero from Scopus, zero from CINAHL, and zero from Cochrane Library, zero Google Scholar, and zero from other sources. Zero articles met the inclusion criteria.

Splints:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: splint, splinting, Wrist Sprain, Wrist Sprain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed zero articles in PubMed, 15 in Scopus, zero in CINAHL, zero in Cochrane Library, zero in Google Scholar, and zero from other sources. Zero articles met the inclusion criteria.

Ice:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ice, hypothermia, cryotherapy, ice packs, wrist sprains, wrist sprain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 614 articles in PubMed, 128 in Scopus, zero in CINAHL, 0 in Cochrane Library, 3243 in Google Scholar, and zero from other sources. We considered for inclusion 2 from PubMed, zero from Scopus, zero from CINAHL, and zero from Cochrane Library, zero Google Scholar, and zero from other sources. Of the 2 articles considered for inclusion, zero randomized trials and 2 systematic studies met the inclusion criteria.

Heat:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Wrist sprains, heat, hot temperatures, therapeutics ; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1290 articles in PubMed, 9 in Scopus, 1 in CINAHL, zero in Cochrane Library, and 2610 in Google Scholar. We considered for inclusion one from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library, zero from google scholar, and zero from other sources. Of the one article considered for inclusion, 1 randomized trial and zero systematic studies met the inclusion criteria.

Evidence for Heat for Wrist Sprain

There is 1 moderate-quality RCT incorporated into this analysis.(1046)

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Heat vs. Other treatments vs. Placebo						
Michlovitz 2004 RCT Sponsored by Procter & Gamble Health Sciences Institute. COI Erasala, Hengehold, and Weingand are employees of	5.5	N = 69 (14 males, 15 females) with acute wrist pain, mostly from sprains, tendinosis, strains, osteoarthritis , or CTS; Mean (± SD)	Self-applied heat wrap group at 104° F (40°C) for 8 hours daily (N= 29) vs. Oral placebo (N= 30) vs.	Mean pain relief greater in heat wrap than oral placebo (mean pain relief 1.68±0.23 vs. 1.15±0.21 (p = 0.045). Grip strength improved more in heat wrap group 6.44± 1.34kg increase vs.	“Continuous low-level heat therapy is a novel strategy in the treatment of musculoskeletal disorders. In this study, increased pain relief, functional gains, and grip strength along with decreased joint stiffness and symptom severity were observed in subjects with CTS treated with the heat wrap as compared to oral placebo. Additionally, subjects with SS/T/OA also had improved pain relief and significant improvements in grip strength as compared with placebo. These results support the benefit of continuous low-level heat wrap therapy in the treatment of common upper-extremity WRMSDs.”	Short (3 days) treatment. Results for acetaminophen and unheated wrap not reported.

Procter & Gamble. Michlovitz is a paid consultant for Procter & Gamble.		age 44.13 (± 10.23) years for all groups.	500mg acetaminophen group; 2 tablets 4x daily (N=5) vs. Unheated placebo wrap group (N=5) All groups received 3 days of treatment. Assessments at baseline, 3, 4 and 5 days.	2.48±1.34 kg (p = 0.021).		
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Evidence for the Use of NSAIDs/Acetaminophen

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDs, non-steroidal anti-inflammatory drugs, Wrist Sprains; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 7 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 50 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Exercise

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: wrist, sprain, sprains, strain, strains, exercise, exercise therapy; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 22 articles in PubMed, 406 in Scopus, 3 in CINAHL, 5 in Cochrane Library, 330 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Surgery

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: surgery, surgeries, general surgery, general surgeries; wrist, sprain, sprains, strain, strains; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 213 articles in PubMed, 335 in Scopus, 2 in CINAHL, 0 in Cochrane Library, 2474 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: general surgery, wrist sprain or wrist sprains, wrist, sprains and strains; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 83 articles. Zero*

Evidence for the Use of X-rays

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: x-ray, computed tomography, radiograph, mallet finger, baseball finger; diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 22 articles in PubMed, 10 in Scopus, 2 in CINAHL, 0 in Cochrane Library, and 243 from Google Scholar. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Splints

There are 5 quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: splint, splints, splinting, finger, mallet, baseball, drop, hammer; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 12 articles in PubMed, 68 in Scopus, 3 in CINAHL, 17 in Cochrane Library, 4,110 in Google Scholar, and 0 from other sources. We considered for inclusion 8 from PubMed, 3 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 12 articles considered for inclusion, 1 randomized trials and 3 systematic studies met the inclusion criteria.

Evidence for the Use of Splint Wear

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: failed splints, splint failure, surgery, finger, mallet, baseball, drop, hammer; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 7 articles in PubMed, 2 in Scopus, 1 in CINAHL, 3 in Cochrane Library, 407 in Google Scholar, and 0 from other sources. We considered for inclusion 2 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 0 from other sources. Of the 6 articles considered for inclusion, 0 randomized trials and 2 systematic studies met the inclusion criteria.

Evidence for the Use of Medications

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: mallet finger, baseball, hammer, NSAIDs, NSAID, acetaminophen, non-steroidal anti-inflammatory; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 1 in Scopus, 0 in CINAHL, 13 in Cochrane Library, 75 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Exercise

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, physical activity, mallet finger, baseball, drop, hammer; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 5 in Scopus, 3 in CINAHL, 1 in Cochrane Library, 187 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Evidence for the Use of Splints and Surgery for Mallet Finger

There are 7 moderate-quality RCTs incorporated into this analysis.(264, 1051, 1054, 1061-1064) (Tocco 13; Toker 15) There are 3 low-quality RCTs in Appendix 2.(1052, 1053, 1065)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: surgical procedure, surgical intervention, surgery, displaced fracture, finger, mallet, baseball, drop, hammer; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 7 articles in PubMed, 75 in Scopus, 0 in CINAHL, 29 in

Cochrane Library, 332 in Google Scholar, and 0 from other sources. We considered for inclusion 5 from PubMed, 4 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 9 articles considered for inclusion, 8 randomized trials and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: surgical procedures, operative or surgical intervention, displaced fractures, displaced fracture, finger, mallet or baseball or drop or hammer; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 7 articles. Of the 7 articles we considered for inclusion 1. Of the 1 considered for inclusion, 1 are randomized controlled trials and 0 systematic reviews.

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
O'Brien 2011 (score=6.5)	Mallet Finger Surgery	RCT	Sponsored by the Alfred Allied Health Research Grant. No COI.	N = 64 with acute type 1a or 1b mallet finger	Mean age: 37.6 ± 1.9 years; 42 males, 22 females	(Dorsal aluminum (13-mm wide padded aluminum) splint group (N= 21) vs Thermoplastic splint (1.6mm Orfit classic soft micro-perforated) group (N=22) vs Stack splint control group (N=21). All groups received a 4 week graduated exercise program after 8 weeks of splinting.	Follow up 1 week, 8, 12 and 20 weeks.	No significant differences reported between groups for extension lag at 8, 10, 12 or 20 weeks. The dorsal splints and stack control group had significantly higher treatment failure rate compared to thermoplastic group: Dorsal split- 23.8% vs. Control- 23.8% vs. Thermoplastic - 0%, (p=0.04).	“Our findings demonstrate that the majority of mallet finger injuries treated with 8 weeks of immobilization and graded exercise thereafter achieve excellent or good results, adding weight to the argument that these injuries can be managed independently in hand therapist-led clinics. To enable patients to comply with this protocol, the splint provided must be robust enough for daily living requirements and must not cause	Data suggests comparable efficacy as no lag differences were observed between the three splint types. Data suggests increased lag occurs after the splint is discontinued.

									complications which are intolerable to the patient. In this study, there was no significant difference in the outcomes achieved in the 3 trial splints; however, the custom-made thermoplastic splint was significantly less likely to result in complications that lead to treatment failure thus supporting its use in the treatment of mallet finger.”	
Tocco 2013 (score=6.0)	Mallet Finger Surgery	RCT	No sponsorship or COI.	N = 57 with closed mallet fingers (60 fingers total) t with a minimum of 20 DIPj active extensor lag that was correctable passively, with an injury onset of less than	Mean age: 45 years; 35 males, 22 females	Low temperature thermoplastic lever-type orthosis group (LTTP) (N=30; 30 fingers) vs Quickcast orthosis group (QC) (N=27; 30 fingers) Both groups wore allocated orthotic 24 hours a day.	Follow up at 3-4 weeks, 6-8 weeks, 7-9 weeks, 8-10 weeks, 10-12 weeks, 12-14 weeks and 24-28 weeks.	At 12 weeks follow up (follow up 5), the LTTP group had significantly higher extensor lag than the QC group, (p=0.05). The QC group had significantly higher average active extensions of 5 degrees or more compared with the LTTP group, (p=0.05).	“The findings of this study demonstrate that full-time immobilization with QC of Type 1 mallet fingers was more effective than the traditional approach of fabricating an LTTP orthosis and instructing the patient to remove it daily	Relatively small sample size. Compliance difficult to assess. Group instructions were different. Data suggest LTTP group had significantly greater extensor lag than QC subjects at 12 weeks and age and amount of edema negatively impacted D/P extensor lag.

				90 days prior to commencing the study.				Success rates were higher in the QC group compared with LTTP group and approached significance; 60% vs. 81%, (p=0.08).	for skin care. Cast immobilization resulted in greater edema reduction, better DIPj extension gains and had no detrimental effects on finger flexion or hand and finger strength. The casting material used in this study offers similar functional advantages to low temperature thermoplastic. Edema reduction and age rather than accidental orthosis removal, seemed to have a more substantial impact on the successful treatment of mallet finger injuries but further investigation into this relationship is warranted. Additionally, further investigation of the	
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									immobilization duration and orthosis discontinuation process after a mallet finger injury is warranted to improve success rates, particularly in older patients and when edema is significant.”	
Pike 2010 (score=5.5)	Mallet Finger Surgery	RCT	Sponsored by the Canadian Orthopedic Association. No COI.	N = 77 with acute mallet finger	Mean age: 43 years; 51 males, 26 females	Dorsal aluminum (with padding) splint group (N=26) vs Volar aluminum splint (without padding) group (N=27) vs Custom thermoplastic with circumferential coverage splint group (N=24) All groups received 6 weeks of treatment. No overnight splinting required.	Follow up at 7 weeks, 12 weeks and 24 weeks.	No statistically significant differences reported between groups for radiographic lag differences or improved outcomes at follow ups.	“No lag difference was demonstrated between custom thermoplastic, dorsal padded aluminum splint and volar padded aluminum splinting for Doyle I acute mallet fingers. Clinical measurement overestimates true lag in mallet injuries. Increased lag occurs after discontinuation of splinting. Increased age and complications correlate with worse	Data suggests comparable efficacy as no lag differences were observed between the three splint types. Data suggests increased lag occurs after the splint is discontinued.

									radiographic lag.”	
Warren 1988 (score=5.0)	Mallet Finger Surgery	RCT	No mention of sponsorship or COI.	N = 114 mallet fingers presenting to the Accident and Emergency Departments at the Royal Hallamshire and Northern General Hospital in Sheffield during a one-year period.	Mean age: 46.1 years; 73 males, 41 females	Stack splint group (N=58) vs Abouna splint group (N=49) Splints worn continuously for 6 weeks, then nightly for 2 weeks	Follow up at 6 and 10 weeks.	Successes: Stack vs. Abouna splint: 19/58 (33%) vs 19/49 (39%) (NS); 20/70 (28.6%) without vs 17/33 (51.5%) with bony injury; Ages 10-39: 23/38 (60.5%); ages 40- 79: 15/69 (21.7%)	“The two splints were equally effective, producing a cure or a significant improvement in approximately 50% of cases. However, the Stack splint was much preferred by the patients, who found it more comfortable, more robust and easier to keep clean.”	Type of splint appears immaterial. Overall healing rates were somewhat low. Lack of fracture and increased age predict worse prognosis.
Maitra 1993 (score=4.0)	Mallet Finger Surgery	RCT	No mention of sponsorship or COI.	N = 60 with mallet finger deformities	Mean age: 44.5 ± 16.6 years; 37 males, 23 females	Aluminum splint group (N=30) vs Stack splint group (N=30) All splints worn continuously for 6 weeks, then nightly for 3 weeks.	Follow up at 3, 6 and 9 weeks.	Success rates 37% vs. 33% (NS); skin complications aluminum vs. stack splint: number of fingers with skin complications: 6.6% vs. 33%; dorsal ulcer: 3% vs. 10%; skin maceration: 3% vs. 20%	“Both splints were equally effective in correcting the deformity but the aluminium [KH1] alloy splint was able to be fitted to a wider variety of finger shapes and sizes and caused significantly fewer skin complications.”	Both splints equally efficacious. Fewer skin complications with aluminum splint.
Splint vs. Surgical Fixation										

Auchincloss 1982 (score=4.0)	Mallet Finger Surgery	RCT	No mention of sponsorship or COI.	N = 41 patients with mallet finger injuries attending the Bristol Royal Infirmary Accident Department from August 1978 to October 1979.	Mean age: 41 years; 29 males, 22 females	Kirschner wire percutaneous fixation (6 weeks) group (N=19) vs Pryor and Howard splint (6 weeks) (N=22)	Follow up 14 to 18 months after injury.	K-wire group vs P&H splint group: Normal function: 19/19 (100%) vs. 20/22 (90.9%). Good objective results: 11 (57.9%) vs. 11 (50%). Unchanged objective results: 1 (5.3%) vs. 4 (18.2%)	“Trial showed no particular advantage for either method, but suggested that patients presenting after some delay may achieve better results after internal fixation.”	High dropout rates preclude strong conclusions.
Displaced Fractures - Fixation										
Toker 2015 (score=4.0)	Mallet Finger Surgery	RCT	No sponsorship or COI.	N = 22 with mallet fractures	Mean age: 32 years; 17 males, 5 females	Extension block pinning group (N = 16) vs Open reduction and hook plate fixation group (N = 6)	Mean follow up 13 months	No significant differences reported between groups at follow up for VAS, mean extensor lag or mean flexion. Extension block pinning found to be more cost-effective than hook plate fixation.	“Extension block pinning and open reduction hook plate fixation comparable in efficacy. The cost of open reduction and plate fixation was higher than that of extension block pinning. This difference would be even higher if plate removal is required.”	Small sample (N=22). Data suggest similar efficacy between extensor block pinning versus open reduction for mallet fractures and pinning more cost effective than open reduction.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: failed splints, surgery, finger, mallet, baseball, drop, hammer; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 27 articles. Of the 27 articles we considered for inclusion 0. Zero articles met the inclusion criteria.

Evidence for the Use of Diagnostic Studies

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Flexor Tendon Entrapment, Tenosynovitis, Trigger Finger Disorder, X-Rays, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 5 articles in PubMed, 24 in Scopus, 0 in CINAHL, 0 Cochrane Library, and 195 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Splints

There is 1 moderate-quality RCT incorporated into this analysis.(1066)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Splints, Flexor Tendon Entrapment, Tenosynovitis, Trigger Finger Disorder, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 20 articles in PubMed, 21 in Scopus, 5 in CINAHL, 1 in Cochrane Library, and 2130 from Google Scholar. We considered for inclusion 1 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 1 randomized trials and 1 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Tarbhai 2012 RCT Supported by University Health Network Allied Health research fund.	4.0	N = 30 (17 females, 13 males) with trigger digit. Mean age 63.4 years.	MCP Group: metacarpophalangeal joint blocking splint (n = 15, 15 digits) vs. DIP Group: distal interphalangeal joint blocking splint (n = 15, 17 digits). Follow-up 3 and 6 weeks.	At 6 weeks, MCP group 77% success rate vs. 47% in DIP group, and slight decrease in grip strength; 4/13 MCP vs. 3/15 DIP (p >0.05). No identified functional limitations. No significant difference in pain intensity, severity of triggering, frequency of triggering, functional limitations (p >0.05).	“Initiating conservative treatment with the MCP joint blocking splint has value for patients with trigger finger and positive outcomes in 77% of subjects, whereas use of the DIP joint splint was effective in about half of subjects.”	Small sample. Trends towards different severity at baseline in outcome measures. Data suggest increase comfort with MCP joint blocking splint but both groups showed significant improvement at 6 weeks maintained for 1 year. Data do not show substantive differences between types of splints.

Evidence for the Use of Medications Trigger Digit

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Flexor Tendon Entrapment, Tenosynovitis, Trigger Finger Disorder, Anti-Inflammatory Agents, Non-Steroidal, non-steroidal anti-inflammatory, NSAIDS; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 12 articles in PubMed, 2 in Scopus, zero in CINAHL, one in Cochrane Library, 5730 in Google Scholar, and zero from other sources. We considered for inclusion 1 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library, one from Google Scholar, and zero from other sources. Of the articles considered for inclusion, 1 randomized trial and 1 systematic studies met the inclusion criteria.

Evidence for the Use of Exercise Trigger Digit

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, exercising; flexor tendon entrapment, trigger finger disorder, trigger thumb, trigger digit, thumb, thumbs, digit, digits; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 0 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 12,060 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Glucocorticosteroid Injections for Flexor Tendon Entrapment

There are 2 high-(38, 1069) and 12 moderate-quality RCTs incorporated into this analysis.(1070, 1071, 1079, 1082-1090) (Jianmongkol 07; Cecen 15)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Glucocorticosteroid injection/flexor tendon entrapment, trigger finger disorder, trigger thumb, trigger digit, tenosynovitis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 31 articles in PubMed, 36 in Scopus, 0 in CINAHL, and 0 in Cochrane Library. We considered for inclusion 18 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 18 articles considered for inclusion, 13 randomized trials and 3 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: glucocorticoids, glucocorticosteroids, flexor tendon entrapment, tenosynovitis, trigger finger disorder, trigger thumb, and trigger digit; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 13 articles. Of the 13 articles we considered for inclusion 5. Of the 5 considered for inclusion, 5 are randomized controlled trials and 0 systematic reviews.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Corticosteroid Injection vs. Placebo										
Baumgarten 2007 (score=9.0)	Corticosteroid Injection vs. Placebo	RCT	Sponsored by Orthopaedic Research and Education Foundation (OREF). COI: One or more authors received funding and grants.	N = 59 diabetic patients with subjective symptoms of pain, catching, or triggering along the A1 pulley, consistent with sterile flexor tenosynovitis	Mean Age: 62.6 years; 21 males, 38 females.	Diabetic Corticosteroid Group: Injected with 1.0mL (6mg) or betamethasone sodium phosphate/ acetate solution and 0.5mL (5mg) of 1% lidocaine (n=16) vs Diabetic Placebo Group: Injected with .05mL (5mg) of 1% lidocaine ad 1 mL of sterile saline solution (n=14)	Follow up at 6 weeks, 3 months, 1 year, and more on if having increased or persistent symptoms.	Non-diabetics: 22/29 (75.9%) responded to 1 injection; 6 required 2nd injection; 86% responded to 1 or 2 injections. Diabetics: 11/19 (57.9%) responded to 1 injection; 63.2% to 1 or 2 injections. Results after 2nd injection significant.	“Corticosteroid injections were significantly more effective in the digits of nondiabetic patients than in those of diabetic patients. In patients with diabetes, corticosteroid injections did not decrease the surgery rate or improve symptom relief compared with the placebo.”	Glucocorticosteroids also effective in diabetics, though less effective.
Murphy 2015 (score=8.0)	Corticosteroid Injection vs. Placebo	RCT	No mention of sponsorship or COI.	N = 24 patients with primary TF	Mean Age: 56 years; 9 males, 15 females	1mL of celestone (6mg) plus 3mL 1% lidocaine vs. 4mL 1% lidocaine only in the placebo group	Follow up at 3 weeks, and 4 months	At 3-week follow-up: steroid group 10/14 (71.4%) vs. 2/10 (20%) asymptomatic. 4-month follow-up, 9/14 (64.3%) vs. 2/10 (20%) asymptomatic (p <0.05).	“Since the treatment was well tolerated by patients and without complications, it is reasonable to offer steroid and lidocaine injection as the initial treatment for primary TF.”	Modest sample size and intermediate-term follow-up.
Lambert 1992 (score= 6.0)	Corticosteroid Injection vs. Placebo	RCT	No mention of sponsorship or COI.	N = 41 patients with a diagnosis or trigger finger or thumb,	Mean Age: 54 years; 16 males, 25 females.	20mg methylprednisolone acetate plus lignocaine (n=20) vs.	Follow up at 1 month.	Steroid group success rate 12/20 (60%) vs. 3/16 (18.8%) for placebo (p <0.02).	“Our prospective, controlled, double-blinded trial shows that steroid injection is a	Depot preparation may have unblinded the treating physician.

				which had been present for at least three months.		0.05ml 1% lignocaine injection (n=21)			satisfactory treatment for trigger finger in 60% of patients. There were no complications and success rate may be even better if repeat injections are used.”	
Peters-Veluthamanin gal 2008 (score=6.0)	Corticosteroid Injection vs. Placebo	RCT	Financially sponsored by the “Fund for Common Disorders” of the Dutch College of General Practitioners. COI: CP-V received an unrestricted educational grant from BristolMyers Squibb.	N = 50 patients with a clinical diagnosis of trigger finger	Mean Age: 63.2 years; 22 males, 28 females.	1ml triamcinolone acetate (TCA) injection vs. 0.9 % NaCl.	Follow up at 12 months.	Immediate reductions in triggering were 13/24 (54.2%) vs. 6/22 (27.3%), p = 0.053. Pain scores significantly improved with TCA (p <0.0005); 80% TCA group improved at 12 months.	“Local injection with triamcinolone acetate is effective and safe for treating trigger fingers as compared to placebo injection. The effects of steroid injections last up to 12 months.”	Mean symptoms duration differ at baseline and favored placebo (7 vs. 24 weeks, p = 0.023).
Axelsen 2013 (score=4.0)	Corticosteroid Injection vs Placebo	Post Hoc Analysis of ___ study	Sponsored by an unrestricted grant from AbbVie, Denmark. COI.	N = 85 disease-modifying antirheumatic drug-naïve patients with early rheumatoid arthritis (ERA)	Mean age: 55 years; 32 males, 53 females.	All patients received and MRI of the right 2nd–5th metacarpophalangeal (MCP) joints and the wrist joint at baseline. All patients received oral methotrexate that increased to 20 mg/week over 2 months along with either: placebo (n=43) or 40 mg of Adalimumab	Follow up monthly for the first 3 months, and then every 3 months after. At all follow ups, patients received a 20 mg/ 0.5 mL triamcinolone hexacetonide injection with a max.	At baseline, the synovitis score was 7 (range 0-21), the osteitis score was 1 (0-35) and the tenosynovitis score was 4 (0-26). At 6 months, the synovitis score was 5 (range 0-13) (p<0.0001), the osteitis score was 0 (0-35) (p=0.001) and the tenosynovitis score was 0 (0-18) (p<0.0001). At 12 months, the synovitis score was	“In conclusion, in this randomised double-blind trial, we found that a treat-to-target strategy with methotrexate and intra-articular glucocorticoid, with or without adalimumab, effectively decreased MRI disease activity in patients with ERA, and no MRI structural damage progression was	Both groups improved over time and no clinical differences between groups

						(n=42) subcutaneously every other week.	of 4 joints and 4mL per visit.	4 (range 0-15), the osteitis score was 0 (0-36) and the tenosynovitis score was 0 (0-0) (all p<0.0001).	found after 1-year of follow-up. The findings suggest that addition of adalimumab was associated with further suppression of osteitis and tenosynovitis.”	
Injection vs. Other Treatments										
Goldfarb 2007 (score=7.5)	Injection vs. Other Treatments	RCT	No mention of sponsorship or COI.	N= 125 patients with trigger finger or de Quervains tenosynovitis	Mean Age: 59 years; 32 males, 93 females.	Group 1: Injection of steroid, lidocaine, bupivacaine alone (standard injection, acidic pH) (n = 57) vs. Group 2: Injection of steroid, lidocaine, bupivacaine, bicarbonate (balanced injection, neutral pH) (n = 68).	Follow-up for 6 weeks.	Both injections provided significantly immediate pain relief reflected in VAS scores (p <0.001). No significant difference between groups for pre-injection VAS (p = 0.89). Group 2 lower VAS scores than group 1 on each of first 7 days. But, differences in VAS scores between groups only significant at days 5, 6, and 7 (p = 0.4 on each day).	“Patients respond to extra-articular steroid injections with gradual improvement over the course of the first week...A pH-balanced injection did not significantly decrease the risk of a flare reaction.”	Data suggest an extra-articular steroid injection gradually benefits patients over first week with about 1/3 of patients reporting a flare response in the days following the injection. A pH-balanced injection did not significantly decrease risk of flare response.
Zyluk 2011 (score=5.5)	Injection vs. Other Treatments	RCT	No mention of sponsorship or COI.	N= 105 patients with trigger digits	Mean Age: 56 years; 28 males, 67 females.	Surgery Group: A1 pulley release (n = 43 patients, 46 digits) vs. Injection Group- Steroid injection of 1ml 2% plain lidocaine (n = 52 patients, 59 digits).	Follow-up at 1 and 6 months.	At 1 month, surgery group significantly lower active ROM of fingers vs. injection group: 264 vs. 270 (p <0.05). Also significantly weaker in surgery group: 85% vs. 99% (p <0.05). No significant	“We conclude that percutaneous A1 pulley release is more effective medium-term therapy for trigger digit than steroid injection, because of lower risk of recurrence.”	Data suggest percutaneous A1 pulley release is better than steroid injection for trigger finger due to lower risk of recurrence (11% vs. 0%). Pain (VAS) was 0.4 in pulley

								differences with regards to other parameters. At 6 months 11% recurrence rate in injection group vs. 0% in surgery group ($p = 0.005$). At 6 months, surgery group showed significantly lower VAS score; 0.4 vs. 1.3 ($p < 0.05$) and significantly worse ROM: 265 vs. 270 ($p < 0.05$) vs. injection group.		release group vs 1.3 in steroid group at 6 months, and ROM varied only 5 degrees.
Yildirim 2016 (Score=5.0)	Injection vs Other Treatments	RCT	No sponsorship or COI.	N = 40 patients with actively correctable trigger fingers	Mean age: 54.5 years; 7 males, 33 females.	Extracorporeal shock wave therapy group: A Vibrolith Ortho ESWT was used. The patient's hand was put into a supine position, stabilizing it. All patients had 3 sessions consisting of 1000 shocks at an energy flux density of 2.1 bar. (n=20) vs Injection group: 0.5 mL of a betamethasone dipropionate/ sodium phosphate solution and 0.5 mL of 2% lidocaine	Follow up at 1, 3, and 6 months	At 1 month, cure rates between the groups was not significantly different ($p=0.684$). However, the before and after treatment values were significant (VAS ($p < 0.001$), FT ($p < 0.001$), ST ($p < 0.001$), FIT ($p < 0.001$), and QuickDASH ($p < 0.001$)). At 3 months, the cure rates between the groups was not significant ($p=0.731$). At 6 months, the cure rate between the groups was not significant ($p=0.778$).	“We conclude that extracorporeal shock wave therapy could be a non-invasive option for treating trigger finger, especially for those patients who wish to avoid steroid injections.”	No differences between treatment groups

						were injected using a 26-gauge needle from the palmar side into the A1 pulley at an angle of 45-degrees distally (n=20)				
Sato 2012 (score=5.0)	Injection vs. Other Treatments	RCT	No mention of sponsorship or COI.	N = 137 patients with 150 trigger fingers	Mean Age: 54.4 years; 18 males, 132 females.	Open: Conventional open surgery of A1 pulley (n = 56) vs. injection: 2ml of methylprednisolone acetate 40mg at site corresponding to A1 pulley (n = 49) vs. Percutaneous: percutaneous release of A1 pulley (n = 45).	Follow-up after 1, 2 weeks and 1, 2, 4, and 6 months.	Cure of trigger finger (N): open 56 vs. 1 injection 28 vs. 2 injections 42 vs. percutaneous 45 (p = 0.004). Topical pain (N) open vs. injection vs percutaneous: 1 week 38 vs. 9 vs. 30 (p = 0.000); 2 weeks 36 vs. 9 vs. 30 (p = 0.000); 1 month 22 vs. 5 vs. 15 (p = 0.008); 2, 4, and 6 months (p = NS). Joint pain (N) open vs. injection vs percutaneous: 1 week 17 vs. 3 vs. 13 (p = 0.014); 2 weeks 18 vs. 3 vs. 12 (p = 0.023); 1 month 15 vs. 3 vs. 13 (p = 0.029); 2, 4, and 6 months (p = NS). Total active motion (TAM) average open vs. injection vs. percutaneous: 1 month 176.41 vs. 207.18 vs. 201.76 (p = 0.012); 2 months 184.89 vs. 208.53 vs. 207.78 (p =	“The levels of effectiveness of open surgical and percutaneous methods were superior to the conservative method of using CSs based on the cure and reappearance rates of the trigger.”	Data suggests comparable efficacy between percutaneous and open surgery and both invasive techniques were superior injection to treat trigger finger. Yet recurrence rates were 0% (open/percutaneous) vs. 86% 1-2 injections.

								0.048); 4 months and 6 months (p = NS).		
Ring 2008 (score= 4.0)	Injection vs. Other Treatments	RCT	Sponsored by AO Foundation, Wright Medical, Joint Active Systems, Smith and Nephew, Small Bone Innovations, and Biomet. No mention of COI.	N = 84 patients with idiopathic trigger finger.	Mean Age: 64.0 years; 44 males, 40 females.	Dexamethaxone 4mg/ml (n = 40) vs. Triamcinolone 10mg/ml (n = 44).	Follow-up at 6 weeks and 3 months after their initial injection.	NS between groups at 6 weeks for average DASH score (p = 0.43) and 3 months (p = 0.61). Absence of triggering rate at 6 weeks: triamcinolone 22 of 35 patients vs. dexamethasone 12 of 32 patients (p <0.05).	“Although there were no differences 3 months after injection, our data suggest that triamcinolone may have a more rapid but ultimately less durable effect on idiopathic trigger finger than does dexamethasone.”	Data suggest at three months there were no differences between groups although triamcinolone acted faster but its effects wore off quicker than dexamethasone.
Shakeel 2012 (score=4.0)	Injection vs. Other Treatments	RCT	No sponsorship or COI.	N = 100 patients clinically diagnosed with trigger digits at least grade 2 by Quinell and without previous treatment of trigger digit.	Mean Age: 57.5 years 30 males, 70 females.	20 mg triamcinolone acetate (n = 50) vs. 12.5mg diclofenac sodium injection (n = 50).	Follow up at 3 weeks and 3 months after injection.	Mean improvement in Quinell grading corticosteroid vs. NSAID: 3 weeks 1.8 vs. 0.9 (p = 0.002); 3 weeks to 3 months 0.3 vs. 0.8 (p = 0.002).	“We concluded that, although steroids gave quicker relief, NSAID injections are equally effective at 3 months in the treatment of trigger digits. We were unable to detect a statistically significant difference in the response of patients with and without diabetes to either treatment”	Data suggest steroids act faster, but at 3 months, NSAIDs equally effective.
Callegari 2011 (score=4.0)	Injection vs. Other Treatments	RCT	Supported by IBSA Institut Biochimique SA, Pambio-Noranco, Switzerland. No COI.	N = 30 patients with ultrasound-confirmed diagnosis of trigger finger.	Mean Age: 52.5 years; 10 males, 20 females.	Group A- ultrasound-guided injection of methylprednisolone acetate (40 mg/mL) with 0.8 mL lidocaine with 1mL	Follow-up at 6 weeks, and 3, 6, and 12 months.	At 6 months complete symptom resolution was observed in 14/15 (93.3%) patients in group A. All 15 patients in group B achieved complete resolution of impairment by 3	“...the results of this explorative study suggest that ultrasound-guided injection of a corticosteroid and hyaluronic acid could be a safe and feasible approach for the	Open label study with small sample size. Data suggest US guided injection of a corticosteroid and HA may be appropriate for trigger finger,

						hyaluraonic acid 0.8% 10 days later (N = 15) Vs Group B- Open surgical release of the first annular pulley (N = 15).		weeks after surgery, but 10 patients needed physical therapy to reach complete resolutions of symptoms approximately 30-40 days after surgery. There were no significant differences between groups for VAS, DASH< and SVAS scores (p>0.05).	treatment of trigger finger.”	but a larger study is required to confirm preliminary results.
Pataradool 2011 (score=4.0)	Injection vs. Other Treatments	RCT	No mention of sponsorship. No COI.	N= 40 with primary trigger fingers.	Mean Age: 57.5 years; 4 males, 36 females.	CI Group: conventional injection technique 0.1% triamcinolone acetonide 1ml and 1% lidocaine hydrochloride without epinephrine 1ml (n = 20) vs. PII Group: Proximal phalanx injection technique (n = 20).	Follow-up 3 months	At final follow-up, mean VAS score 7.3 in CI group vs. 3.2 in PII group. Difference significantly lower in PII group (p <0.001). Rise of recurrent symptoms occurred in both groups at 3 month follow-up, 3/20 (15%) in CI group and 5/20 (25%) in PII group. Difference not statistically significant (p >0.05).	“We concluded that the PII technique is less painful than the CI technique without any significant difference in recurrence rate between the two groups at three months follow-up.”	Data suggest PII less painful than CI, but complication, recurrence rates and general outcome measures comparable.
Intrasheath Glucocorticosteroid Injection vs Subcutaneous Injection										
Taras 1998 (score=6.0)	Intrasheath Glucocorticoid Injection vs. Subcutaneous Injection	RCT	No sponsorship or COI.	N = 95 patients with 107 trigger digits	Mean Age: 61.0 years; 37 males, 58 females.	Intrasheath glucocorticosteroid injection group (n=48) vs. subcutaneous injection along sheath	Follow up at 2 weeks	Intrasheath complete in 19/55 (37%), 24/55 (46%) partial, 9/55 (17%) no evidence of intrasheath injection.	“The results of this study suggest that true intrasheath injection offers no apparent advantage over subcutaneous injection in the	Evidence suggests subcutaneous injections may be superior. Intrasheath injections

						(betamethasone acetate suspension 6mg with 0.5mL 1% lidocaine with Omnipaque) (n=47)		Intrasheath group overall: 27/52 (52%) good, 10/52 (19%) fair, 15/52 (29%) poor results. Complete intrasheath injection 47% good, 16% fair, 37% poor. Partial injection 50% good, 17% fair, 33% poor. Subcutaneous injection 70% good, 11% fair, 19% poor. Subcutaneous group: 39/55 (71%) good, 4/55 (7%) fair, 12/55 (22%) poor results.	treatment of trigger digits.”	usually not completely successful. Excluded those >6 months duration, and diabetes.
Jianmongkol 2007 (score=4.5)	Intrasheath Glucocorticoid steroid Injection vs. Subcutaneous Injection	RCT	No mention of sponsorship or COI.	N=103 trigger fingers	Mean Age: 53.0 years; 14 males, 87 females.	Conventional technique of injection (CI technique) (n=53) Vs. Mid-Axial injection technique (MAI technique): (n=48)	Follow up at 1, 3, and 6 weeks.	After insertion of injections the mean pain score for the MAI technique group was 40.19 and the mean pain score for the CI technique group was 48.39. No statistical significance in mean paracetamol count during follow up periods for both groups. Chi-squared test revealed a score of 5.7 with statistical significance of p<0.05 for both groups. In CI technique group, two fingers had recurrent symptoms and no recurrent	“In conclusion, the injection technique by Carlson and Curtis’ approach can provide the good results of treatment and there were no complications from the injection. The technique can be easily used and safe for injection in the primary trigger finger.”	Sparse methodological details. Baseline comparability is questionable. Data suggest MAI technique had less reported post injection pain associated with procedure compared to CI technique. But at 6 weeks there were no differences in reported VAS pain scores.

								symptoms in the MAI technique group.		
Ultrasound-Guided Injection										
Cecen 2015 (score=4.5)	Ultrasound-Guided injection	RCT	No mention of sponsorship. No COI.	N=74 patients with persistent or increasing symptoms of a single trigger digit.	Mean Age: 55 years; 15 males, 55 females.	Ultrasound-guided group (USG): a Philips IU22 ultrasound system with high-frequency linear-array probe 17 MHz was positioned on the volar aspect of the hand and a 26-gauge needle was used to inject methylprednisolone acetate 40 mg/1 mL into the sheath of the flexor tendons, distally to the A1 pulley (n=37) Vs. Blinded group (BIG): treated with blinded corticosteroid injection (n=37). All patients were injected under aseptic conditions using 40 mg/1 mL methylprednisolone acetate	Follow up at 6 weeks and 6 months.	Of the 35 patients treated in BIG, 29 responded to a single corticosteroid injection and 6 required a second injection. Thirty-two of the 35 USG group responded to a single injection and 3 required a second injection. There was no significant difference between BIG and USG for requirement of second injection (p>0.05). Both groups showed significant improvement in Quinell grades, but no significant improvement between the pre-steroid, post-steroid 6 week, and post-steroid 6 month scores. Both groups showed significant improvement in VAS scores. BIG VAS scores decreased from 4.80 to 1.5 at 6 weeks and 0.5 after 6 months. USG VAS	“In conclusion, corticosteroid injection can be recommended as a sound, low-risk primary treatment option for trigger finger, which can be given in an office setting, as a low-cost procedure. The use of ultrasound-guided injection of corticosteroid may be associated with extra time and effort, and seems to have no superior clinical benefits compared to the blinded technique.”	Higher rate of diabetics in BIG group and more females in USG group. Data suggest non superiority of US guided injections (USG) versus blinded injections (BIG).

								scores decreased from 4.7 to 1.6 at 6 weeks and to 0.5 after 6 months. VAS in each group showed significant reduction. (p<0.01).		
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Evidence for Surgery for Flexor Tendon Entrapment

There are 10 moderate-quality RCTs incorporated into this analysis.(1083, 1084, 1091, 1092, 1096, 1097, 1099, 1101-1103) (Pegoli 08)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: flexor tendon entrapment, trigger finger disorder, trigger thumb, trigger digit, tenosynovitis Surgery, Open release surgery, percutaneous release surgery; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 147 articles in PubMed, 13 in Scopus, 8 in CINAHL, 23 in Cochrane Library, 570 in Google Scholar, and 3 from other sources. We considered for inclusion 5 from PubMed, 0 from Scopus, 0 from CINAHL, 1 from Cochrane Library, 1 Google Scholar, and 3 from other sources. Of the 10 articles considered for inclusion, 10 randomized trial and 0 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: surgery, open release, flexor tendon entrapment, tenosynovitis, and trigger finger disorder, trigger thumb, and trigger digit; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 122 articles. Of the 122 articles we considered for inclusion 2. Of the 2 considered for inclusion, 1 are randomized controlled trials and 1 systematic reviews.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Percutaneous Release with Steroid Injection vs. Steroid Injection										
Maneerit 2003 (score=5.5)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	No mention of sponsorship or COI.	N = 115 patients with N = 127 idiopathic trigger thumbs	Mean age: 52.5 years; No mention of gender.	Percutaneous release with steroid injection (n=66) vs. steroid injection alone (n=61)	Follow-up at 2 and 6 weeks and 6 months.	Surgical results satisfactory in 59/65 (90.8%) treated surgically vs. 28/60 (46.7%) treated with injection, p = 0.001. No significant differences in pain ratings or paracetamol tablets required post-procedure. After 2nd injection, success rate 56.7% for injections.	“We conclude that percutaneous trigger thumb release combined with steroid injection has a higher success rate than that of steroid injection alone.”	Success rates, especially in injection arm, low compared with other quality evidence raising questions about subject selection/other issues. No mention of gender.
Open vs. Percutaneous Release										

Gilberts 2001 (score=5.5)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	No mention of sponsorship. No COI.	N = 96 patients with N = 100 trigger fingers with symptoms for at least 1 month.	Mean age: 61.1 years; 56 male, 44 female	Open surgical release of the first annular pulley group (n=46) vs. percutaneous surgical release of the first annular pulley group (n=54)	Follow-up at 10 days, 6 and 12 weeks after surgery.	Open vs. percutaneous release – Operative time 11 vs. 7 minutes, p <0.0001. Mean post-op pain 5.7 vs. 3.1 days, p = 0.039. Motor recovery 18 vs. 7 days, p <0.002. Return to work 7.5 vs. 3.9 days, p <0.001. Complications 3 vs. 2. Success rate 98 vs. 100%, NS	“We conclude that percutaneous correction of trigger digits is a quicker procedure, is less painful, and shows significantly better results in rehabilitation than open surgery.”	All measures favored percutaneous release. Discrepancy with patient number and gender.
Bamroongs hawgasame 2010 (score=4.5)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	No mention of sponsorship or COI.	N= 142 patients with N = 160 trigger fingers and thumbs.	Mean age: 47.4 years; 58 male, 84 female	Open Group: Open release surgery (N = 70 patients, N = 80 digits) vs. Percutaneous group (N = 72 patients, N= 80 digits).	Follow-up 3 and 6 weeks.	Mean time of open surgery 2.2 minutes; percutaneous 1.8 minutes (p> 0.05). Post-op patient satisfaction scores similar at weeks 3 and weeks 6 (p> 0.05). Percutaneous surgery group had lower mean pain score vs. open group at weeks 1, 2, 3 and 4.	“Percutaneous trigger digit surgery using the full handle knife 45° is effective and safe, and results functional outcomes equal to those with open trigger digit surgery.”	Data suggest comparable efficacy between open and percutaneous release in trigger digits
Dierks 2008 (score=4.5)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	No mention of sponsorship or COI.	N= 36 patients with trigger fingers.	Mean age: 62.9 years; 16 male, 20 female	Open group- Open surgical release of the A-1 pulley (n = 16) vs. Percutaneous	Follow-up at 1 and 12 weeks.	Both groups showed decrease in pain level, but no significant difference between groups (p	“Because of lower costs and quicker procedure with equal functional outcome when compared with open surgery, we recommend the percutaneous technique using a L15 blade for trigger finger release.”	Sparse methodological details. Data suggest percutaneous release of A1-pulley for stenosing tendovaginitis as it is quicker, less costly and has comparable efficacy to surgery.

						group-percutaneous release of A-1 pulley (n = 20).		>0.05). Mean surgery time 26 s in percutaneous group; 4 minutes 17 s open group (p <0.05). Active ROM of PIP joint significantly lower open group at 1 week; 81 vs. 95 (p <0.05). No significant difference for ROM at 12 weeks.		
Pegoli 2008 (score=4.0)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	No mention of sponsorship or COI.	N = 200 patients with a trigger finger.	Mean age: 58.5 years; 60 male, 140 female	Group A-open surgical release of the A-1 pulley (N=100) vs Group B-endoscopic surgical release of the A-1 pulley (N=100)	Follow-up pre-operative and at 7, 30, and 90 days post-operative.	Three patients in Group A reported dyesthesia for 10 days that resolved and 8 patients from Group B reported dyesthesia for 6 days that resolved. The sum of excellent and good results (questionnaire) at 90 days post-operation was similar for both groups with a prevalence of excellent results in Group B. A higher difference in results was observed at 30 days post-	“The main complaint of the patients after an open trigger finger release is a discomfort at the incision site. In this prospective study, we compared the two consecutive groups of patients with trigger fingers. One was treated by an open approach and the other by the endoscopic release of the A1 pulley. Pre- and post-operative evaluation at seven, 30 and 90 days showed a faster recovery from the discomfort with a faster return to daily and working activities, after the endoscopic procedure.”	Sparse methodological details. Data suggest the endoscopic procedure showed faster recovery at all times of evaluation (7 days, 30 days & 90 days) compared to open procedure although surgical times for both procedures are similar.

								operation. Group B showed faster recovery. Aesthetic appearance of incision site had significant statistical analysis (p<0.001) with a variable percentage of 30% between the groups and pain under load (p<0.017)		
Sectioning Different Thirds of the A1 Pulley										
Topper 1997 (score=4.5)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	No mention of sponsorship or COI.	N = 19 patients with trigger fingers who had failed a trial of non-operative management .	No mention of age or gender.	The proximal third of the pulley group (n=7) vs the middle third of the pulley group (n=7) vs the distal third of the pulley group (n=5)	Follow-up post-surgery.	“In all 19 patients, a partial resection of the first annular pulley resulted in continued clinical triggering with active digital flexion. At this point, a standard complete first annular pulley release was performed, with resolution of clinical triggering of the involved digit in all patients.”	“We conclude that there is no “critical third” of the first annular pulley responsible for clinical digital triggering.”	Suggests release of the entire pulley is preferred treatment. No mention of gender.
Topical Anesthesia vs. Lidocaine Injection										
Yiannakopoulos 2006 (score=5.5)	Flexor Tendon Entrapment	RCT	No mention of sponsorship or COI.	N = 50 patients with trigger	Mean age: 60.0 years; 20	Transdermal anesthesia using eutectic	Follow up during anaesthesia	Visual analogue pain scale EMLA vs Lidocaine:	“Percutaneous trigger finger release can be performed as an office procedure with the use of EMLA	EMLA requires 2-3 hours for effectiveness potentially resulting in NS satisfaction scores despite marked differences in pain

	Open/Percutaneous Release			finger syndrome undergoing percutaneous release of the A1 annular pulley	male, 28 female	mixture of lidocaine and prilocaine (EMLA) group (N = 25) vs 3ml lidocaine 1% infiltration group (N = 25)	a and during operation.	VAPS: 0 vs. 5.96±2.41 (p <0.05); Patient Satisfaction: 4.6±0.2 vs. 4.4±0.3 (NS)	avoiding the use of injectable local infiltration anaesthesia.”	scores. *The number of males and females compared to the groups does not add up.
Injection vs. Surgical Release										
Zyluk 2011 (score=5.5)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	No mention of sponsorship. No COI.	N= 105 trigger digits in N = 95 patients with trigger finger.	Mean age: 56 years; 28 male, 67 female	Surgery Group- A1 pulley release (n = 43, 46 digits) vs. Injection Group- Steroid injection of 1ml 2% plain lidocaine (n = 52 patients, 59 digits).	Follow-up at 1 and 6 months.	At 1 month, surgery group significantly lower active range of motion of fingers vs. injection group: 264 vs. 270 (p <0.05). Also significantly weaker group in surgery group: 85% vs. 99% (p <0.05). No significant differences with regards to other parameters. At 6 months, 11% recurrence rate in injection group vs. 0% in surgery group (p = 0.005). At 6 months surgery group showed significantly lower VAS score: 0.4 vs. 1.3 (p <0.05) and	“We conclude that percutaneous A1 pulley release is more effective medium-term therapy for trigger digit than steroid injection, because of lower risk of recurrence.”	Data suggest percutaneous A1 pulley release is better than steroid injection for trigger finger due to study suggesting a lower risk of recurrence. Pain (VAS) 0.4 in pulley release group vs 1.3 in steroid group at 6 months, and ROM varied only 5 degrees.

								significantly worse range of motion; 265 vs. 270 (p <0.05) vs. injection group.		
Chao 2009 (score=4.5)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	No mention of sponsorship. No COI.	N= 83 patients with N = 93 trigger thumbs.	Mean age: 48.5 years; 26 male, 57 female	Group A- miniscalpel-needle percutaneous release (n = 41, 46 thumbs) vs. Group B: Steroid injection 1ml triamcinolone acetone (10 mg/ml) injected (n = 42, 47 thumbs).	Follow-up at 1 and 12 months	Group A achieved successful release in 93% at 1 month and 86% at 12 months. 45% of thumbs in group B satisfactory at 1 month and 26% were satisfactory at 12 months. The mean percent decrease in pain intensity was significantly higher in group A vs. group B at 1 month; 65.7% vs. 38.4% (p <0.001) and 12 months; 89.4% vs. 6.8% (p <0.001).	“Percutaneous release with a miniscalpel-needle had a higher success rate than steroid injection.”	Data suggest percutaneous release via miniscalpel-needle had better efficacy than steroid injection.
Callegari 2011 (score=4.0)	Flexor Tendon Entrapment Open/Percutaneous Release	RCT	Sponsored by IBSA Institut Biochimique SA, Pambio-Noranco, Switzerland. No COI.	N = 30 patients with ultrasound-confirmed diagnosis of trigger finger.	Mean age: 52.5 years; 20 male, 10 female	Group A: ultrasound-guided injection of methylprednisolone acetate (40mg/mL) with 0.8mL lidocaine with 1mL hyaluraonic acid 0.8% 10 days later (n =	Follow-up for 12 months.	At 6 months complete symptom resolution observed in 14/15 (93.3%) in group A. All 15 in group B achieved complete resolution of impairment by 3 weeks after surgery, but 10	“...the results of this explorative study suggest that ultrasound-guided injection of a corticosteroid and hyaluronic acid could be a safe and feasible approach for the treatment of trigger finger.”	Open label study with small sample size. Data suggest US guided injection of a corticosteroid and HA may be appropriate for trigger finger, but a larger study is required to confirm preliminary results.

						15) vs. Group B: Open surgical release of first annular pulley (n = 15).		needed physical therapy to reach complete resolutions of symptoms approximately 30-40 days after surgery. No significant differences between groups for VAS, DASH< and SVAS scores (p >0.05).		
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Evidence for the use of Special Studies - Extensor Compartment Tenosynovitis

There is 1 moderate-quality study incorporated into this analysis.(1107) (Chien 01)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: X-Rays, Tomography Scanners, X-Ray Computed, Extensor Compartment Tenosynovitis, De Quervain's Stenosing Tenosynovitis; diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 13 articles in PubMed, 7 in Scopus, 1 in CINAHL, 0 in Cochrane Library, and 393 from Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, from Google Scholar, 0 from Cochrane Library and 0 from other sources. Of the 1 articles considered for inclusion, 1 diagnostic study met the inclusion criteria.

Author/Year Study Type	Score	Number	Area of Spine	Diagnoses	Type of X-rays	CT used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Chien 2001 Diagnostic No mention of sponsorship or COI.	6.5	N = 45, (11 Men (24%), 34 Women (76%)) with de Quervain tenosynovitis. Mean age, 43 years.	Wrist	de Quervain tenosynovitis confirmed	Not given	-	-	+	+	-	-	+	-	The association between focal radial styloid abnormality and de Quervain tenosynovitis, for both observers, (p < 0.05). The areas under the receiver operating characteristic curves for both observer: 0.71 (95% CI, 0.62–0.79%) and 0.76 (95% CI, 0.67–0.84%). The Kappa values for inter observer variability = 0.44 (moderate agreement), and intra observer variability = 0.62 (substantial).	“Focal radial styloid abnormality is an indicator of de Quervain stenosing tenosynovitis of the wrist.”	A retrospective review of radiography Showed that focal radial steroid abnormalities to be an indicator of de Quervain stenosing tenosynovitis.

Evidence for the Use of MRI to Diagnose Extensor Compartment Tenosynovitis

There are 2 moderate-quality studies incorporated into this analysis.(1108, 1109) There is 1 low-quality study in the Appendix 2.(1110) (Hadidy 09)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: MRI OR Magnetic Resonance Imaging Extensor Compartment Tenosynovitis, De Quervain's Stenosing Tenosynovitis, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 12 articles in PubMed, 60 in Scopus, 0 in CINAHL, and 0 in Cochrane Library, and 1020 from Google Scholar. We considered for inclusion 2 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 3 articles considered for inclusion, 3 diagnostic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score	Number	Area	Diagnoses	Type of MRI used	Type of CT used	T1 weighted images	T2 weighted images	X-ray	Mveloeranhv	More than one rater	Surgery Performed	Clinical outcomes	Long term follow-up	Results	Conclusion	Comments
Nieuwenhuis 2015 Diagnostics Sponsored by EU Seventh Framework and DAF. Drs. Nieuwenhuis, Krabben, and van der Helm-van Mil's supported by DAF and Vidi grant, and Drs. Stomp and Reijnerse's sponsored by TRACER project grant. Dr. Stomp received speaking fees from GE health care.	6.5	N = 69 with RA. Mean age 54.2 ± 15.2.	Wrist	RA	1.5T	N/A	+	+	-	-	+	-	+	+	65% had MRI-detected tenosynovitis. RA patients had tenosynovitis vs. non-RA patients, (p = 0.023). Flexor tendons at MCP5/ extensor tendons at MCP2 and MCP4 in extensor compartment I of wrist affected in RA vs non-RA; 2.8, 95% CI: 1.9-42.8/14.2, 95% CI: 1.7 – 115.9 and 4.0, 95% CI: 1.4 – 11.1.	“MRI-detected tenosynovitis is commonly seen in early arthritis.”	MRI-detected tenosynovitis occurrence frequently in early arthritis. RA patients found to have tenosynovitis more often than non RA patients. Flexor tendons at MCPs, extensor tendons at MCP2 and first extensor compartment of wrist most likely affected in RA patients.

Parellada 2007	5.5	N = 5 with pain on the dorsal and radial aspect of the wrist. Mean age, 49 years.	Wrist	Tenosynovitis	1.5-T scanner	N/A	+	+	-	-	+	-	+	+	5 signs of tenosynovitis/ 4 had tendons of 2nd and 3 rd extensor compartments affected/5 had signs of tenosynovitis of ELP tendon/3 showed tenosynovitis proximal and distal to point of intersection; 2 of 3 had discrete point of intersection.	“Distal intersection tenosynovitis may be related to the biomechanical pulley effect exerted by Lister’s tubercle on the EPL tendon as it leaves the third compartment and crosses over the extensor carpi radialis tendons, as well as the constraining effect of the extensor retinaculum.”	Distal intersection tenosynovitis may be related to pulley effect exerted by Lister’s tubercle on EPL tendon as it leaves 3 rd compartment and cross over extensor carpi radialis tendons.
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Evidence for the Use of Splints Extensor Compartment Tenosynovitis

There are 3 moderate-quality RCT incorporated into this analysis.(1112-1114) (Mardani-Kivi 14; Mehdinasab 10)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Splinting, thumb spica, Extensor Compartment Tenosynovitis (Including De Quervain’s Stenosing Tenosynovitis and Intersection Syndrome); controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 7 articles in PubMed, 3 in Scopus, 3 in CINAHL, 295 from Google Scholar, and 51 in Cochrane Library. We considered for inclusion 3 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 2 from other sources. Of the 359 articles considered for inclusion, 3 randomized trials and 6 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Menendez 2015 RCT No mention of sponsorship or COI.	5.0	N = 83 (49 females, 9 males in final randomization) with clinically diagnosed extensor compartment tenosynovitis, or de Quervain tendinopathy. Mean (±SD) age 50 (±13) for full-time group and 50 (±15) for as-desired group.	Forearm-based thumb spica splint to be worn full-time (n = 43) vs. forearm-based thumb spica splint to be worn as desired (n = 40). Both groups received allocated treatment for 6 weeks. Follow-up at 6 weeks.	No significant differences reported between full-time and as-desired groups for grip strength, pain intensity, disability and satisfaction with treatment.	“Our study supports the following concepts: (1) there is no difference in patient-reported outcomes and grip strength with full-time and as-desired splinting, and patients can wear the splint as they prefer; (2) de Quervain tendinopathy appears to be a self-limited condition in the majority of patients; (3) depressive symptoms are strongly associated with greater disability.”	High dropout rate in full time splinting group. Data suggest strict splint vs. selective splint wear to treat de Quervain tendinopathy is palliative at best and should be left to patient preference as data suggest equal outcome efficacy.
Mardani-Kivi 2014 Randomized prospective trial No sponsorship or COI.	4.0	N = 67 patients (12 males, 47 females) with extensory compartment tenosynovitis, or de Quervain tendinopathy, radial pain of the wrist, a positive Finkelstein test, tenderness of the first dorsal compartment and a pain score >6 Mean (±SD) age 42 (±13) for CSI+TSC group and 45 (±12) for CSI only group.	Corticosteroid injection (CSI) and thumb spica cast (TSC) (3 weeks casted) group (n = 33) vs. Corticosteroid injection only group (n = 34). Both groups 40mg of methylprednisolone acetate with 1cc of lidocaine 2%. Follow-up at 3 weeks and 6 months.	At 3 weeks and 6 months follow-up, CSI+TSC group had significantly higher percentages of success compared to TSC alone group: 3 weeks-97% vs. 76%, (p = 0.027), 6 months- 93% vs 69%, (p = 0.021). At 6 months follow-up, CSI+TSC group had significantly higher percentages of decreased VAS scores vs. CSI-only group: 96% vs. 80%, (p <0.001). At 6 months, CSI+TSC group significantly higher mean (±SD) reduction of	“The results of this study indicated that the CSI + TSC treatment method was superior to CSI alone with regards to success rate and functional outcomes.”	Differences in success percentages at follow up due to dropout. Data suggest a combination of spica casting and corticosteroid injection was superior to injection alone.

				QuickDASH score vs. CSI only group: 74 (± 15) vs. 66 (± 18), ($p < 0.001$).		
Mehdinasab 2010 RCT No mention of sponsorship or COI.	4.0	N= 73 patients (9 males, 64 females) with de Quervain's tenosynovitis. Mean age was 32.6 years.	Injection Group- Injection of methylprednisolone acetate in first dorsal compartment of wrist followed by wrist thumb spica cast (n = 37) vs. Casting Group- Casting only (n = 36). Follow-up for 6 months,	Overall success rate at final follow-up (6 months) 86.4% in injection group and 36% in casting group. Difference significant ($p < 0.001$) with regards to final VAS pain score at 6 months: 6.70 vs. 17.3. Both groups showed significant differences in VAS pain score and cure rate vs. baseline ($p < 0.05$).	"Support of the wrist with casting alone had less favorable outcome in de Quervain's tenosynovitis. Adding methylprednisolone acetate injection into the _rst dorsal compartment of the wrist is necessary for more optimal results."	Data suggest casting the wrist plus methylprednisolone injections was beneficial in the treatment of de Quervain's tenosynovitis over casting alone measured by improvement in wrist pain, tenderness and Finkelstein test.

Evidence for the Use of NSAIDs for Extensor Compartment Tenosynovitis

There are 2 high-(1115, 1116) and 1 moderate-quality (1117) RCTs incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Extensor Compartment Tenosynovitis, De Quervain Disease, De Quervain Stenosing Tenosynovitis, Intersection Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, zero in Scopus, 2 in CINAHL, zero in Cochrane Library, 163 in Google Scholar, and zero from other sources. We considered for inclusion 3 from PubMed, zero from Scopus, zero from CINAHL, and zero from Cochrane Library, zero Google Scholar, and zero from other sources. Of the 2 articles considered for inclusion, 3 randomized trials and zero systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Diclofenac Gel vs. Placebo						
May 2007 RCT	6.5	N = 42 (36 males/ 6 females) with Kayakers in 5-day marathon. Mean age: 36 \pm 12 years	Diclofenac 2.5g 1% gel vs. placebo gel applied 3 times before each day's race. All received ice, massage, stretches, night bandage.	Pain higher on diclofenac than placebo gel especially in days 2 and 3. Comparisons with day 1: 2 (1.7), 3 (0.5), 4 (-0.1), 5 (-0.9).	"[S]tandard treatment appears to be sufficient for the management of wrist extensor tenosynovitis during competition."	Applications from kayaking marathon to occupational settings unclear. May be more analogous to acute, unaccustomed forceful use. Applications not throughout day may limit conclusions.
NSAIDs vs. Placebo						
Mazieres 2005 RCT	10.0	N = 172 (98 female/74 male) with tendinitis of upper or lower limbs. Age 18-70 years.	Ketoprofen patch (n = 87) vs placebo (n = 85).	Changes from baseline in pain on daily activity (100mm VAS) in ketoprofen vs. placebo: D0: 69.1 \pm 12.9 vs 70.1 \pm 11.5 p = 0.5876; D3-4: 48.6 \pm 23.2 vs.	"This trial suggested that a 3-14 day course of treatment by ketoprofen patch is useful in nonarticular rheumatisms, the duration of treatment depending on the results obtained."	Many diagnoses included and results not stratified by diagnosis.

No mention of sponsorship or COI.				56.1±20.0 p = 0.0491; D7±1: 30.8±23.8 vs. 44.3±25.6 p = 0.0013; D14±2: 25.1±25.9 vs. 36.4±27.6 p = 0.0146.		
Injection with vs. without NSAID						
Jirattanaphochai 2004 RCT No sponsorship. One or more authors received grants or outside funding from Faculty of Medicine, Khon Kaen University.	9.0	N = 160 (144 female/16 male) with de Quervain disease, positive Finkelsein test, radial styloid tenderness, pain on first extensor compartment with thumb abduction or extension. Mean (±SD) age 48.98 (±9.10) for nimesulide group; 46.87 (±12.79) placebo.	Injection 10mg of triamcinolone acetone and 0.5mL of 1% lidocaine and either 200mg daily oral nimesulide group (= 80) vs. placebo control group (n = 80). Follow-up at 1 week, 6, 12, 18 and 24 months.	No significant differences reported between the nimesulide and placebo groups for VAS pain scores, success rates, adverse reactions and probability of recurrence.	“[S]teroid injection alone was safe and effective in the treatment of de Quervain’s disease, but the oral administration of nimesulide did not provide any additional benefit beyond that of the injection.”	Data suggest nimesulide does not enhance effectiveness of a single triamcinolone injection in de Quervain’s disease treatment. Disease recurrence was correlated to the presence of crepitation in the first dorsal compartment at thumb extensor abduction.

Evidence for the Use of Exercise - Extensor Compartment Tenosynovitis

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following term Exercise, Physical Activity, Extensor Compartment Tenosynovitis, De Quervain Disease, De Quervain's Stenosing Tenosynovitis, Intersection Syndrome, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion zero articles in PubMed, zero in Scopus, 1 in CINAHL, 1 in Cochrane Library, zero in Google Scholar and zero in other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Iontophoresis - Extensor Compartment Tenosynovitis

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Iontophoresis, Extensor Compartment Tenosynovitis, De Quervain Disease, De Quervain's Stenosing Tenosynovitis, Intersection Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion Zero articles in PubMed, Zero in Scopus, Zero in CINAHL, Zero in Cochrane Library, 25 in Google scholar and zero in other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Acupuncture - Extensor Compartment Tenosynovitis

There is 1 moderate-quality RCT on acupuncture.(1120) (Hadianfard 14) There are no quality studies incorporated into this analysis for manipulation and mobilization or massage.

Manipulation & Mobilization:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Manipulation and Mobilization, Extensor Compartment Tenosynovitis, De Quervain Disease, De Quervain's Stenosing Tenosynovitis, Intersection Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion Zero articles in PubMed, Zero in Scopus, Zero in CINAHL, Zero in Cochrane Library, 169 in Google Scholar, and zero other sources. Zero articles met the inclusion criteria.

Acupuncture:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms; Acupuncture, Extensor Compartment Tenosynovitis, De Quervain's Stenosing Tenosynovitis, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 articles in PubMed, 6 in Scopus, 0 in CINAHL, and 2 in Cochrane Library, and 206 from Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 1 from Cochrane Library and 0 from other sources. Of the 3 articles considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

Massage:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Massage, Massage Therapy, Extensor Compartment Tenosynovitis, De Quervain Disease, De Quervain Stenosing Tenosynovitis, Intersection Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion Zero articles in PubMed, 38 in Scopus, 1 in CINAHL, 1 in Cochrane Library and 121 in other sources. Zero articles met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Hadianfard 2014 RCT Supported by Vice- Chancellery of Research and Technology of Shiraz University of Medical Sciences, Shiraz, Iran. No mention of COI.	5.0	N= 35 (6 Males and 24 Females) patients with clinical diagnosis of De Quervain's tenosynovitis. Mean age was 40.7 years.	Acupuncture group- Received 5 acupuncture sessions of 30 minutes duration (N= 18) Vs. Injection Group- 1 methylprednisolone acetate injection in the first dorsal compartment of the wrist (N= 17) Follow-up for 6 weeks.	At the last follow-up the Q-DASH score decreased by 55.1 in the injection group vs. 54.6 in the acupuncture group. No significant differences between groups. The difference between baseline and final VAS score decreased significantly between groups, but was not significant between groups (p>0.05).	“We demonstrated short-term improvement of pain and function in both groups. Although the success rate was somewhat higher with corticosteroid injection, acupuncture can be considered as an alternative option for treatment of De Quervain's Tenosynovitis.”	Acupuncture and Glucocorticosteroid related. Data suggests methylprednisolone injections somewhat better than acupuncture for improved pain and function in deQuervain's tenosynovitis although both groups improved from baseline at 2 and 6 weeks.

Evidence for the Use of Glucocorticosteroid Injections for Wrist Compartment Tendinoses

There are 2 high-(1079, 1115) and 5 moderate-quality (1113, 1114, 1120, 1126, 1135) RCTs incorporated in this analysis. There are 3 low-quality RCTs and 1 longitudinal study (1121, 1122, 1132, 1136) in Appendix 2.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Glucocorticosteroid injection, corticosteroid injection, glucocorticoid injection, glucocorticoids, extensor compartment tenosynovitis, de Quervain's stenosing tenosynovitis, and intersection syndrome, de Quervain disease; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 10 articles in PubMed, 43 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 19 in Google Scholar, and 2 from other sources. We considered for inclusion 7 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 2 from other sources. Of the 7 articles considered for inclusion, 7 randomized trials and 0 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: glucocorticoids, glucocorticosteroids, flexor tendon entrapment, tenosynovitis, trigger finger disorder, trigger thumb, and trigger digit; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 5 articles. Of the 5 articles we considered for inclusion 1. Of the 1 considered for inclusion, 0 are randomized controlled trials and 1 systematic reviews.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Glucocorticosteroid vs. Saline Injections										
Jirattanapho chai 2004 (score=10.5)	Glucocorticoid steroid	RCT	No sponsorship. COI: One or more authors received grants or outside funding from the Faculty of Medicine, Khon Kaen University.	N = 160 with de Quervain disease, positive Finkelstein test, radial styloid tenderness, pain on first extensor compartment with thumb abduction or extension.	Mean Age: 47.9 years; 16 males, 144 females.	Injection of 10mg of triamcinolone acetonide and 0.5mL 1% lidocaine and either 200mg daily oral nimesulide group (n = 80) vs. placebo control group (n = 80). Both groups received allocated treatment for 7 days.	Follow-up at 1 week, 6, 12, 18 and 24 months.	No significant differences reported between the nimesulide and placebo groups for VAS pain scores, success rates, adverse reactions and probability of recurrence.	"[S]teroid injection alone was safe and effective in the treatment of de Quervain's disease, but the oral administration of nimesulide did not provide any additional benefit beyond that of the injection."	Data suggest nimesulide does not enhance effectiveness of a single triamcinolone injection in de Quervain's disease treatment. Also, disease recurrence was correlated to the presence of crepitation in the first dorsal compartment at thumb extensor abduction.
Peters-Veluthama-ningal 2009 (score=7.5)	Glucocorticoid steroid	RCT	No mention of sponsorship or COI.	N = 21 clinical diagnosis of de Quervain's with Finkelstein's or crepitations on exam.	Mean age: 51.8 years; 8 males, 13 females.	NaCl, 1-2 injection 1ml triamcinolonacet onide (n = 12) vs. placebo or TCA, 1mL NaCl at site of maximal tenderness. Second injection by different MD at 2 weeks if not satisfied with results; 12 month follow-up (n = 9).	Follow-up at 1, 3, 6, and 12 months.	Short-term results of mean pain severity in the past week of saline 4.3 vs. corticoid 1.3. Patients much better or better: 2/12 (33%) saline vs. 7/9 (77.8%), p = 0.047. Maintained improvement over 12 months.	"One or two local injections of 1 ml triamcinolonacetoni de 10 mg/ml provided by general practitioners leads to improvement in the short term in participants with de Quervain's tenosynovitis when compared to placebo."	Under enrollment. Small sample size. Considerable differences nevertheless suggest efficacy.
Glucocorticosteroid with Normal vs. Acidic pH										
Goldfarb, 2007 (score=8.0)	Glucocorticoid steroid	RCT	No sponsorship or COI.	N = 125 with trigger finger	Mean age: 59±15 years; 32	Balanced group, methylprednisol one acetate	Follow-up at 5 min, daily for a	All immediately responded to injection. Pain	"A pH-balanced injection did not significantly	No placebo group. Some trends in baseline differences of unclear significance. Purpose to assess steroid

				or de Quervain's.	males, 93 females.	40mg, lidocaine, bupivacaine alone (n = 68) vs. Standard group or injection except balanced solution and neutral pH (n = 57); 6 week follow-up.	week, and at 6 weeks.	rebounded at one day, and then gradually decreased. 23/68 (33.8%) in balanced group vs. 18/57 (31.6%) in acidic pH group had flare reactions (NS).	decrease the risk of a flare reaction.”	flare and whether normal pH could reduce this adverse effect. Study suggests steroid flare unrelated to pH.
Glucocorticosteroid with vs. without NSAID										
Jirattanaphochai, 2004 (score=10.5)	Glucocorticosteroid	RCT	No sponsorship. COI: One or more authors received grants or outside funding from the Faculty of Medicine, Khon Kaen University.	N = 160 patients with de Quervain disease, positive Finkelstein test, radial styloid tenderness, pain on first extensor compartment with thumb abduction or extension.	Mean age: 47.9 years; 16 males, 144 females.	Injection of 10mg of triamcinolone acetonide and 0.5mL of 1% lidocaine and either 200mg daily oral nimesulide group (n = 80) vs. Placebo control group (n = 80). Both groups received allocated treatment for 7 days.	Follow-up at 1 week, 3 weeks, and 6, 12, 18, and 24 months.	Success rates after 1 injection: 67% nimesulide vs. 68% placebo (NS). Overall success 95% both groups. Risk for recurrence doubles with crepitation (RR = 2.13, 95% CI 1.19-3.8).	“Supplemental oral administration of the nonsteroidal anti-inflammatory drug nimesulide does not improve the effectiveness of a single injection of triamcinolone acetonide in the treatment of de Quervain disease.”	No placebo; no recording of pain scores for purposes of evaluating reduced pain after injection. Variable follow-up. Data suggest NSAID provides no incremental benefit to prevent recurrence in addition to steroid injection.
Injection vs. Other Treatments										
Hadianfard, 2014 (score=5.0)	Glucocorticosteroid	RCT	Sponsored by Vice-Chancellery of Research and Technology of Shiraz University of Medical Sciences, Shiraz, Iran. No mention of COI.	N= 30 patients with clinical diagnosis of De Quervain's tenosynovitis.	Mean age: 40.7 years; 6 males, 24 females.	Acupuncture group: Received 5 acupuncture sessions of 30 minutes duration (n = 15) vs. Injection Group: 1 methylprednisolone acetate injection in first	Follow-up at baseline, 2 weeks, and 6 weeks.	At last follow-up Q-DASH score decreased by 55.1 in injection group vs. 54.6 in acupuncture group. No significant differences between groups. Difference between baseline and final VAS score	“We demonstrated short-term improvement of pain and function in both groups. Although the success rate was somewhat higher with corticosteroid injection, acupuncture can be	Data suggests methylprednisolone injections somewhat better than acupuncture for improved pain and function in deQuervain's tenosynovitis although both groups improved from baseline at 2 and 6 weeks.

						dorsal compartment of wrist (n = 15).		decreased significantly between groups, but not significant between groups (p> 0.05).	considered as an alternative option for treatment of De Quervain's Tenosynovitis."	
Kume, 2012 (score=4.5)	Glucocorticoid steroid	Randomized prospective trial	No sponsorship or COI.	N = 44 wrists patients with diagnosed de Quervain's disease	Mean age: 44.8 years; 5 males, 39 females.	Ultrasound guided injection group (n = 22) vs. Manual injection group (n = 22). Both groups received 20 mg of triamcinolone and 1 ml of 1% lidocaine.	Follow-up at baseline and 4 weeks.	Reduction in mean VAS pain from baseline to 4 weeks significantly higher in ultrasound guided group vs. manual injection group: 80.3 to 25.6 vs. 78.0 to 58.2, (p = 0.0007). No adverse reactions related to treatment for either group.	"[U]S-guided injection targeting the EPB of dQD with septation was found to be more effective than clinically guided manual injection."	Data suggest US guided injection targeting EPB in deQuervain's patients with septation is better than manual injection although both groups showed improvement in pain on VAS.
Mardani-Kivi 2014 (score=4.0)	Glucocorticoid steroid	Randomized prospective trial	No sponsorship or COI.	N = 67 patients with extensor compartment tenosynovitis, or de Quervain tendinopathy, radial pain of the wrist, a positive Finkelstein test, tenderness of the first dorsal compartment and a pain score >6	Mean age: 47 years; 12 males, 55 females.	Corticosteroid injection (CSI) and thumb spica cast (TSC) (3 weeks casted) group (n = 33) vs. Corticosteroid injection only group (n = 34). Both groups 40mg of methylprednisolone acetate with 1cc of lidocaine 2%.	Follow-up at 3 weeks and 6 months.	At 3 weeks and 6 months follow-up, CSI+TSC group had significantly higher percentages of success compared to TSC alone group: 3 weeks-97% vs. 76%, (p = 0.027), 6 months- 93% vs 69%, (p = 0.021). At 6 months follow-up, CSI+TSC group had significantly higher percentages of decreased VAS scores vs. CSI-only group: 96% vs. 80%, (p <0.001). At 6 months, CSI+TSC group significantly higher mean (±SD) reduction of QuickDASH score vs. CSI only group:	"The results of this study indicated that the CSI + TSC treatment method was superior to CSI alone with regards to success rate and functional outcomes."	Differences in success percentages at follow up due to dropout. Data suggest a combination of spica casting and corticosteroid injection was superior to injection alone.

								74 (±15) vs. 66 (±18), (p <0.001).		
Mehdinasab 2010 (score=4.0)	Glucocorticoid steroid	RCT	No mention of sponsorship or COI.	N= 73 with de Quervain's tenosynovitis.	Mean age: 31.2 years; 9 males, 64 females.	Injection Group- Injection of methylprednisolone acetate in first dorsal compartment of wrist followed by wrist thumb spica cast (n = 37) vs. Casting Group- Casting only (n = 36).	Follow up monthly for 6 months.	Overall success rate at final follow-up (6 months) 86.4% in injection group and 36% in casting group. Difference significant (p <0.001) with regards to final VAS pain score at 6 months: 6.70 vs. 17.3. Both groups showed significant differences in VAS pain score and cure rate vs. baseline (p <0.05).	"Support of the wrist with casting alone had less favorable outcome in de Quervain's tenosynovitis. Adding methylprednisolone acetate injection into the first dorsal compartment of the wrist is necessary for more optimal results."	Data suggest casting the wrist plus methylprednisolone injections was beneficial in the treatment of de Quervain's tenosynovitis over casting alone measured by improvement in wrist pain, tenderness and Finkelstein test.

Evidence for the Use of Surgery - Extensor Compartment Tenosynovitis

There is 1 moderate-quality RCT incorporated into this analysis. {Abrisham, 2011 #3501} (Abrisham 11)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: extensor compartment tenosynovitis, de Quervain's stenosing tenosynovitis, and intersection syndrome, de Quervain disease; Surgical release; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 30 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 Google Scholar, and 0 from other sources. Of the 31 articles considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: surgery, surgical release, surgery release, flexor tendon entrapment, tenosynovitis, trigger finger disorder, trigger thumb, and trigger digit; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 1 articles. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Extensor Compartment Tenosynovitis (Including De Quervain's Stenosing Tenosynovitis and Intersection Syndrome)										
Abrisham 2011 (score-5.5)	Surgery	RCT	No sponsorship or COI.	N = 120 patients with positive Finkelstein's tests and no response to conservative treatment for three months.	Mean age: 45.3 years; 24 males, 96 females	Transverse Incision (N = 60) vs Longitudinal Incision (N =60).	Followed for three months. An additional follow up of 2 weeks to remove sutures and finally three months for final assessment	Complications of surgical treatment with longitudinal incision were lower than the transverse incision. Longitudinal incision had five hypertrophic scars and no injury to nerve or vein reported. Transverse incision had 3 lesions to superficial branch of radial nerve, five injuries to vein in snuffbox area, and five hypertrophic scars.	“Longitudinal incision can be recommended for surgical treatment of De Quervain disease.”	Data suggest longitudinal incision is superior to transverse incision for treatments of De Quervain tenosynovitis in terms of post-op complication. After a period of 3 months, 14 patients (8 transverse and 6 longitudinal) did not cooperate in follow up from the first time.

EVIDENCE FOR THE USE OF ELECTRODIAGNOSTIC STUDIES - Ulnar Nerve Entrapment at the Wrist

THERE ARE 4 MODERATE-QUALITY STUDIES INCORPORATED INTO THIS ANALYSIS.(1139-1142)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Electrodiagnostics nerve conduction study, electromyography, Ulnar Nerve Entrapment at the Wrist (Including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome) diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 0 articles in PubMed, 48 in Scopus, 2 in CINAHL, 3 Cochrane Library, and 350

from Google Scholar. We considered for inclusion 0 from PubMed, 2 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 4 articles considered for inclusion 4 diagnostic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score	Study Design	Population/ Case Definition	Investigative Test	Gold Standard/ Comparative Test	Results	Conclusion	Comments
Lander 2007	6.0	Cross-sectional study	N = 162 referred for hand-arm vibration syndrome or HAVS assessment at specialist occupational health clinic, plus history of exposure to vibrating tools. Mean age onset of symptoms 38.4 (9.0).	Nerve conduction studies (NCS) and current perception threshold (CPT). Using Stockholm sensorineural or SSN scale and quantitative sensory tests (QSTs) measuring vibration and temperature perception.	NCS vs. CPT tests for both upper extremities. Perception measured at 5 Hz, 250 Hz and 2 kHz at index finger for median nerve and at little finger for ulnar nerve.	160 (99%) complained of numbness and/or tingling. CPT in left hand abnormal in 99 subjects, In left hand, overall CPT results ($\chi^2 = 9.87$, $p = 0.007$) and results from ulnar nerve ($\chi^2 = 11.27$, $p = 0.004$); significantly associated with SSN staging. CPT and NCS results significantly associated for each of ulnar, median and overall nerve results in right hand and left hand, ($p = 0.0001$).	“Workers being assessed for HAVS should have nerve conduction testing to detect neuropathies proximal to the hand.”	Data suggests NCS and CPT significantly associated for the overall results and for ulnar and median results in each hand.
Hirata 2007	5.0	Age-matched	N = 75 males and controls with hand-arm vibration syndrome (VS). Mean age 58.7 years.	Sensory nerve conduction velocities (SCVs); 0.1-ms rectangular electric pulses at 1 Hz	Associations between frequency of slowed SCV and reduced AMP and frequency of neuropathy types	In median nerve, SCVfp-fd, SCVw-e, AMPw-fp and AMPw-fd significantly reduced vs. controls, ($p = 0.005$, 0.011 , 0.024 , 0.013). In ulnar nerve, SCVfp'-fd', SCVw'-fp', AMPw'-fp', AMPw'-fd', AMPfo'-fp' and AMPp-fp' significantly reduced in VS patients vs. controls ($p = 0.000$, 0.015 , 0.007 , 0.000 , 0.027 and 0.008). In radial nerve, AMPfo'-th significantly reduced in VS patients vs controls, ($p = 0.003$).	“These findings suggest that VS affects all three nerves in the hand. According to classification results, the main disorders of peripheral nerves comprise digital neuropathy.”	Small sample size. Data suggests that vibration syndrome affects all three hand nerves and neuropathy due to VS may in fact represent a multi-focal neuropathy.
Alaranta 1977	4.5	An automatic analysis of the electromyographic activity.	N = 38 forest workers and pneumatic-tool operators. Male workers	Velocity of lower motor fibers (CVSF) of ulnar nerve and motor distal latency (DL) of median nerve	Subgroup 0 = normal conduction velocity of CVSF and distal latency DL Subgroup 1 = Only one CVSF of ulnar nerve or DL Subgroup 2 = polyneuropathic	Exposed workers had statistically significantly lower CVSFs of ulnar nerve ($p < 0.001$) and dSCVs of median nerve ($p < 0.001$), longer DLs of median nerve ($p < 0.01$), and slightly slower dSCVs of ulnar nerve ($p < 0.05$) and SCVs of median nerve ($p < 0.05$) vs. none exposed, as a group.	“In accordance with previous reports the CVSF of the ulnar nerve was a potent factor in differentiating the vibration exposed workers from those nonexposed.”	Data suggests conduction velocity of slower motor fibers of ulnar nerve, distal sensory conduction velocity and motor distal latency of median nerve most sensitive measurement for separation of those with traumatic vasospastic disease from those not exposed.

			aged 26 to 61 years.		findings vs vibration syndromes, at least 2 abnormal CVSF or DL findings.			
Chatterjee 1982	4.0	Exploratory /observational	N = 31 rock-drillers and controls. Age range 24-57, mean age 37.9 (9.6).	Exploratory electromyography; Disa-type 14 A 30 3-channel electromyography with a 14 G 01 digital average capable of averaging up to 1024 successive stimuli.	Motor and sensory conduction velocities in median and ulnar Nerves; and latency, duration, and the amplitude of evoked action potentials measured.	Significant difference between groups, in 1st (p <0.05), 2nd (p <0.01), fourth (p <0.05) digits supplied by median nerve in right hand and first and fourth digits, (p < 0.05). Sensory duration varied from 2.1msec to 2.6 msec in right hand and 1.9 msec to 2.2 msec in left hand vs. controls 1.8 msec and 2.1 msec. Vibration groups significant in first (p < 0.05), second (p < 0.05), third (p < 0.01), fourth (p < 0.01) digits supplied by median nerve and other half of fourth digit (p < 0 05) supplied by ulnar nerve in right hand vs. controls.	“The results showed that apart from sensory duration the control group had values that were closest to the students while the vibration group had values furthest away.”	Small sample. Data suggests neurophysiological changes are frequent in those who regularly use vibrating tools and with the exception sensory duration, the median nerve is affected more than the ulnar nerve.

Evidence for the Use of MRI and Ultrasound - ULNAR NERVE ENTRAPMENT AT THE WRIST

There are no quality studies incorporated into this analysis.

MRI:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Magnetic resonance imaging, MRI, Ulnar Nerve Entrapment, Guyon’s Canal Syndrome, Hypothenar Hammer Syndrome, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 88 articles in PubMed, 0 in Scopus, 0 in CINAHL, 3 in Cochrane Library, 85 from Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Ultrasound:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ultrasound, Ultrasonography, Ulnar Nerve Entrapment at the Wrist (Including Guyon’s Canal Syndrome and Hypothenar Hammer Syndrome), diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 69 articles in PubMed, 2 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 95 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of CT - ULNAR NERVE ENTRAPMENT AT THE WRIST

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: CT, CAT, X-Ray CT, Ulnar Nerve Entrapment, Guyon’s Canal Syndrome, Hypothenar Hammer Syndrome, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 Cochrane Library, and 300 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Activity Modification FOR ULNAR NERVE COMPRESSION AT THE WRIST

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Rest, resting, Ulnar Nerve Entrapment at the Wrist (Including Guyon’s Canal Syndrome and Hypothenar Hammer Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 1 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 0 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 0 randomized trials and 1 systematic study met the inclusion criteria.

Evidence for the Use of Splints for ULNAR NERVE COMPRESSION AT THE WRIST

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: splint, splints, splinting; ulnar nerve compression syndromes, ulnar nerve entrapment, wrist, guyon’s canal syndrome, guyon syndrome, ulnar tunnel syndrome, hypothenar hammer syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 68 articles in PubMed, 6 in Scopus, 0 in CINAHL, 9 in Cochrane Library, 283 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of NSAIDs for Ulnar Nerve Compression at the Wrist

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDs, acetaminophen Ulnar Nerve Entrapment at the Wrist (Including Guyon’s Canal Syndrome and Hypothenar Hammer Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 150 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Glucocorticosteroids for Ulnar Nerve Compression at the Wrist

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Glucocorticosteroids, glucocorticoids, Ulnar Nerve Entrapment at the Wrist (Including Guyon’s Canal Syndrome and Hypothenar Hammer Syndrome ; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 3784 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 150 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 0 randomized trials and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: glucocorticoids, glucocorticosteroids, ulnar nerve compression syndromes, and ulnar nerve entrapment; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 2 articles. Zero articles met the inclusion criteria.*

Evidence for the Use of Physical Methods/Rehabilitation for Ulnar Neuropathy at the Wrist

There are no quality studies incorporated into this analysis.

Iontophoresis

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: iontophoresis; ulnar nerve compression syndromes, ulnar nerve entrapment, wrist, guyon’s canal syndrome, guyon syndrome, ulnar tunnel syndrome, hypothenar hammer syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 0 in Scopus, 0 in CINAHL, 2 in Cochrane Library, 41 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria

Ice

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ice; Self Application, Ulnar Nerve Compression Syndromes, Ulnar Nerve Entrapment, Wrist, Guyon’s Canal Syndrome, Guyon Syndrome, ulnar tunnel syndrome, Hypothenar Hammer Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 1 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 350 in Google Scholar and 0 in other sources. Zero articles met the inclusion criteria.

Heat

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Heat; Self Application, Ulnar Nerve Compression Syndromes, Ulnar Nerve Entrapment, Wrist, Guyon’s Canal Syndrome, Guyon Syndrome, ulnar tunnel syndrome, Hypothenar Hammer Syndrome, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 1 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 730 in Google Scholar, and 0 in other sources. Zero articles met the inclusion criteria.

Manipulation/Mobilization

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: manipulation, mobilization, Ulnar Nerve Entrapment at the Wrist including Guyon’s Canal Syndrome and Hypothenar Hammer Syndrome, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in

CINAHL, 0 in Cochrane Library, and 0 in Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 0 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Massage

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Massage, Ulnar Nerve Compression Syndromes OR Ulnar Nerve Entrapment, Wrist, Or Guyon Syndrome or Guyon's Canal Syndrome or ulnar tunnel syndrome or Hypothenar Hammer Syndrome ;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, and 0 in Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 0 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Acupuncture

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: acupuncture, Ulnar Nerve Entrapment at the Wrist (Including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome) ;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, and 0 in Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar and 0 from other sources. Of the 0 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Evidence for the Use of Exercise for Ulnar Neuropathy at the Wrist

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, exercising, physical activity; ulnar nerve compression syndromes, ulnar nerve entrapment, wrist, guyon's canal syndrome, guyon syndrome, ulnar tunnel syndrome, hypothenar hammer syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 9 articles in PubMed, 3 in Scopus, 0 in CINAHL, 16 in Cochrane Library, 468 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Surgery for Ulnar Neuropathy at the Wrist

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: surgery, surgeries, surgical decompression; Ulnar Nerve Compression Syndromes, Ulnar Nerve Entrapment, Wrist, Guyon's Canal Syndrome, Guyon Syndrome, ulnar tunnel syndrome, Hypothenar Hammer Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 224 articles in PubMed, 12 in Scopus, 3 in CINAHL, 12 in Cochrane Library, 628 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: surgical decompression, ulnar nerve compression syndromes, and ulnar nerve entrapment; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 97 articles. Of the 97 articles, we considered for inclusion 1. Of the 1 considered for inclusion, 1 is a randomized controlled trial and 0 are systematic reviews.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Schmidt 2015 (score: 4.5)	Ulnar Nerve Entrapment at the Wrist	RCT	No mention of sponsorship or COI.	N = 54 patients and 56 arms with cubital tunnel syndrome. However, methods only defined above/below elbow conduction slowing, without inching technique	Mean age: 49.2 years; 32 males, 22 females	Endoscopic Neurosurgical decompression procedure (N =29) vs Standard Open Decompression procedure (N =27)	Follow-ups conducted at 3, 6, 12 and 24 months	There were no significant differences between both methods concerning numeric analog scale (P=.84) and Bishop-Score (early follow-up P=1.00, long-term follow-up P=.47). Additionally there was no difference between the methods concerning wound pain (P=.56) and the postoperative electrophysiological findings (P=.62).	“The endoscopic technique showed no additional benefits to open surgery. We could not detect relevant compressions distal to the FCU arch. Therefore, and extensive far distal endoscopic decompression is not routinely required. The open decompression remains the procedure of choice at our institution.”	Methods did not differentiate whether included only cubital tunnel or also condylar groove ulnar neuropathy. No meaningful differences between groups, both showed improvements in outcomes over time. Significantly more hematomas in the endoscopic treatment vs. open treatment groups.

Evidence for the Use of Electrodiagnostic Studies FOR RADIAL NERVE MOTOR NEUROPATHY

There are no quality studies incorporated into this analysis. There are 2 low-quality studies in Appendix 2.(1146, 1147) (Spindler 90; Verhaar 91)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: electrodiagnostic study, nerve conduction study, electromyography, radial nerve entrapment, radial tunnel syndrome, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 6 articles in PubMed, 86 in Scopus, 0 in CINAHL, 1 in Cochrane Library, and 160 from Google Scholar. We considered for inclusion 2 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion 2 diagnostic studies met the inclusion criteria.

Evidence for the Use of Ultrasound FOR RADIAL NERVE MOTOR NEUROPATHY

There is 1 moderate-quality study incorporated into this analysis.(446)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ultrasound , diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 7 articles in PubMed, 93 in Scopus, 0 in CINAHL, 0 in Cochrane Library, and 8540 from Google Scholar, and 0 from other sources. We considered for inclusion 2 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. One article met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score	N	Area	Diagnoses	Type of Ultrasound	CT used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Lo 2008 Diagnostic No mention of sponsorship or COI.	7.0	10 (3 female/7 male) with suspected radial neuropathy	HWF	Radial nerve entrapment	Medtronic Keypoint EMG Machine	-	+	+	-	-	-	-	-	Ultrasound correctly identified all 6 with radial neuropathy. Significantly less mean (SD) time for US exam time vs. NCS/EMG: 6.1 (1.1) minutes vs. 30.3 (2.7), p <0.001.	“US is of value as a rapid diagnostic adjunct for the localization of radial nerve entrapment.”	Data suggests US has adjunct value along with EP testing for radial entrapment neuropathy. Small sample. Data suggest US is beneficial as an adjunct in diagnosing radial nerve entrapment and takes less time than EP testing.

Evidence for the Use of Splints for RADIAL NERVE COMPRESSION NEUROPATHY

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: splint, splinting, thumb spica, radial nerve entrapment, radial tunnel syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 3 in Scopus, 2 in CINAHL, 7 in Cochrane Library, 180 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of NSAIDs for RADIAL NERVE COMPRESSION NEUROPATHY

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDs, acetaminophen, non-steroidal anti-inflammatory, radial nerve entrapment, radial tunnel syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 10 in Scopus, 0 in CINAHL, 2 in Cochrane Library, 170 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of MRI and Ultrasound for Radial Nerve Compression at the Wrist

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: oral, injection, intravenous, glucocorticosteroid, corticosteroids, steroid, radial nerve entrapment, radial tunnel syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 53 in Scopus, 2 in CINAHL, 5 in Cochrane Library, 236 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 2 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 0 randomized trials and 3 systematic studies met the inclusion criteria.

Evidence for the Use of Physical Methods/Rehabilitation for Radial Neuropathy at the Wrist

There are no quality studies incorporated into this analysis.

Ice:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ice; Self Application of Ice, Radial Nerve Entrapment, Radial Tunnel Syndrome, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 6 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 5670 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Heat:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Heat; Self Application of Heat, Radial Nerve Entrapment, Radial Tunnel Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 2384 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Manipulation & Mobilization:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Manipulation, mobilization, Radial Nerve Entrapment, Radial Tunnel Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, and 0 in Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 0 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Massage:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Massage, friction massage, Radial Nerve Entrapment, Radial Tunnel Syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 0 from Google Scholar and 0 in other sources. Zero articles met the inclusion criteria.

Acupuncture:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Acupuncture, Radial nerve entrapment, Radial tunnel syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 0 from Google Scholar and 0 in other sources. Zero articles met the inclusion criteria.

Iontophoresis:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Iontophoresis, Radial Nerve Entrapment, Radial Tunnel Syndrome,; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 34 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 60 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Exercise for Radial Neuropathy at the Wrist

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, exercising, physical activity, radial nerve entrapment, radial tunnel syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 94 in Scopus, 0 in CINAHL, 7 in Cochrane Library, 16,630 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: surgical release, surgery release, surgery, surgical procedures, radial tunnel release, radial nerve entrapment, radial tunnel syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 6 articles in PubMed, 97 in Scopus, 8 in CINAHL, 10 in Cochrane Library, 423 in Google Scholar, and 0 from other sources. We considered for inclusion 2 from PubMed, 2 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 0 randomized trials and 2 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: surgical release or surgery release, radial nerve entrapment, radial tunnel syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 4 articles. Zero articles met the inclusion criteria.*

Evidence for the Use of Rheumatological Studies and Joint Aspiration

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Non-specific hand, wrist, and forearm pain, Arthrocentesis, Joint Effusion, Nonspecific, Hydrarthrosis, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 0 articles in PubMed, 9 in Scopus, 1 in CINAHL, 6 in Cochrane Library, 50 from Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Electrodiagnostic Studies to evaluate non-specific hand, wrist, or forearm pain

There is 1 low-quality study in Appendix 2.(1151)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Electrodiagnostic, studies, Nerve conduction, study, NCS, Electromyography, EMG, Non-specific, hand, wrist, forearm, paint controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 31 articles in PubMed, 10870 in Scopus, 298 in CINAHL, 183 from Google Scholar, and 7 in Cochrane Library. We considered for inclusion 1 from PubMed, 0 from Scopus, 1 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 11358 articles considered for inclusion, 1 randomized trials and 1 systematic studies met the inclusion criteria.

Evidence for the Use of X-rays for Evaluation of Non-specific Hand, Wrist, or Forearm Pain

There is 1 moderate-quality study incorporated into this analysis.(1152)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: X-ray, Non-specific, HWF, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 7 articles in PubMed, 332343 in Scopus, 0 in CINAHL, 0 in Cochrane Library and 277000 in other sources. We considered for inclusion 1 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the 1 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type	Score	Number	Area of upper extremity	Diagnoses	Type of X-rays	CT used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Huellner 2013 Diagnostic	6.0	32	Hand and wrist	Non-specific hand or wrist pain.	Plain radio-graphs	x	x	x	x	-		x	20 months and 16 months (group dependent)	Plain radio-graphs accuracy (25%-31%), sensitivity (24%-30%), and specificity (20%-60%). PPV (66%-76%) SPECT/ CT diagnostics resulted in 44%-77% accuracy, 41%-74% sensitivity, and 60%-90% specificity. PPV (88%-98%)	SPECT/ CT resulted in the best imaging modality for non-specific hand and wrist pain. MRI showed better result when comparing typification of lesion.	Data suggest inter-observer agreement for imaging non-specific wrist pain via SPECT/ CT good and only MRI better.

Evidence for the Use of Relative Rest for Acute Non-specific Hand, Wrist, or Forearm Pain

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: rest or relative rest, bed rest, nonspecific, non-specific, hand pain, wrist pain, and forearm pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 314 in Scopus, 0 in CINAHL, 2 in Cochrane Library, 34029 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Splints for Acute or Subacute Non-specific Hand, Wrist, or Forearm Pain

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: splint, splints or splinting; nonspecific, non-specific, hand pain, wrist pain, forearm pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 43 in Scopus, 0 in CINAHL, 9 in Cochrane Library, 8,360 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Ice/Heat for Acute or Subacute Non-specific Hand, Wrist, or Forearm Pain

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: ice, icing; nonspecific, non-specific, hand pain, wrist pain, forearm pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 11 in Scopus, 0 in CINAHL, 18 in Cochrane Library, 32,300 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: heat, heating, heat therapy, hot temperature; nonspecific, non-specific, hand pain, wrist pain, forearm pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 75 in Scopus, 0 in CINAHL, 45 in Cochrane Library, 269 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of NSAIDs/Acetaminophen for Acute or Subacute Non-specific Hand, Wrist, or Forearm Pain

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDs, acetaminophen, non-steroidal anti-inflammatory, acetaminophen, ibuprofen, non-specific, hand, wrist, forearm, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 83 in Scopus, 0 in CINAHL,

9 in Cochrane Library, 420 in Google Scholar, and 1 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 1 from other sources. Of the 3 articles considered for inclusion, 2 randomized trials and 1 systematic studies met the inclusion criteria.

Evidence for the Use of Physical or Occupational Therapy for Acute, Subacute, or Chronic Non-specific Hand, Wrist, or Forearm Pain

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms physical therapy, occupational therapy, nonspecific, non-specific, hand pain, wrist pain, forearm pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 13 articles in PubMed, 172 in Scopus, 8 in CINAHL, 3 in Cochrane Library, 150 in Google Scholar and 0 in other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Exercise for Acute, Subacute, or Chronic Non-specific Hand, Wrist, or Forearm Pain

There are 2 moderate-quality RCTs incorporated into this analysis.(1153, 1154) (

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library and Google Scholar without date limits using the following terms exercise, physical activity, non-specific Hand, Wrist, Forearm Pain, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 14 articles in PubMed, 38 in Scopus, 1 in CINAHL, 3 in Cochrane Library, and 437 in Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 in Google Scholar and 0 from other sources. Of the 1 articles considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
van Eijsden- Besseling 2008 RCT Sponsored by Research Stimulation Fund of University Hospital Maastricht, Institute for Rehabilitation Research, Hoensbroek, The Netherlands. No mention of COI.	5.0	N = 88 with non-specific upper limb disorders; Mean age PE group 33.3±7.7 and SFE group 34.8±7.7. PE group Gender, M:F. (19:25) SFE group Gender M:F (19:25)	Postural exercise group. Received 6 postural therapy sessions first 3 weeks, then tapered to 3 sessions in 3 weeks, 2 sessions in 2 weeks, then home exercise (n = 44) vs. strength/fitness exercise group. Received 9 strength/fitness therapy sessions first 3 weeks, then tapered to 6 sessions in 3 weeks, 2 sessions in 2 weeks, and finally home exercise (n = 44). Follow-up at baseline and months 3, 6, and 12.	No significant difference in decrease in pain between the groups at 3 months (0.6 cm, 95% CI 0.0 to 1.2), 6 months (0.2, 95% CI -0.3 to 0.7), or at 12 months (0.1, 95% CI - 0.6 to 0.8)	“Postural exercises showed no additional benefits to recovery when compared to strength and fitness exercise. Roughly 55% of patients reported being complaint free after one year.”	Data suggest no significant differences between types of exercises (comparable efficacy). Some baseline differences in groups for potentially compromising comparability.

Evidence for the Use of X-rays for scaphoid fractures

There are 7 moderate-quality studies incorporated into this analysis.(1157-1163) (Herneth 01)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: x-ray, scaphoid fracture, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 2 articles in PubMed, 934 in Scopus, 2 in CINAHL, 9 Cochrane Library, and 0 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 3 articles considered for inclusion 3 diagnostic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score	Number	Area of Body	Diagnoses	Type of CT	X-ray used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Mallee 2011 Diagnostic	6.5	N = 34	Wrist	Suspected scaphoid fracture	Presence of sharp lucent line within trabecular bone pattern, break in continuity of cortex, sharp step in cortex, or dislocation of bone fragments	-	+	+	+	-	-	-	+	Follow-up for 6 weeks. CT imaging resulted in a diagnosis of 20 fractures in 17 patients. For scaphoid fractures there was a sensitivity of 67% and specificity of 96% with an accuracy of 91% in depicting scaphoid fractures. MRI showed sensitivity of 67% for scaphoid fracture, specificity 89% and accuracy 85%.	“CT and MRI had comparable diagnostic characteristics. Both were better at excluding scaphoid fractures than they were at confirming them, and both were subject to false-positive and false-negative interpretations. The best reference standard is debatable, but it is now unclear whether or not bone edema on MRI and small unicortical lines on CT represent a true fracture.”	Data suggest comparable between CT and MRI for suspected scaphoid fractures.
Memarsadeghi 2006 Diagnostic	5.5	N = 29, mean age 34 years	Wrist	Wrist trauma accompanied by severe pain over scaphoid with negative radiograph.	Multi-detector with 4-detector row scanner	+	+	+	+	-	-	-	-	At 6-week follow-up with radiographs, 11 of 29 (38%) had scaphoid fracture; 8 had cortical fracture; 3	“Multi-detector CT is highly accurate in depicting occult cortical scaphoid fractures but appears inferior to MR	Small sample. Data suggest similar performance efficacy between CT and

															had trabecular involvement. MR imaging identified all 11 scaphoid fractures: 100% sensitivity and 100% specificity. 2 of 8 cortical fractures could be seen: 38% sensitivity, 100% specificity and 55% accuracy. Multidetector CT identified 8 cortical scaphoid fractures: 100% sensitivity/100% specificity. No trabecular fractures detected. MRI vs. CT p = 0.25 scaphoid fractures; p = 0.03 cortical involvement.	imaging in depicting solely trabecular injury. MR imaging is inferior to multidetector CT in depicting cortical involvement.”	MRI for occult scaphoid fracture detection, but CT superior for cortical involvement detection.
Fotiadou 2011 Diagnostic	5.0	N = 34 mean age 23 years	Wrist	Wrist trauma, both acute and chronic.	16 multislice rows CT scanner	+	+	-	-	-	-	-	-	In 21 of 22 general hospital patients, MRI method of choice following x-rays. CT	“Both CT and MRI might be considered in patients with acute or chronic wrist injury, clinical dilemma and	Small sample. Data suggest similar efficacy between CT and	

														performed in 1 case. At university hospital CT solely performed in 5/12 cases and was first method of choice in another 3 cases, followed by MRI. Bone injury detected in 17/34 cases. In 7/9 (77.8%) fracture not detected on initial radiographs. Ligament trauma identified solely on MRI in 11 patients. In 4 patients with both MRI and CT, CT revealed 2 fractures not found on MRI.	normal initial radiographs, depending on the availability and the individual institution policies.”	MRI but both with limitations .	
Temple 2005 Experimental	4.5	N = 11 cadavers	Wrist	Cadaveric wrists.	Sagittal	+											Cadaveric study. Data suggest sagittal CT not superior to xray for

																	detecting scaphoid fractures.
Smith 2009 Diagnostic	4.5	N = 31 mean age 29 at time of injury	Wrist	Scaphoid fracture	Pre-op CT scans performed in longitudinal axis of scaphoid. Used GE LightSpeed 16-slice helical scanner. Slice thickness 0.625mm with reconstructions every 0.50mm (120 per kilovoltage, 80 mili-amps, and 0.5 seconds per rotation).	-	-	+	+	-	+	-	+	Median time from injury to CT scan 6 months and median time from injury to surgery 6 months. 20 had histologic avascular necrosis according to criteria established by Ficat. With CT increased radiodensity of proximal pole had strongest correlation with avascular necrosis (p = 0.004). Increased radio density of proximal pole significantly correlated with post-op union rates.	“Preoperative longitudinal CT of scaphoid nonunion is of great value in identifying avascular necrosis and predicting subsequent fracture union.”	Small sample. Data suggest CT effective for detecting avascular necrosis of scaphoid proximal pole and non-union after fixation.	
Ilica 2011 Diagnostic	4.0	N = 54; mean age 22 years	Wrist	Clinically suspected scaphoid fracture with negative radiograph.	MDCT with a 64-detector multislice system.	+	+	+	+	-	-	-	-	In 20 of 55 (36%) wrists, MRI identified 22 fractures: 16 scaphoid fractures. MDCT	“MDCT offers highly accurate results, especially concerning cortical involvement,	Data suggest MDCT useful in detecting cortical involvement, but not	

														identified 19 fractures in 17 of 55 (30%) wrists. 3 fractures missed: 2 scaphoid fractures. MDCT 100% specificity, 86% sensitivity, 100% PPV, and 91% NPV.	and is a useful alternative in facilities lacking MRI.”	superior to MRI for scaphoid fracture detection.
Herneth 2001 Diagnostic No mention of sponsorship or COI.	4.0	N = 15 (7 male and 8 female) with acute wrist trauma had scaphoid fractures. Age range 15.8 – 55.2.	HWF	Wrist trauma and scaphoid fractures	High-spatial resolution 10-5-MHz probe	+	-	-	-	-	+	-	9 or 60% of the 15 patients with acute wrist trauma had scaphoid fractures. At high-spatial-resolution US, 7/9 or 78% had positive results, and 22% false negative. 8/9 or 89% had clinical signs of scaphoid fractures, 3/6 or 50% had false positive	“High-spatial-resolution US is a reliable diagnostic tool for the evaluation of occult scaphoid fractures and should be considered an adequate alternative diagnostic tool prior to computed tomography or MR imaging.”	Small sample size. Data suggest high spatial resolution US “may” assist in diagnosing scaphoid fractures when conventional radiography is negative for fractures.	

													<p>results, and 1/9 or 11% had false-negative results. Sensitivity of high-spatial-resolution US in depicting scaphoid fractures was 78%, and the specificity was 100% vs with 56% and 100% obtained for conventional radiographs and 89% and 50% obtained for clinical examination.</p>			
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Evidence for the Use of MRI for Scaphoid Fracture

There are 30 moderate-quality studies incorporated into this analysis.(1157, 1158, 1162, 1164, 1165’Beeres, 2008 #3210, 1172-1195) (Mallee 11; Fotiadou 11; Tiel-van Buul 96; Bergh 15; Ilica 11; Bretlau 99; Hunter 97; Jorgsholm 13; Kitsis 98; Kusano 02; Moller 04; Raby 01; Lozano-Calderon 06; Larribe 14) There are 6 low-quality studies in Appendix 2.(1021, 1166, 1196-1199) (Imaeda 92; Sharifi 15; Gaebler 96; Senevirathna 13; Schmitt 11)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Scaphoid Fracture, Magnetic Resonance Imaging, MRI, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 267 articles in PubMed, 762 in Scopus, 22 in CINAHL, 2 in Cochrane Library, and 1940 from Google Scholar. We considered for inclusion 10 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 29 from other sources. Of the 40 articles considered for inclusion 36 diagnostic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Brooks 2005 RCT Sponsored by Consultative Committee on Diagnostic Imaging. No COI.	6.5	N = 37 (24 female/13 male) suspected scaphoid fractures in 5 hospitals. Age for MRI and Control: 35.0 (27-41) and 29.0 (24.75-50).	MRI group (n = 11) vs. Control group (n = 17).	\$44.37 (Australian) per day saved from unnecessary immobilization by use of MRI. Early MRI improved date of confirming diagnosis by 7 days, Day 3 vs. Day 10 (p = 0.003). When only subjects diagnosed as having no fracture included in analysis, median number of days unnecessarily in plaster in MRI group 3 days, which is significantly less than median of 10 days in control group (p = 0.006).	“Use of MRI in the management of occult scaphoid fracture reduces the number of days of unnecessary immobilisation and use of healthcare units.”	Study may be biased toward justification of early MRI in universal health care models.

Author/Year Study Type	Score	Number	Area of Body	Diagnoses	Type of MRI used	Type of CT used	T1 weighted images	T2 weighted images	X-ray	Mylorography	More than one rater	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Ng 2013 Diagnostic	7.0	N=35 patients (34 male, 1 female) Mean age: 27.4±9.4 years	Hand	Scaphoid fracture delayed-union or non-union who underwent surgery within 12 months of imaging.	Dynamic contrast-enhanced (DCE); 3T imaging system using phased array wrist coil with 8 elements of 1.5T imaging system using 2 element surface flex coil.	-	+	+	-	-	-	+	-	-	Unenhanced MRI vascularity at surgery (sensitivity/ specificity/ PPV/ NPV/ accuracy): impaired 70/48/35/80/54; fair 25/74/11/89/69; poor 67/76/36/92/74. Contrast MRI vascularity at surgery (sensitivity/ specificity/ PPV/ NPV/ accuracy): impaired 56/64/36/80/62; fair 25/73/11/88/68; poor 60/93/60/93/88. DCE MRI vascularity at surgery (sensitivity/ specificity/ PPV/ NPV/ accuracy): impaired 67/86/67/86/80; fair 67/96/67/96/93; poor 67/92/67/92/87.	“Comparative relative enhancement in the proximal scaphoid fragment with that in the distal fragment on DCE MRI improved diagnostic accuracy for assessment of proximal fragment vascularity in scaphoid delayed and non-union compared to non-contrast and contrast-enhanced MRI examination.”	Data suggest DCE MRI is superior to both non-enhanced MRI or contrast enhance MRI for assessing proximal fragment vascularity in scaphoid delayed union and non-union fractures. Incorporation of the time frame between injury and MRI is essential to accurate interpretation.
Low 2005 Diagnostic	7.0	N=50 patients (40 males, 10 females) Mean age: 29 years	Hand	Scaphoid fracture	0.2T dedicated extremity system	-	+	-	+	-	+	-	-	-	Observer agreement: 2 fractures identified by all 4 observers; 3 fractures by 3 observers; 5 fractures by 2 observers; incorrectly judged as normal 13 times by 4 observers. Observers saw poor sensitivities (11/9/43/49) and low NPV (31/30/39/40) but good specificities (93/93/87/80).	“[T]he present study findings show that follow-up radiography for detection of scaphoid fracture after normal initial radiographs, has poor sensitivity when MRI is adopted as the gold standard and poor reliability as assessed by reliability analysis of inter-observer agreement of four expert observer. “	Data suggest follow-up radiography for acute scaphoid fracture has suboptimal sensitivity, negative predictive value, and reliability for those patients who were initially diagnosed with normal radiographs.

Gäbler 2001 Diagnostic	6.5	N= 121 patients (77 males, 44 females) Mean age: 30.3±13.2 years	Hand	Occult scaphoid fracture	1.0 T unit and circular surface coil	-	+	+	+	-	-	-	+	6 weeks	MRI injury detection: none 39 patients, injuries detected 112 in 82 patients. 10 days after injury: of 62 patients with MRI detectable injures 39 diagnosed correctly and another 7 partially correct. 24 days after injury: 14 patients with MRI-detectable injuries, correct diagnosis in 6 cases and partially correct in 2, another 6 cases were diagnosed as negative which was incorrect. All 28 scaphoid fractures were diagnosed correctly; occult fractures diagnosed after a mean of 14.9±9.3 days. Negative diagnosis correctly achieved after mean 12.2±5.12 days. No false-positives in study	“[R]epeated clinical and radiographic examinations are still state of the art. They allow diagnosis of OFSs and other wrist injuries with high reliability.”	Data suggests that when performed by experienced clinicians, standard clinical and radiological procedures are reliable in the diagnoses of occult fractures of the carpus and wrist MRIs are indicated for early diagnosis.
Unay 2009 Diagnostic	6.5	187 (29 males, 12 females) Mean age: 28.9 years	Hand	History of fall on outstretched hand and tenderness upon palpation of anatomical snuffbox and scaphoid tubercle without angulation	1.5 T superconductor	-	+	+	+	-	+	-	-	-	Test-10: sensitivity 0.73, specificity 0.75, positive predictive value 0.96, negative predictive value 0.23, and accuracy 0.73.	“[T]he MRI results of patients presenting with tenderness at the anatomical snuffbox and scaphoid tubercle after a fall on the outstretched hand without a radiographically evident bony injury could indicate any of the following conditions: no bony injury, scaphoid fracture, distal radial fracture, bone-bruise, or triquetral fracture.”	Data suggest pronation of the forearm and thumb-index pinch were highly correlate to MRI confirmed bone injury in patients with clinically suspected occult scaphoid fracture.

Mallee 2011 Diagnostic	6.5	N = 34 patients (25 males, 15 women)with suspected scaphoid fracture	Wrist	Scaphoid fracture	Presence of sharp lucent line within trabecular bone pattern, break in continuity of cortex, sharp step in cortex, or dislocation of bone fragments	-	+	+	+	-	-	-	+	Follow-up for 6 weeks. CT imaging resulted in a diagnosis of 20 fractures in 17 patients. For scaphoid fractures there was a sensitivity of 67% and specificity of 96% with an accuracy of 91% in depicting scaphoid fractures. MRI showed sensitivity of 67% for scaphoid fracture, specificity 89% and accuracy 85%.	“CT and MRI had comparable diagnostic characteristics. Both were better at excluding scaphoid fractures than they were at confirming them, and both were subject to false-positive and false-negative interpretations. The best reference standard is debatable, but it is now unclear whether or not bone edema on MRI and small unicortical lines on CT represent a true fracture.”	Data suggest comparable between CT and MRI for suspected scaphoid fractures. Follow up include only 34 patients of original 40.	
Patel 2013 Diagnostic	6.0	N=91 patients (37 males, 47 females)	Hand	Occult scaphoid fractures	1.0T Philips Intera using C3 surface coil	-	+	+	-	-	-	-	+	42 days	Scaphoid fractures: MRI 3, control group 4. Normal MRI scan: MRI 28.9% vs. control 84.6% (p=0.03). Mean±SD clinical fracture appointment: MRI 1.1±0.5 vs. control 2.3±0.8 (p=0.001). Mean±SD plain radiographs: MRI 1.2±0.8 vs. control 1.7±1.1 (p=0.03). Mean±SD perceived effect of injury (MRI vs. control): day 42, work 0.6±0.9 vs. 1.2±1.6	“Early MRI in occult scaphoid fractures is marginally cost saving compared with conventional management and may reduce potentially large societal costs of unnecessary immobilisation.”	Data suggest early MRI minimally cost effective, driven by PT, r-rays and appts rather than lost work. Lost to follow up: 7 people

																(p=0.03); hindrance 6.3 vs. 4.9 (p=0.03).		
Fox 2010 Diagnostic	6.0	N=29 patients (25 males, 4 females) Mean age: 21 years	Wrist	Scaphoid fracture	1.5 tesla MRI scan	-	+	+	-	-	+	+	-	-		The mean interval from the date of MRI to the date of surgery was 54 days. When comparing the MR and surgical findings, there were 6 true positive results, 17 true-negative results, 1 false-positive result and 5 false-negative results. There was a sensitivity of 55% and a specificity of 94%.	“T1-weighted unenhanced MRI is an acceptable alternative to delayed contrast-enhanced MRI in the preoperative assessment of the vascular status of the proximal pole of the scaphoid in patients with chronic fracture nonunions.”	Data suggest T1 weighted MR images can be an acceptable alternative to enhance MRI for preoperative assessment of the vascular status of scaphoid proximal pole in those with a non-union.
Fowler 1998 Diagnostic No mention of sponsorship of COL.	6.0	N=45 patients (21 males, 22 females) with acute trauma and clinical symptoms of scaphoid fractures. Mean age: 32 years.	Wrist	Acute wrist trauma and suspected scaphoid fracture	1.0 T unit	N/A	+	+	+	-	+	-	+	+		MRI results showed 100% sensitivity and 100% specificity while Bone Scintigraphy showed 83% sensitivity and 95% specificity.	MRI was found to be more effective than Bone Scintigraphy for the diagnostic potential for scaphoid fractures. MRI has increased convenience for the patient and no use of radiation.	Data suggest MRI more sensitive and specific for occult scaphoid waist fractures compared with bone scan. Two patients dropped.

Bretlau 1999 Diagnostic No mention of sponsorship or COI.	6.0	N=52 patients (27 males, 25 females) Mean age: 44	Wrist	Clinical suspicion of scaphoid bone fracture after trauma	Dedicated E-MRI, 2 sequences: T1-weighted turbo gradient echo 3D and fast short inversion recover STIR	-	+	-	-	-	+	-	-	+	E-MRI detected occult fractures of the scaphoid in 9 patients, and of the distal radius in a further 6 patients. All these fractures were confirmed at follow-up radiographs. Furthermore, EMRI revealed a fracture of the capitate bone in 1 patient, and of the triquetrum in 2 patients, and in 8 patients, bone bruise in 1 or more of the carpal bones. However, these fractures and bone lesions could not be confirmed by the follow-up radiographs. The agreement between the two examiners was high (kappa = 0.8) for E-MRI detection of fractures.	“E-MRI seems to be better than radiographs in the early diagnosis of occult”	Data suggest extremity MRI (E-MRI) better than radiographs for early diagnosis of occult scaphoid fractures.
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Lozano-Calderon 2006 Prospective	6.0	30 Gender and age not mentioned	Wrist	Scaphoid fracture	Not mentioned	+	-	+	+	-	-	-	-	Not mentioned	CT scans had a interobserver reliability value of 0.44 (95% CI = 0.16 – 0.44, p<0.001) compared to the radiography value of 0.16 (95% CI = 0 – 0.25, p<0.01). CT had a sensitivity of 72% (95% CI = 58-87%), specificity of 80% (95% CI =72%-87%) and an accuracy of 77% (95% CI = 70%-83%). Radiography had values of 75% (95% CI = 67%-88%), 64% (95% CI =52%-70%), 68% (95% CI = 60%-74%), respectively. However, when both viewed at the same time, the sensitivity increased (80% (95% CI = 70%-94%) while the specific and accuracy decreased (73% (95% CI = 65%-89%) and 75% (95% CI = 67% - 82%), respectively).	“This study suggests that computed tomography scans are useful for ruling out displacement but not for diagnosing it.”	Data suggest CT is useful in ruling out scaphoid fractures displacement but not in the diagnosis of.
De Zwart 2012 Diagnostic	5.5	N=62MRI scans of 31 healthy volunteers (44 male scans, 20 female scans) Mean age: 28 years.	Wrist	Scaphoid fractures	1.5 Tesla MRI scanner was used.	-	+	+	-	-	+	-	-	-	Among 319 rated MRI scans 247 were diagnosed with no injury, 13 with scaphoid fracture, 23 with other fracture and 36 as a bone bruise. Based on these data, the specificity of MRI was estimated as 95.9%.	“The specificity of MRI for scaphoid fractures is high (96%), but falsepositives do occur. Radiologists have only moderate agreement when interpreting MRI scans from healthy volunteers. MRI is not an adequate reference standard for true fractures among patients with suspected scaphoid fractures.”	Data suggest MRI has a high specificity but false positives occur. Even radiologists have only moderate consensus regarding MRI results in healthy volunteers suggesting MRI is not the preferred reference standard for R/O scaphoid fractures.

Laribe 2014 Diagnostic	5.5	N=18 patients (16 males, 2 females) Mean age: 30.4±8.5 years	Wrist	Acute scaphoid fracture	1.5-Tesla imaging system with a dedicated wrist coil 7 days or less before surgery.	-	+	+	-	-	-	+	-	-	The mean interval between MRI and surgery was 0.7 days. 4 of the 6 necrotic fragments were correctly classified into the necrotic group and 2 patients into the viable group. The was a sensitivity of 67%, specific of 67%, positive predictive value of 50% and a negative predictive value of 80%.	“Our data are consistent with previously reported data supporting contrast-enhanced MRI for assessment of viability, and showing that dynamic imaging with time–intensity curve analysis does not provide additional predictive value over standard delayed enhanced imaging for acute scaphoid fracture.”	Data suggest dynamic gadolinium enhance MRI does not provide more information to increase the predictive value in evaluation of acute scaphoid fractures over standard delayed enhance imaging.
Cook 1997 Diagnostic	5.5	N=18 patients (11 males, 7 females) skeletally immature with radiographic evidence of open physeal plates in distal ulna and radius and potential scaphoid fracture. Mean age:(11 years males, 12 years females)	H/W/F	Scaphoid fractures	1.5 T MR scanner (Gyrosan ACS II)	N/A	+	+	-	-	-	-	-	-	During MRI analysis, 10 with T1 and T2 signal intensities correlating to scaphoid fractures or bone marrow edema. Six had scaphoid fractures and 4 had scaphoid bone marrow edema; 5 with scaphoid fractures also had dorsal soft tissue edema affecting signal intensity.	“[I]t may be worth considering early application of MRI in the diagnostic algorithm of skeletally immature patients sustaining wrist trauma. A normal initial MR has a negative predictive value of 100% as early as 2 days after injury, whereas clinical and radiographic findings are not as reliable; also, scaphoid fractures may be identified on MR earlier than on radiographs in many patients. Additionally, MRI identified a large number of other injuries of both osseous and soft tissue structures.”	Small sample size, all children. Data suggest normal MRI has 100% NPV.
Kusano 2002 Diagnostic No mention of sponsorship or COI.	5.5	N=52 patients (32 males, 20 females) with suspected scaphoid fracture. Mean age: 36.7	WRS T	Scaphoid Fracture	MRI (0.2 T) coronal T1-weighted spin-echo and (2) T2-weighted turbo spin-echo.	+	+	+	+	-	-	+	+	+	In 18 of the 53 wrists, fracture was detected on MRI. Fracture was also found in the distal end of the radius in 11 patients and in the capitate in one patient. A bone contusion was found in the distal end of the radius in two	“This study may provide useful information in choosing treatment methods. Three (19%) of 16 patients with fracture evidence on MRI but without a fracture line on	Data suggest MRI as well as CT are useful when diagnosing occult carpal scaphoid fractures.

																patients. A fracture line was found in 13 of 16 diagnosed scaphoid fractures via CT.	the initial CT did well without surgery and demonstrated evidence of a healed fracture on the follow-up CT. The drawback of MRI and CT examination is its high cost; however, may avoid unnecessary treatment or decrease treatment period and thus reduce total expense.	
Fotiadou 2011 Diagnostic	5.0	N = 34 mean age 23 years	Wrist	Wrist trauma, both acute and chronic.	16 multislice rows CT scanner	+	+	-	-	-	-	-	-	In 21 of 22 general hospital patients, MRI method of choice following x-rays. CT performed in 1 case. At university hospital CT solely performed in 5/12 cases and was first method of choice in another 3 cases, followed by MRI. Bone injury detected in 17/34 cases. In 7/9 (77.8%) fracture not detected on initial radiographs. Ligament trauma identified solely on MRI	“Both CT and MRI might be considered in patients with acute or chronic wrist injury, clinical dilemma and normal initial radiographs, depending on the availability and the individual institution policies.”	Small sample. Data suggest similar efficacy between CT and MRI but both with limitations. No mention of gender.	Small sample. Data suggest similar efficacy between CT and MRI but both with limitations	

															in 11 patients. In 4 patients with both MRI and CT, CT revealed 2 fractures not found on MRI.			
Brydie 2003 Diagnostic No sponsorship or COI.	5.0	N=195 patients (112 males, 83 females) with suspected scaphoid fracture. Mean age: 36 years	Wrist	Suspected scaphoid fracture	0.2-T low field scanner	N / A	+	+	+	-	+	-	+	+	Of 195 patients, 99 (51%) had normal MRI results, 20 (10%) showed carpal or distal radius bone bruising. 74 patients (38%) were diagnosed with fractures, 37 (19%) with scaphoid fractures and 28 (14.4%) with distal radius fractures.	“MRI can now justifiably be regarded as the gold standard investigation for clinical scaphoid fracture. Using MRI we have determined that the incidence of occult scaphoid fracture is 19%. MRI enables the correct diagnosis to be reached early and by directing appropriate patient management, prevents the unnecessary overtreatment of the majority of patients thus bringing both health and economic benefits.”	Large sample size. Data suggest early MRI helpful for early management of scaphoid fractures.	
Jorgsholm 2013 Diagnostic No mention of sponsorship or COI	5.0	N=300 wrists in 296 patients (179 males, 117 females) with posttraumatic radial wrist tenderness. Mean age: 39 years.	WRIST	Scaphoid Fracture	0.23-T low-field MRI unit with dedicated small joint coil and coronal short tau inversion recovery (STIR), 3-mm slice thickness; coronal T1 field echo 3-dimensional, 2-mm slice thickness; axial T1 fast	+	-	-	+	-	-	-	+	-	Two hundred twenty-four fractures were found in 196 of the 300 wrists. An isolated scaphoid fracture was shown in 107 wrists, and a scaphoid association with other fractures was found in 18 wrists. Other fractures were found in 71 wrists.. The most commonly found fracture combinations were that of the scaphoid and distal radius, followed by scaphoid and capitate fracture. The sensitivity of	“Low-field MRI showed a high incidence of fractures in patients with posttraumatic radial wrist tenderness and demonstrated more fractures than radiographs and CT. A scaphoid fracture was by far the most common injury. However, it is not clear whether diagnosis of subtle injuries only demonstrated on MRI improves outcomes.”	Data suggest MRI detected significant numbness of fractures in patient with posttraumatic radial wrist tenderness better than either CT or radiography.	

					spin-echo, 3.5-mm slice thickness; and sagittal T1 field echo 3-dimensional, 2-mm slice thickness.											radiographs for visualization of scaphoid fractures was 70% and the specificity was 98%. Radiographic sensitivity for other fractures was less than 60%. The sensitivity of CT for visualization of scaphoid fractures was 95%, and between 75% and 100% for other fractures. MRI revealed 9 wrists with bone edema in the scaphoid and capitate		
Møøller 2004 Diagnostic No mention of sponsorship or COI.	5.0	N=224 patients (109 males, 115 females). Mean age: 31.5 years.	Wrist	Scaphoid Fracture	T1w and STIR coronal 3 mm thickness	-	+	-	+	-	+	-	+	-		The MRI radiographers reported 43 scaphoid fractures, whereas the radiologist ultimately diagnosed only 36 scaphoid fractures (16.1% of patients) (sensitivity, 100%; specificity, 96.3%). Six of the seven false-positive fractures occurred in patients with edema of the scaphoid. The seventh false-positive was a fracture of the capitate. The hospital saved at least €20,000 and the social care system €70,000.	“It is possible to provide an acute MRI service to patients with clinically suspected fracture of the scaphoid and a normal plain radiograph. The MR images can be primarily read by sufficiently trained MR radiographers. This new work-up protocol reduces the cost for society.	Data suggest MRI useful in diagnosing scaphoid fractures when plain radiographs are negative.
Tiel-van Buul 1996 Diagnostic Articles	4.5	N=16 patients (11 males, 5 females)	Wrist	Clinical suspected scaphoid fracture	3-phase radionuclide bone scintigraphy was obtained after 72 hours following trauma using 200 MBq 99mTc-	-	+	+	-	-	+	-	72 hours after injury	MRI only available for 16 of 19 patients. X-ray also performed. Bone scintigraphy positive in 7 for scaphoid fractures while	“We conclude that in the diagnostic management of patients with suspected scaphoid fracture and negative initial radiographs, the use of MRI may be promising, but is not superior to three-phase bone scintigraphy.”	Small sample size. Data suggest MRI not superior to 3-phase bone scan for scaphoid fracture detection.		

					methylene diphosphonate									MRI only positive in 5.			
Tibrewal 2012 Diagnostic No mention of sponsorship and no COI.	4.5	N=137 patients (79 males, 57 females) with suspected scaphoid fractures, Mean age: 34.6 years.	Wrist	Suspected scaphoid fracture	1.5 T scanner	N / A	+	+	+	-	+	-	+	-	37 (27%) MRI exams normal, 59 (43.4%) diagnosed with soft tissue injuries. 17 (12.5%) resulted in scaphoid fractures and 30 (22%) resulted in fractures in carpal bones or distal radius.	“MRI should be regarded as the gold standard investigation for patients in whom a scaphoid fracture is suspected clinically.”	Data suggest MRI useful in diagnosis of scaphoid fractures and may detect occult in boney injuries.
Hunter 1997 Diagnostic No mention of sponsorship or COI.	4.5	N=36 patients (28 males, 8 females) with wrist trauma injury suspected of scaphoid fracture. Mean age: 26	Wrist	Scaphoid Fracture	Signa 1.5-T MR imager with a phased-array coil.	+	+	+	-	-	+	-	+	+	MR imaging revealed 22 occult fractures in 20 patients. Thirteen of these 22 fractures were in the scaphoid bone, and 9 were in the distal radius. On MR images, 16 patients had no evidence of fracture. Follow-up radiographs were available in 17 of the 20 patients who had occult fracture revealed by MR imaging. Eleven of the 13 occult fractures of the scaphoid bone were followed up(2 lost to follow-up), and three of these showed evidence of healing fracture. Three patients without MR evidence of a fracture had follow-up radiographs that showed no fracture. Three patients had findings	“MR imaging can reveal occult wrist fracture when findings on radiographs are normal or equivocal.”	Data suggest in patients where there is a clinically high index of suspicion of scaphoid fracture but the radiographs are either negative or indeterminate, MRI can be useful in detecting occult wrist fracture.

Querellou 2014 Diagnostic	4.0	N=57 patients (26 males, 31 females) with unilateral acute carpal trauma, hand pain or wrist pain. Mean age: 34 years	H/W/F	Wrist trauma occult fractures	1.5-T Scanner (Magnetom Avento 1.5 T; Siemens)	D u a l - h e a d e d g a m m a c a m e r a w i t h b u i l t i n C T	+	-	+	-	+	-	+	+6 months	26 presented wrist and hand fractures through SPECT/CT; 26 presented positive results for wrist and hand fractures or bruising during MRI scans; 17 had discordant results between MRI and SPECT/CT in regards to bruising vs. fracture diagnoses.	“This study highlights that bone scintigraphy associated with SPECT/CT is a very useful and sensitive imaging technique to depict occult wrist fracture in patients with carpal trauma. Its interest is to allow the detection of these specific fractures and reduces the secondary risks such as nonunion. When a carpal occult fracture is strongly suspected clinically, SPECT/CT might be proposed as a sensitive follow-up examination.”	Data suggest SPECT/CT more sensitive than MRI for detection of occult wrist fractures.
Bergh 2015 Diagnostic	4.0	N=125 patients (68 males, 56 females) with clinically suspected scaphoid fracture. Mean age: 30 years.	Wrist	Scaphoid fractures	1.5 Tesla whole-body scanner with a wrist coil.	-	?	?	-	-	+	-	+	-	7 diagnosed scaphoid fractures in MIR group vs. 4 in control group. For patients without fractures, those in MRI group used cast for fewer days (1 day) vs. control group (mean 14 days) (p <0.001). MRI group also had less days on sick leave than controls; 7 vs. 15 (p = 0.002).	“In a Norwegian setting, an early MRI was of value in patients with clinically suspected scaphoid fracture and normal plain radiographs.”	Quasi-randomized cast analysis study in Norway, part of Bergh 2012, 14. Early MRI found cast effective largely due to lost work.

Bhat 2004 Diagnostic No sponsorship or COI.	4.0	N=50 with fractures of waist of scaphoid. Age not given.	Wrist	Isolated fracture of waist of scaphoid.	1.5 Tesla	Not given	-	-	-	-	+	-	-	+	Assessments of both observers showed: sensitivity of 100%, specificity of 74%-87%, negative predictive value of 100%, and accuracy of 76%-88% for predicting nonunion, but less satisfactory positive predictive values (20% and 33%). Assessment of displacement on scaphoid series of radiographs had sensitivity between 33%-47% and positive predictive value between 27%-86%. Correct identification of displaced fractures from plain radiographs by both observers no more than 33%-47%.	“[T]he assessment of displacement of scaphoid fractures on MRI can probably be used to assess the likelihood of union although the small number of nonunions limits the power of the study.”	Data suggest plain xray less accurate for degree of displacement for scaphoid fractures. No mention of gender.
Breitenseher 1997 Diagnostic No mention of sponsorship or COI.	4.0	N=42 patients (23 males, 19 females) with clinical suspicion of scaphoid fracture after acute wrist injury. Mean age: 30.5±13.8 years	Wrist	Acute wrist injury	1.0-T unit	N / A	+	+	-	-	+		+	+	MI depicted occult fractures of scaphoid bone in 14 or 33%; capitate bone in 4 or 10%; and trapezium in 1 patient (5%). Sensitivity and specificity for detection of radiographically occult fractures of wrist; 100%, and 95% and 100% for second radiologist, (k = 0.953). Sensitivities for detection of cortical fracture time; 21%, 100%, and 14% (T1 and T2* sequences, respectively). Sensitivities for detection of bone marrow abnormality 100%, 100%, and 59%, respectively.	“MR imaging has a high sensitivity for detection of fractures of the scaphoid bone and wrist not evident on plain radiographs and may enable early diagnosis and treatment.”	Data suggest MRI sensitive for occult scaphoid fracture detection and other fractures detection.

Kitsis 1998 Diagnostic No mention of sponsorship or COI.	4.0	N=22 patients (9 males, 13 females) Mean age:34	W RI ST	Scaphoid Fracture	The MRI scan was on a picker vista 0.5 tesla knee coil	-	-	-	+	-	-	-	-	+	Eight patients had no bone injury in either the MRI or the bone scan. Three scaphoid fractures were found on the MRI and the bone scan and one scaphoid fracture was diagnosed with bone scanner and not on the MRI.	“We feel that MRI gives the most information and is the closest to a gold standard that exists. If MRI is not available, bone scanning remains a sensitive method of detecting scaphoid fractures. Although it is less specific in diagnosing other injuries and has a higher rate of false positives.”	Small sample. Data suggest MRI provides more information for diagnosing scaphoid fractures which are negative on plain radiographs.
Raby 2001 Diagnostic	4.0	N=56 patients	W RI ST	Scaphoid Fracture	0.2T extremity MR system. Spin echo T1 and STIR T1 70	-	-	-	+	-	+	-	+	-	The early MR group had seven scaphoid, six radial and four other fractures. Management was altered in 89%. The late MR group had 14 scaphoid, nine radial and three other fractures. Management was altered in 69%. A cost model showed that overall costs are less with early rather than late scanning.	“MRI of the wrist when scaphoid fracture is suspected can be undertaken in all patients with negative radiographs and could be performed in most departments with an MRI machine. There are significant patient benefits and overall costs would change little from conventional practice.”	No mention of gender or mean age. Data suggest when scaphoid fracture is suspected but radiographs are negative, MRI is useful in diagnosing scaphoid fractures.

Evidence for the Use of High-Spatial Resolution Sonography to diagnose scaphoid fractures

There are 4 moderate-quality studies incorporated into this analysis.(1163, 1170, 1200, 1201) (Fusetti 05; Hauger 02; Herneth 01; Tiel Van-Buul 93)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: high spatial resolution sonography, scaphoid bone, fractures, bone or scaphoid fractures, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 2 articles in PubMed, 2 in Scopus, 1 in CINAHL, 0 from Cochrane Library, and 418 from Google Scholar. We considered for inclusion 2 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 5 from Google Scholar, and 0 from other sources. Of the 7 articles considered for inclusion 3 diagnostic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score	Number	Area of Body	Diagnoses	Type of CT	X-ray used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Fusetti 2005 Diagnostic No mention of sponsorship or COI.	6.5	N = 24 (11 female and 13 male) with clinically suspected fracture and normal radiographs .	Hand	Occult scaphoid fractures	MX-8000 16 Slices; High-spatial-resolution sonography (HSR-S)	-	-	+	+	-	-	+	-	10 (42%) presented high index of suspicion, 7 (29%) moderate index, and 7 (29%) a low index. RS effusion observed in 16 or 66% and STT effusion in 8 or 33%. Sensitivity / specificity / PPV/and NPV of HSR-S for early detection of occult SFs 100% (5/5), 79% (15/19), 56% (5/9), and 100% (15/15).	“HSR-S is a reliable, available, and cost-effective method in early diagnosis of occult fractures of the scaphoid.”	Small sample size. Data suggest (HSR-S) is reliable as well as cost effective method in early diagnosis of occult fractures of the scaphoid and this method is not without problems and CT is still superior.
Tiel-Van Buul 1993 RTC	5.5	160 82 male 78 female Mean age = 38.6	Wrist	Scaphoid fracture	Scaphoid Radiography	-	-	+	+	-	-	+	Patients were reviewer after at least one year.	35 patients showed evidence for a scaphoid fracture on the initial radiographs. Overall, 21 patients were positive for a scaphoid fracture, 24 was positive for other bone fractures, and 80 were negative. The bone scan revealed 41 patients with a scaphoid fracture, 49 with other bone fractures, and 41 negative results. No information about sensitivity and specificity were mentioned.	“We advise scaphoid radiography using at least four views”	Data suggest at one year, suspected scaphoid fractures via posture bone scans or radiographs did not affect frequency or severity of late symptoms when compared to patients with normal bone scans.
Hauger 2002 Diagnostic No mention of sponsorship or COI.	4.5	N = 54 (35 males and 19 female) with clinically suspected scaphoid fracture and normal findings on initial radiographs , including	HWF	Suspected scaphoid fracture	high-spatial-resolution 12-MHz transducer	+	-	-	-	-	+	-		11% showed cortical disruption of the scaphoid on sonography 15% showed hematoma alone, eight (15%) showed hemarthrosis alone, and 32 or 59% did not show any abnormality. The overall prevalence of occult fracture was 9.3% (5/54), ranging from 3.7% (1/27) for low suspicion to	“High-resolution sonography is a reliable and accurate method of evaluating occult fractures of the scaphoid waist.”	Data suggest high spatial resolution sonography can be beneficial in diagnosing scaphoid fractures when plain radiographs are negative when there is a high index of suspicion for scaphoid fracture. However, findings support cortical disruption is key in making the diagnosis.

		specific scaphoid images. Age range 10 – 75.												6.3% (1/16) for moderate suspicion and to 27% (3/11) for high suspicion of fracture. Sensitivity / specificity / positive predictive value / and negative predictive value of sonography for early detection of occult scaphoid fractures to be 100% / 98% / 83% / and 100%, respectively.		
Herneth 2001 Diagnostic No mention of sponsorship or COL.	4.0	N = 15 (7 male and 8 female) with acute wrist trauma had scaphoid fractures. Age range 15.8 – 55.2.	HWF	Wrist trauma and scaphoid fractures	High-spatial resolution 10-5-MHz probe	+	-	-	-	-	+	-		9 or 60% of the 15 patients with acute wrist trauma had scaphoid fractures. At high-spatial-resolution US, 7/9 or 78% had positive results, and 22% false negative. 8/9 or 89% had clinical signs of scaphoid fractures, 3/6 or 50% had false positive results, and 1/9 or 11% had false-negative results. Sensitivity of high-spatial-resolution US in depicting scaphoid fractures was 78%, and the specificity was 100% vs with 56% and 100% obtained for conventional radiographs and 89% and 50% obtained for clinical examination.	“High-spatial-resolution US is a reliable diagnostic tool for the evaluation of occult scaphoid fractures and should be considered an adequate alternative diagnostic tool prior to computed tomography or MR imaging.”	Small sample size. Data suggest high spatial resolution US “may” assist in diagnosing scaphoid fractures when conventional radiography is negative for fractures.

Evidence for the Use of CT Imaging for Diagnosing Scaphoid Fractures

There are 10 moderate-quality studies incorporated into this analysis.(1157-1159, 1200, 1203-1205, 1209-1211) (Mallee 11; Memarsadeghi 06; Ilica 11; Cruickshank 07)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: CT imaging, CT, CAT, scaphoid fracture, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 0 articles in PubMed, 20 in Scopus, 20 in CINAHL, 3 Cochrane Library, and 20 from Google Scholar. We considered for inclusion 0 from PubMed, 4 from Scopus, 3 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 4 from other sources. Of the 11 articles considered for inclusion, 10 diagnostic studies met the inclusion criteria

Author/Year Study Type Conflict of Interest (COI)	Score	Number	Area of Body	Diagnoses	Type of CT	X-ray used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Adey 2007 Diagnostic Sponsored by unrestricted research grants from AO Foundation, Small Bone Innovations, Smith and Nephew, Wright Medical, Biomet, and Joint Active Systems. No mention of COI.	7.0	N = 13 (gender not specified) with nondisplaced scaphoid fractures and 17 diagnosed with suspected fractures, average age 33 years	Hand	Non-displaced scaphoid waist fractures	GE Lightspeed Qx/i CT Scanner; GE Medical Systems, Pewaukee, WI	-	-	+	-	-	-	-	-	Average sensitivity/ specificity/ and accuracy of CT for nondisplaced scaphoid fracture, for 1 st round: 89% / 91% / and 90% 2 nd round: 97% / 85% / and 88%. Positive predictive value or PPV for detection of radiographically occult scaphoid fractures with tomography of wrist 0.28 (95% CI, 0.23-0.32); NPV 0.99 (95% CI, 0.97- 0.99).	“Computed tomography should be used with caution for triage of nondisplaced scaphoid fractures because false-positive results occur, perhaps from misinterpretation of vascular foraminae or other normal lines in the scaphoid.”	Data suggest CT as better for ruling out fractures that result in due to relative infrequency of time fractures in patients with suspected scaphoid fractures.
Fusetti 2005 Diagnostic No mention of sponsorship or COI.	6.5	N = 24 (11 female and 13 male) with clinically suspected fracture and	Hand	Occult scaphoid fractures	MX-8000 16 Slices; High-spatial-resolution sonography (HSR-S)	-	-	+	+	-	-	+	-	10 (42%) presented high index of suspicion, 7 (29%) moderate index, and 7 (29%) a low index. RS effusion observed in 16 or 66% and STT effusion in 8 or 33%. Sensitivity / specificity / PPV/and NPV of HSR-S for early detection of occult SFs 100% (5/5), 79% (15/19), 56% (5/9), and 100% (15/15).	“HSR-S is a reliable, available, and cost-effective method in early diagnosis of occult fractures of the scaphoid.”	Small sample size. Data suggest (HSR-S) is reliable as well as cost effective method in early diagnosis of occult fractures of the scaphoid and this method is not without problems and CT is still superior.

		normal radiographs.															
Hannemann 2013 Diagnostic Sponsored by a research grant from the Netherlands Organisation for Health Research and Development. No COI.	6.5	N = 44 (10 female/34 male) with radiologically proven unilateral scaphoid fracture. Age over 18.	Hand	Proven unilateral scaphoid fracture	Multiplanar reconstruction CT	-	-	+	-	-	-	-	+	All views combined (transversal, coronal, and sagittal) for: no union, partial union, or union was moderate overall inter-observer agreement ($\kappa = 0.576$) (95 % CI: 0.399–0.753). Overall inter-observer agreement ($\kappa = 0.699$, 95 % CI: 0.529–0.870). Average sensitivity of multiplanar reconstruction CT was 73% and average specificity 80%.	“In conclusion, for follow-up after a scaphoid fracture, multiplanar reconstruction computed tomography is a reliable and accurate method for assessing union or nonunion of scaphoid fractures.”	Data suggest multiplanar reconstruction CT is accurate and reliable in the diagnosis of union and – non union scaphoid. Wrist fractures with respect to partial union fractures is significant variation between observers.	
Hannemann 2014 Diagnostic RCT Double-blind No sponsorship or COI.	6.5	N = 102 \geq 18 years	Hand	Randomized to: Group A or active PEMF (n = 51) vs. Group B, or placebo (n = 51) Assessed functional and radiological outcomes (multiplanar reconstructed CT scans) at 6, 9, 12, 24 and 52 weeks.	Multiplanar reconstructed CT (MRCT)	-	-	+	+	-	-	+	+	Time to clinical union; median of 6 weeks (6-24, IQR 6-9) in group A vs. median of 6 weeks (6-52, IQR 6-9) in group B. The range of movement returned to normal at 12 week in both groups. Weighted mean inter observer agreement for union ($\kappa = 0.683$, 95% CI 0.473 - 0.893) and nonunion ($\kappa = 0.791$, 95% CI 0.599 - 0.984) for all CT scans, ($p < 0.002$). Median time to radiologically confirmed union in group A was six weeks vs 12 weeks in group B, ($p = 0.30$). Waist fractures proceeded to union earlier in group A vs B (median 12 weeks (6 to 12) vs 52 weeks (6 -52), chi-squared test = 4.156, ($p = 0.04$).	“[T]he addition of PEMF bone growth stimulation to the conservative treatment of acute scaphoid fractures does not accelerate bone healing.”	Data suggest addition of PEMF bone growth stimulation did not accelerate bone healing when compared to placebo.	
Mallee 2011 Diagnostic	6.5	N = 34	Wrist	Suspected scaphoid fracture	Presence of sharp lucent line within trabecular bone pattern, break in	-	+	+	+	-	-	-	+	Follow-up for 6 weeks. CT imaging resulted in a diagnosis of 20 fractures in 17 patients. For scaphoid fractures there was a sensitivity of 67% and specificity of 96% with an accuracy of 91% in depicting scaphoid fractures. MRI showed sensitivity of 67% for scaphoid	“CT and MRI had comparable diagnostic characteristics. Both were better at excluding scaphoid fractures than they were at confirming them, and both were subject to false-positive and false-negative interpretations. The best reference standard is debatable, but	Data suggest comparable between CT and MRI for suspected scaphoid fractures.	

					continuity of cortex, sharp step in cortex, or dislocation of bone fragments										fracture, specificity 89% and accuracy 85%.	it is now unclear whether or not bone edema on MRI and small unicortical lines on CT represent a true fracture.”	
Cruikshank 2007 Prospective observational	6.5	47 patients with suspected scaphoid fractures 26 men 21 women Age not mentioned	Wrist	Scaphoid fracture	Siemens Somatome Zoom (4 slice) for first 13 patients. Rest of patients were scanned with Siemens 64 slices machine.	+	+ if patient continued to have snuff box tenderness and normal x-ray	-	-	-	-	+	10-14 days post injury. Again at 7 days and 6-8 weeks if x-ray shows evidence of fracture	CT had a positive predictive value of 100% (95% CI = 78%-100%) and the specificity was 100% (95% CI = 87%-100%). The negative predictive value for fractures are 96.7% (95% CI 82%-100%) with a sensitivity of 94.4% (95% CI = 72%-100%) One fracture was missed on the CT but was visible on a MRI.	“CT has the potential to limit the need for immobilization for the majority of patients with clinical Scaphoid fracture, who do not actually have a fracture.”	Data suggest early CT is reliable for diagnosing scaphoid fractures and other fractures of the wrist and carpal.	
Clementson 2015 Diagnostic RCT No sponsorship or COI.	5.5	N = 65 with scaphoid waist fractures.	Hand	Scaphoid waist fracture	Operative treatment (n = 26) and Cast immobilization (n = 39), followed with CT scans at 10 and 14 weeks and 6 and 12 months.	-	-	+	-	-	+	-	+	24 fractures immobilized 5-8 weeks, 11 for 10-12 weeks, 4 for 13-16 weeks. 6-week CT scan demonstrated 27/30 or 90% of non- or minimally displaced fractures had united, linear association, (p = 0.47). In operatively treated group, 17 fractures immobilized in plaster for 2 weeks, 2 for 3-4 weeks, 5 for 6 weeks, 2 for 10 weeks; union rate at 6 weeks for non- or minimally displaced fractures 82%, dropping to 40% for severely displaced fractures. CT scan demonstrated 80% united at 6 weeks, increasing to 94% after 10 weeks. Significant difference in union rate between treatment groups at any measure point, (p = 1.00).	“The majority of non- or minimally displaced scaphoid waist fractures are sufficiently treated with 6 weeks in a cast.”	Data suggests most non or minimally displaced scaphoid wrist fractures adequately treated for 6 weeks in cast. Screw fixation did not appear to shorter time to fracture union. Conservative treated fractures with prolonged time to union comminuted.	

Rhemrev 2010 Diagnostic No sponsorship or COI.	5.5	N = 100 with clinically suspected scaphoid fracture.	Hand	Evaluated with CT within 24 hours after injury and bone scintigraphy between 3 and 5 days after injury.	Lightspeed Qx/I CT Scanner, Pewaukee, WI	-	-	+	+	-	-	+	+	13 had positive bone scintigraphy and negative CT scan. CT false negative in 5 and false positive in 1 patient. Bone scintigraphy has sensitivity of 93% (13/14) and a specificity of 91% (78/86). CT has sensitivity of 64% (9/14) and specificity of 99% (85/86).	“In conclusion, this study confirms that bone scintigraphy remains the gold standard to date.”	Data suggest bone scan 3-5 deep laser superior to CT within 24° of accident. Timing is different not a head to head comparison.
Memarsadeghi 2006 Diagnostic	5.5	N = 29, mean age 34 years	Wrist	Wrist trauma accompanied by severe pain over scaphoid with negative radiograph.	Multi-detector with 4-detector row scanner	+	+	+	+	-	-	-	-	At 6-week follow-up with radiographs, 11 of 29 (38%) had scaphoid fracture; 8 had cortical fracture; 3 had trabecular involvement. MR imaging identified all 11 scaphoid fractures: 100% sensitivity and 100% specificity. 2 of 8 cortical fractures could be seen: 38% sensitivity, 100% specificity and 55% accuracy. Multidetector CT identified 8 cortical scaphoid fractures: 100% sensitivity/100% specificity. No trabecular fractures detected. MRI vs. CT p = 0.25 scaphoid fractures; p = 0.03 cortical involvement.	“Multi-detector CT is highly accurate in depicting occult cortical scaphoid fractures but appears inferior to MR imaging in depicting solely trabecular injury. MR imaging is inferior to multidetector CT in depicting cortical involvement.”	Small sample. Data suggest similar performance efficacy between CT and MRI for occult scaphoid fracture detection, but CT superior for cortical involvement detection.
Ilica 2011 Diagnostic	4.0	N = 54; mean age 22 years	Wrist	Clinically suspected scaphoid fracture with negative radiograph.	MDCT with a 64-detector multislice system.	+	+	+	+	-	-	-	-	In 20 of 55 (36%) wrists, MRI identified 22 fractures: 16 scaphoid fractures. MDCT identified 19 fractures in 17 of 55 (30%) wrists. 3 fractures missed: 2 scaphoid fractures. MDCT 100% specificity, 86% sensitivity, 100% PPV, and 91% NPV.	“MDCT offers highly accurate results, especially concerning cortical involvement, and is a useful alternative in facilities lacking MRI.”	Data suggest MDCT useful in detecting cortical involvement, but not superior to MRI for scaphoid fracture detection.

Evidence for the Use of Bone Scans for Scaphoid Fractures

There are 9 moderate-quality studies incorporated into this analysis.(1155, 1187, 1213-1215, 1217-1220) (Tiel van Buul 93; Murphy 95; Hiscox 14; Beeres 05; Beeres 07) There is 1 low-quality study in Appendix 2.(1216)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: bone scan, scaphoid fracture, scaphoid bone fracture, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 42 articles in PubMed, 85 in Scopus, 2 in CINAHL, 1 in Cochrane Library, and 96 from Google Scholar. We considered for inclusion 10 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and from 0 other sources. Of the 11 articles considered for inclusion 10 diagnostic studies met the inclusion criteria.

Author/Year Study Type	Score	N	Area of Body	Diagnoses	Type of Bone Scans	CT used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Rolfe 1981 Diagnostic	5.0	99	Hand	Recent history of carpal trauma, clinical signs suggestive of scaphoid fracture, no identifiable fracture on initial radiographic.	Isotope bone imaging (IBI)	-	-	-	-	-	-	-	-	Of 99 cases, 47 had abnormal focal increased uptake (AFIU). Of the 47, 26 had evidence of scaphoid injury. Of those 19 had retrospective radiographic evidence of fracture.	“In select cases of carpal trauma, IBI provides a satisfactory alternative means of identifying the presence and site of localized injury within the carpus and may be used to confidently exclude those patients with nonosseous symptomatology.	Data suggest IBI results are only reliable if imaging is performed at least 48 hours after injury but in cases of fracture, AFIU may persist for years. In certain selective cases of carpal trauma, IBI may be used as an alternative technique of identification of a localized injury within the carpus.
Nielsen 1983 Diagnostic	4.5	100 (101 wrists)	Wrist	Scaphoid fracture. Mean age 33 years.	99m-Tc_MDP wrist scintigraphy performed with a Nuclear-Chicago Pho/Gamma 3 scanner.	-	-	-	-	-	-	+	2 months.	Scintigram result: 54 positive, 13 inconclusive, among which 25 fractures detected (11 were scaphoid).	“99m-TC-MDP wrist scintigraphy appears expedient to exclude scaphoid bone fracture, if performed in case of doubt after secondary clinical and radiographic assessment and guided by negative scintigrams, the number of clinical examinations, radiographies and superfluous casting days are reduced.”	Data suggest wrist bone scan highly sensitive but low specificity for scaphoid fractures.

Tiel-van Buul 1996 Diagnostic Articles	4.5	19 patients	Wrist	Clinical suspected scaphoid fracture	3-phase radionuclide bone scintigraphy was obtained after 72 hours following trauma using 200 MBq 99mTc-methylene diphosphonate	-	+	+	-	-	+	-	72 hours after injury	MRI only available for 16 of 19 patients. X-ray also performed. Bone scintigraphy positive in 7 for scaphoid fractures while MRI only positive in 5.	“We conclude that in the diagnostic management of patients with suspected scaphoid fracture and negative initial radiographs, the use of MRI may be promising, but is not superior to three-phase bone scintigraphy.”	Small sample size. Data suggest MRI not superior to 3-phase bone scan for scaphoid fracture detection.
Tiel-Van Buul 1993 Diagnostic	6.5	78 35 male 43 female Mean age = 42	Wrist	Recent history of carpal trauma, clinical signs suggestive of scaphoid fracture, no identifiable fracture on initial radiographic.	Three phase radionuclide bone scintigraphy (72 hours after injury)	-	-	+	+	-	-	-	1 day, 2 weeks, 6 weeks	A total of 152 scaphoid radiographs were available for interpretation. In 18 patients the initial radiographs were judged positive for scaphoid fracture, whereas 60 patients had negative initial radiographs. After 2 weeks, two more scaphoid fractures were recognized, and one additional scaphoid fracture was identified after 6 weeks. Bone scintigraphy was obtained in the 60 patients with initially negative radiographs and in 15 patients a “hot-spot” in the scaphoid region was seen.	“The best diagnostic strategy in the management of clinically suspected scaphoid fractures consist of initial radiography followed by bone scintigraphy in patients with negative radiographs.”	Data suggest bone scan should be used only after failed radiograph. Bone scans should be used instead of multiple radiographs after a failing initial radiograph.
Murphy 1995 Diagnostic	7.0	99 55 male, 44 female Mean age = 36	Hand and wrist	Clinical scaphoid fracture was defined as presence of “snuffbox tenderness” or pain on direct palpation of the anatomic snuffbox. Patients with normal repeat radiographs were referred for bone scanning.	Three-phase technetium methylene diphosphate bone scan	-	-	+	+	-	-	+	4 days, 14 days	Day 4 bone scans, when compared to the diagnosis made with a radiograph on day 14, had a sensitivity of 100%, specificity of 92%, positive predictive value of 65%, negative predictive value of 100%, accuracy of 93%.	“Day 4 bone scans are an accurate means of ruling out scaphoid fracture. However, because of a significant number of false-positive scans at day 4, they do not reliably confirm the diagnosis of scaphoid fracture. The bone scans also permitted identification of several other wrist fractures that had not been radiographically apparent.	Data suggest bone scans performed on day 4 detect more wrist fractures of all types not just scaphoid fractures.

Hiscox 2014 Bone Scan Vs. Radiograph Diagnostic	6.0	27 16 males, 11 females Mean age = 36	Wrist	Patients with clinical scaphoid fractures based on acute wrist injury and snuffbox tenderness and normal radiographs.	Three-phase bone scan	-	-	-	+	-	-	+	10 to 14 days, then 6 weeks, then 12 months	Mean number of days immobilized was 26 in radiograph/traditional diagnosis group while the mean was 29 for bone scan/early diagnosis group. The Kaplan-Meier survival analysis using the log-rank test revealed that there was no statistically significant difference between days immobilized between the radiograph and bone scan groups (p = 0.38).	“The current study suggests that the use of bone scans to help diagnose occult scaphoid fractures does not reduce the number of days immobilized and that the differential diagnosis of occult scaphoid fractures should remain broad because other injuries are common.”	Small sample so study aim cannot be adequately answered. Data suggest comparable efficacy and bone scans do not appear to reduce the number of casted days for occult scaphoid fracture.
Beeres 2005 Diagnostic	5.5	56 36 male, 26 female Mean age = 38	Wrist	Patients with suspected scaphoid fracture that did not show on plain radiographs. Clinical signs of fracture include swollen and tender anatomical snuffbox.	Three-phase bone scan. Technetium-diphosphonate, Tc99m-HDP	-	-	+	+	-	-	+	Week 1, then week 6, and then month 3	Bone scans showed a fracture in 38/56 patients. 15 fractures were at the scaphoid bone.	“If there is a strong clinical suspicion of a scaphoid fracture, which cannot be confirmed by conventional radiology, BS is a valuable diagnostic tool.”	Data support bone scans for detecting scaphoid fractures when there is a high clinical suspicion and radiographs are negative.
Beeres 2007 Diagnostic	5.5	50 29 male, 21 female Mean age = 42	Wrist	Acute trauma and suspected scaphoid fracture. Tender anatomical snuffbox and pain when applying axial pressure	Palmar and dorsal images after injection of 500 MBq of Technetium-diphosphonate (Tc99m-HDP)	-	-	-	+	-	-	+	Depending on injury and grouping – between two weeks and 24 weeks	Bone scans revealed occult scaphoid fractures in 16 out of 50 patients. Bone scans also identified other occult fractures in 20 out of 50 patients. Bone scans resulted in a false positive in five patients and one false negative for scaphoid fracture.	“Bone scintigraphy in combination with protocolised physical examination is the gold standard for patients with signs of a scaphoid fracture that cannot be proven on scaphoid radiographs.”	Data suggest bone scintigraphy in combination with physical examination is the gold standard for diagnosing suspected scaphoid fractures when scaphoid radiographs cannot confirm the scaphoid fracture.
Stordahl 1984 Diagnostic Articles	4.0	30 mean age 31	Wrist	Clinical signs of fractured scaphoid and either negative or non-diagnostic initial x-rays.	Radionuclide imaging. administration of 10-15 mCi 99 mTc Dimethylene Phosphonate. We used a Pho/Gamma 4 Camera with divergent low energy collimator, or	-	-	+	-	-	-	-	Follow up at 2 and 6 weeks	9 had focal increased activity on bone scan located on the scaphoid bone, 4 of these had negative x-rays and 5 had inconclusive x-rays. These fractures did not show up until 2-6 weeks after trauma.	“We found bone scanning using 99 mTc a valuable diagnostic tool in the assessment of wrist trauma, in particular the early assessment of fractures in the presence of non-diagnostic radiographs.”	Data suggest isotopic bone scan useful to for early scaphoid fracture detection.

No mention of sponsorship. No COI.		fracture of scaphoid. Mean±SD age no thumb: 42±18 years. Thumb cast 33±14 years.	up at 10 weeks and 6 months.			measures between groups comparable.
Cohen 2001 RCT No mention of sponsorship or COI.	4.0	N = 200 with arm and leg injuries requiring cast support. Age and gender not reported.	Standard cast consisting of synthetic or plaster of paris, vs. focused rigidity cast of synthetic material.	Focused rigidity casting superior to traditional techniques for ability score (p = 0.0001), satisfaction score (p = 0.0023), overall impairment of function (p = 0.019), limitation of movement following cast removal (p = 0.024)	“Compared with the standard technique, focused rigidity casting has been shown to be superior to traditional methods with regard to satisfaction and functional scores without any detriment to clinical results.”	Data suggest increased patient satisfaction with FRC vs. conventional plaster of Paris cast with comparable efficacy.
Colles' Cast						
Gellman 1989 RCT No mention of sponsorship or COI.	4.0	N = 51 (46 males, 5 females) with fractures of scaphoid. Mean age: 30 years.	Long thumb spica cast (N=28) vs. short-thumb spica cast (N=23).	Fractures of proximal and middle thirds had shorter time to union when treated initially with long thumb-spica cast (9.5 weeks vs. 12.7 weeks), p <0.05. Fractures of distal third did less well regardless of immobilization method.	“[W]e recommend an initial period of immobilization of six weeks in a long thumb-spica cast, followed by application of a short thumb-spica cast for non-displaced fractures of the proximal or middle third of the scaphoid.”	Pseudorandomization, allocation not hidden, no blinding.
Clay 1991 RCT No industry sponsorship. No mention of COI.	4.0	N = 392 (222 males, 170 females) with scaphoid injury. Mean age: 29.7 years.	Colles' cast (N=145) vs. scaphoid cast (N=140) with thumb enclosed to the interphalangeal joint for 8 weeks	No difference in non-unions (10% in both groups), cast tolerance or in functional outcomes.	“Both types of cast were equally well tolerated and rehabilitation did not appear to be adversely affected by immobilisation of the thumb.”	Lack of details on randomization, allocation, no blinding. High withdrawal rate in one study center (college students).
Hambidge 1999 RCT No industry sponsorship. No mention of COI.	4.5	N = 121 with fractures of scaphoid. Gender not reported. Mean age 30 years (range 16-76).	Immobilized with Colles'-type plaster cast in either 20° flexion (n = 58) vs. 20° extension (n = 63). Follow-up for 6 months.	Nonunion was not influenced by the position of immobilization: flexion 91% vs. extension 87%, p = 0.46.	“[A]cute fractures of the scaphoid should be treated in a Colles'-type cast with the wrist in slight extension.”	Data suggest position of wrist before casting is not important, rather, immobilization via casting is for scaphoid fracture union.

Evidence for the Use of NSAIDs/Acetaminophen for Scaphoid Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDs, non-steroidal anti-inflammatory, acetaminophen, ibuprofen, scaphoid bone, scaphoid fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 4 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 80 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Physical Methods/Rehabilitation for Scaphoid Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Cast, Casts, Immobilization, Remove, Removal; scaphoid bone, scaphoid fractures, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 105 articles in PubMed, 15 in Scopus, 23 in CINAHL, 1 in Cochrane Library, 112 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 0 randomized trials and 1 systematic studies met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Physical, Therapy, Rehabilitation, scaphoid bone, scaphoid fractures, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 121 articles in PubMed, 65 in Scopus, 21 in CINAHL, 16 in Cochrane Library, 153 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Surgery vs. Non-operative Treatment for Scaphoid Fractures

There are 13 moderate-quality RCTs incorporated into this analysis.(401, 402, 1209, 1228, 1240-1242, 1245-1250) (Drac 14) There is one low-quality trial included in the Appendix 2.(1251) (Jeon 09)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Surgical Fixation, Surgery, Scaphoid fracture, scaphoid bone, fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 132 articles in PubMed, 343 in Scopus, 2 in CINAHL, 4 in Cochrane Library, 657 in Google Scholar, and 0 from other sources. We considered for inclusion 17 from PubMed, 5 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 25 articles considered for inclusion, 14 randomized trials and 2 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: surgical fixation, surgery, scaphoid bone, fractures, bone, and scaphoid fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized

controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 161 articles. Of the 161 articles we considered for inclusion 1. Of the 1 considered for inclusion, 0 are randomized controlled trials and 1 systematic reviews.

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Surgical Fixation vs. cast										
McQueen 2008 (score=7.5)	Surgical Fixation/Cast	RCT	The Scottish Orthopaedic Research Trust into Trauma (SORTIT) assisted in performing the study. No mention of COI.	N=60 patients with a Herbert type B1 or B2 fracture of the scaphoid.	Mean age was 29.4 years; 50 males, 10 females	Percutaneous fixation of the scaphoid within 14 days of injury using a standard Acutrak screw (Group 1, n=30) Vs. Colles cast with the thumb free (Group 2, n=30). Immobilization continued for at least 8 weeks, no patient was treated in a last for longer than 12 weeks.	Follow-up for 1 year.	Mean decrease grip strength (%) (8 weeks/12 weeks/26 weeks/52 weeks): operative (10/3/-1/-2) v. non-operative (42/25/11/5), (p<0.001) at week 8, 12, and 26, NS at 52. Mean decrease pinch strength (5): operative (9/4/0/-5) v. non-operative (29/15/3/1), (p<0.001) at week 8, (p=0.012) at week 12, NS at week 26 and 52. Mean decrease range of movement (%): operative (11/6/3/2) v. non-operative (52/32/11/6), (p<0.001) at weeks 8 and 12, (p=0.018) at week 26, NS at week 52. Mean Green/O'Brian score: week 8, operative (79) v. non-operative (39), p<0.001; week 12, operative (88) v. non-operative (56),	“[O]ur study confirms earlier time to union and quicker return to work and sport with percutaneous screw fixation of nondisplaced fractures of the waist of the scaphoid.”	Effects of surgical intervention allowed earlier return to work or sport with faster mean time to union. There were no differences in function at 1 year.

								(p<0.001); week 26 (92 v. 78), (p=0.006); week 52 NS. Percentage good and excellent results: week 8 (52 v. 0), (p<0.001); week 12 (68 v. 15), (p<0.001); week 26 (81 v. 56), (p=0.055); week 52 (100 v. 88), (p=0.025). Radiological outcome resportion: operative 0 v. non-operative 8, (p=0.02). Mean time to union (weeks): operative (9.2) v. non-operative (13.9), (p<0.001). Mean time to normal ADLs (weeks): full sports (6.4 v. 15.5), (p<0.001); full employment (3.8 v. 11.4), (p<0.001).		
Vinnars 2008 (score=7.0)	Surgical Fixation/Cast	RCT	Sponsored by Folksam research fund (Sweden) and the AFA research fund (Sweden). COI: One ore more of the authors have received or will receive benefits for personal or professional use.	N = 75 with an acute nondisplaced or minimally displaced scaphoid fracture.	Mean age was 30.5 years; 58 males, 17 females	Nonoperative treatment with a cast (n=35) vs. Internal fixation with a Herbert screw (n=40).	Follow up over 10 years.	All fractures united. A significant increase in prevalence of osteoarthritis in scaphotrapezial joint found in operatively treated group. No differences in subjective symptoms, as measured with limb-specific outcome scores found	“This study showed that the primary benefit of operative treatment-(i.e., a short immobilization time and an early return to work) was transient. Our observation of an increased risk of osteo-arthritis in the operatively treated group	10-yr follow-up of non displaced scaphoid fracture suggests conservative management has equal long term functional outcomes and lower risk for scaphotrapezial arthritis.

								between two groups. No significant differences in range of motion, grip strength, changed hand dominance after injury, or return to same work after injury. Scaphotrapezial arthritis occurred in 1 patient in nonoperatively treated group and in 11 in operatively treated group (p = 0.005).	points to the importance of careful selection of patients who may benefit from operative treatment.”	
Dias 2005 (score=6.5)	Surgical Fixation/Cast	RCT	No industry sponsorship or COI.	N = 88 patients with a bicortical fracture of the scaphoid.	Mean age: 29.5 years; 79 males, 9 females	Internal fixation with Herbert screw (no cast) (n=44) vs. Below elbow cast with thumb free (Colles’)(n=44)	Follow up for 52 weeks.	Grip strength and range of motion better in operative group at 8 weeks, but differences disappeared by 12 weeks. No other significant differences in pain, patient evaluation, or return to work.	“Each fracture should be treated non-operatively in a functional cast. Surgical intervention should be offered only to the every few patients who cannot return to work in a cast, and such patients should be made fully aware of the risks and limited gains provided by acute fixation.”	Allocation, randomization details unclear.
Saedén 2001 (score=5.0)	Surgical Fixation/Cast	RCT	No industry sponsorship or COI.	N = 62 acute fractures of the scaphoid.	Mean age: 32.9 years; 49 males, 13 females	Short arm cast (n=30) vs. Herbert screws group (n=32)	12-year follow-up.	Patients treated by surgery who were working at time of injury were on sick leave an average of 6 + 3 weeks compared with 15 + 10 weeks in conservatively	“In our study the fractures united whether they were treated operatively or conservatively. Internal fixation of an acute fracture of the scaphoid allows early return	Randomization and allocation methods are unclear. Surgery may result in faster recovery times and less time off work, although it may

								treated group (p = 0.002, t = -3.77). At 12 year follow-up, 90% surgical and 69% conservative groups reported no pain or wrist discomfort. Grip strength and ROM not different between groups. Radiographic evidence of osteoarthritis more common in surgical group (p = 0.049), although no difference in symptoms.	to normal function and should be regarded as an alternative to conservative treatment in those patients who cannot accept immobilisation in a cast for three months or more, for sport, social or work-related reasons.”	come at the expense of higher radiographic arthritic changes.
Bond 2001 (score=5.0)	Surgical Fixation/Cast	RCT	Sponsored by the Chief, Bureau of Medicine and Surgery, Navy Department, Washington, DC, Clinical Investigation program. No mention of COI.	N=25 full-time military personnel with acute nondisplaced fracture of the scaphoid waist.	Mean age: 24 years; 22 males, 3 females	Cast immobilization (n=14) vs. fixation with a percutaneous cannulated Acutrak screw (Acumed, Beaverton, Oregon) (n=11).	Follow up for 2 years.	Average time to fracture union: seven weeks in screw fixation vs. 12 weeks in cast immobilization, p=0.0003. Return to work: 8 weeks fixation group vs. 15 weeks cast immobilization group, p=0.0001.	“Percutaneous cannulated screw fixation of nondisplaced scaphoid fractures resulted in faster radiographic union and return to military duty compared with cast immobilization. The specific indications for and the risks and benefits of percutaneous screw fixation of such fractures must be determined in larger randomized, prospective studies.”	Small sample size (n=25). Data suggest average time to fracture union in percutaneous screw fixation group was seven weeks compared to twelve weeks in cast group. Additionally, the time to return to work in surgical group was eight weeks compared to fifteen week in cast group. Both groups showed comparable results for grip strength, ROM and patients

										satisfaction at 2 years.
Adolfsson 2001 (score=4.0)	Surgical Fixation/Cast	RCT	No mention of COI or sponsorship.	N=53 with undisplaced fracture of the waist of the Scaphoid.	Mean age of 31 years; 39 males, 14 females	Immobilization in a below elbow plaster cast for 10 weeks. If no union cast immobilization was continued for another 6 weeks (n=28) vs. Percutaneous Acutrak screw fixation (n=25).	Follow up for up to 16 weeks if nonunion.	No statistically significant differences between the two treatment groups with regard to either the rate of union or the time to union.	“Acute percutaneous internal fixation of undisplaced scaphoid waist fractures using the Acutrak screw allows early mobilisation without adverse effects on fracture healing.”	Data suggest comparable results between casting versus Acutrak screw insertion in terms of rate of or time to union. Patients with screw insertion had significantly better ROM at 16 weeks but no better grip strength.
Clementson 2015 (score=4.0)	Surgical Fixation/Cast	RCT	Supported by grants from the Swedish Research Council (Medicine) and Funds from Region Skåne. No COI.	N=38 with acute non- or minimally displaced scaphoid waist fracture.	Mean age and gender were not provided.	Conservative treatment: below-elbow thumb spica cast, incorporating the thumb up to the interphalangeal joint (n=24) vs. arthroscopic screw fixation (n=14).	Follow-up for 3 years.	ROM at 26 weeks: 88% fixation group vs. 97% conservative group; p=0.004.	“Non- and minimally displaced scaphoid waist fractures are best treated conservatively. Operative treatment may provide an improved functional outcome in the short term but at the price of a possible increased risk of arthritis in the long term.”	Data suggest conservative treatment group (cast) had significantly better ROM at 26 weeks. No significant differences between grip and for pinch strength. Surgery group “may” provide improved short term functional outcomes but at 6 years radiography showed more signs of arthritis in surgically treated group.
Vinnars 2008 (score=7.0)	Surgical Fixation/Cast	RCT	In support of their research for or preparation of the	N=75 patients with a scaphoid	Mean age was 30.5 years; 58	Non-operative treatment: immobilization	Follow-up for a	There were no significant differences between	“This study did not demonstrate a true long-term benefit	10-yr follow-up of non displaced scaphoid

			<p>article, one or more authors received, in any one year, outside funding or grants in excess of \$10,000 from the Folksam research fund (Sweden) and the AFA research fund (Sweden)</p>	<p>fracture that occurred less than 28 days before being seen.</p>	<p>males, 17 females</p>	<p>in a below-the-elbow scaphoid cast with the thumb in palmar abduction, the interphalangeal joint free, and the wrist in neutral or slight extension; cast worn for 6 weeks with option of an additional cast worn for another 2-4 weeks (n=42) vs. operative treatment: used volar approach centered over the tubercle of the scaphoid, with minimal incision exposing only the scaphotrapexial joint, dorsal approach, or combined volar and dorsal approach; after surgery, application of well-padded short arm noncircumferential dorsal plaster splint with the thumb left free for 2 weeks (n=43).</p>	<p>median of 10 years.</p>	<p>groups for primary outcomes.</p>	<p>of internal fixation, compared with nonoperative treatment, for acute nondisplaced or minimally displaced scaphoid fractures.”</p>	<p>fracture suggests conservative management has equal long term functional outcomes and lower risk for scaphotrapezial arthritis.</p>
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Bone grafting										
Caporrino 2014 (score=5.0)	Bone Grafting	RCT	No COI. No mention of sponsorship.	N=75 with scaphoid nonunion.	Mean age: 27.7 years; 71 males, 4 females	Vascularized bone grafting (VBG) using the 1, 2 intercompartmental suprareticular artery vs. distal radius non-vascularized bone graft (NVBG).	Follow-up every 2 weeks until bone healing for up to 29 months.	Mean±SD time to union: NVBG 69.7±15.1 days vs. VBG 58.0±10.3 days; (p=0.002). Ulnar deviation degrees: NVBG 29.4±5.8 vs. VBG 25.4±8.5; (p=0.033).	“Although the VBG group attained earlier union, this may not be clinically meaningful, nor justify the greater technical difficulty and use of resources associated with this intervention.”	Patient blinding unclear. Data suggest VBG group achieved an earlier union compared to distal radius nonvascularized bone graft group by 12 days, union rates for both groups were comparable. Also, there was significantly less ulnar deviation in VBG group.
Fixation vs. Bone graft										
Braga-Silva 2008 (score=6.5)	Surgical Fixation/Bone Graft	RCT	No mention of COI or sponsorship.	N = 80 with symptomatic scaphoid nonunion pseudoarthrosis of single wrist submitted for surgery. Dominant hand involved in 88% of cases.	Mean age was 26 years; 56 males, 24 females	Distal radius vascularised bone graft (n = 35) vs. Iliac crest non-vascularised bone graft (n=45).	Mean follow up radial grafts: 3.1±1.2 years. Iliac grafts: 2.6±1.6 years.	No statistically significant difference between two groups with regards to ranges of extension, flexion and ulnar deviation movements.	“The use of bone graft in the treatment of scaphoid nonunion has improved the prognosis, allowing an increase in the likelihood of painless bone consolidation and restoration of wrist function”	Data suggest comparable results between techniques for grip strength and ROM post-op mean time 2.8 years. Union consolidation of fracture quickest in non-vascularized group.
Garg 2013 (score=6.0)	Surgical Fixation/Bone Graft	RCT	No mention of sponsorship. No COI	N=100 with scaphoid nonunion.	Mean age: 34.7 years; 30 males, 16 females	Internal fixation plus distal radius bone graft (Group 1: n=50) vs. Iliac crest bone graft was	Follow up for 3 years.	Bone fusion was achieved in 87.1 % of group 1 and 86.5 % of group 2 patients. No p-value given. Mean time	“There is no advantage of the iliac crest over the distal radius graft to justify its greater morbidity.”	Data suggest comparable results between distal radius bone grafts vs. iliac crest bone

						used instead (Group 2: n=50).		for union was 4.2 months in group 1 and 4.5 months in group 2. No p-value given.		graft for scaphoid nonunion.
Ribak 2010 (score=5.0)	Surgical Fixation/Bone Graft	RCT	No mention of COI or sponsorship	N = 86 with scaphoid nonunion.	No mention of mean age or sex.	Vascularised bone graft from dorsal and distal aspect of radius (n = 46) vs. Conventional non-vascularised bone graft from distal radius (n = 40).	Mean follow up in group 1 25.3 months. Group 2 22.5 months.	Vascularized bone graft achieved 89.1% bone fusion compared to 72.5% bone fusion rate in non-vascularized bone graft. (p = 0.024)	“[V]ascularised bone grafting yields superior results and is more efficient when there is a sclerotic, poorly-vascularised proximal pole in patients in scaphoid nonunion. On the other hand, in patients with well vascularised fragments, either the vascularised or conventional technique can be used, depending upon the surgeon’s experience and preference.”	Data suggests vascularized bone grafting is superior to non-vascularized bone grafting. More patients receiving vascularized grafts achieved bone fusion (89.1%) vs. non-vascularized (72.5%). Functional results better in vascularized vs. non-vascularized.
Raju 2011 (score=4.0)	Surgical Fixation/Bone Graft	RCT	No mention of COI or sponsorship.	N=33 with non-union of the scaphoid.	Mean age: 28 years; 27 males, 6 females	Herbert screw fixation (n=11) vs. Matti Russe bone grafting (n=9) vs. Kohlman modification of vascularized muscle pedicle graft procedure (n=13).	Mean follow-up duration was 28 months.	Herbert vs. Matti vs. Kohlman: 8, 6 and 11 patients achieved scaphoid union after mean intervals of 17, 16, and 15 weeks. No p-values given.	“The time to union was earliest in the Kohlman modification of vascularised muscle pedicle graft procedure, which is recommended for patients with old non-union (>1 year) or proximal pole fractures.”	Small sample. Data suggest all 3 fixation techniques were of comparable efficacy with time to union of fracture occurring earlier in the Kohlman procedure which is recommended for patients with non-union fractures older

										than one year or proximal pole fractures.
Drac 2014 (score=4.0)	Surgical Fixation	RCT	Supported by grant project IGA MZCR NS 9623-4/2008. No COI.	N=76 Patients with acute nondisplaced or minimally displaced type B2 scaphoid fractures.	Mean age: 30 years; 68 males, 8 females	Group A- Palmar Percutaneous approach (n=36) Vs. Group B- Dorsal Limited Approach (n=36)	Follow-up for 1 year after surgery.	There were no significant differences between Group A and Group B for flexion, extension, radial and ulnar deviation, grip strength, presence of persisting complaints, patient satisfaction or DASH score at any of the follow-up points (p>0.05).	“We found no advantage to the palmar percutaneous approach in the treatment of nondisplaced and minimally displaced scaphoid fractures type B2 compared to dorsal limited approach.”	Data suggest comparable efficacy at one year.

Evidence for the Use of Ultrasound with Bone Graft for Scaphoid Fractures

There is 1 moderate-quality RCT incorporated into this analysis.(1258)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ultrasound, Osteogenic Protein Adjuvant, Scaphoid Fractures, Ultrasonography, Ultrasonic, Scaphoid Bone, bone fractures, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 18 articles in PubMed, 80 in Scopus, 0 in CINAHL, 4 in Cochrane Library, and 2,268 in Google Scholar. We considered for inclusion 1 from PubMed, 4 from Scopus, 0 from CINAHL, 1 from Cochrane Library, 5 from Google Scholar, and 0 from other sources. Of the 11 articles considered for inclusion, 1 randomized trials and 10 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: ultrasound, ultrasonography, bone transplantation, bone graft, osteogenic protein adjuvant, scaphoid bone, fractures, bone, scaphoid fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies, BMP-7 to find 70 articles. Of the 70 articles we considered for inclusion 2. Of the 2 considered for inclusion, 0 are randomized controlled trials and 2 systematic reviews*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Ricardo 2006 (score= 4.5)	Ultrasound with Bone Graft	RCT	No mention of sponsorship or COI.	N = 21 with vascularized bone graft and internal fixation with k-wire	Mean age: 26.7 years; All pts were males.	Ultrasound treatment vs. sham ultrasound	Follow up from 1-4 years. Average of 2.3 years.	Daily 20 minute low intensity ultrasound treatment over scaphoid led to reduced time to overall (clinical and radiographic) healing by 38 days (average 56±3.2 days compared with 94±4.8 days; p <0.0001).	“All patients achieved fracture union (active and placebo groups), but compared with the placebo device (11 patients), the active device (ten patients) accelerated healing by 38 days (56±3.2) days compared with 94±4.8 days, p<0.0001, analysis of variance.”	Study suggests low intensity ultrasound treatment beneficial in improving healing time in this subset of patients undergoing bone graft with internal fixation.

Evidence for the Use of Osteogenic Protein Adjuvant with Bone Graft for Scaphoid Fractures

There is 1 moderate-quality RCT incorporated into this analysis.(1259)

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Bilic 2006 (score=6.0)	Osteogenic Protein Adjuvant	RCT	No mention of sponsorship or COI.	N = 17 patients with symptomatic proximal pole scaphoid non-union of 9 months or more with no evidence of progressive healing over	Mean age: 21.3 years; no mention of sex.	Autologous iliac graft vs. Autologous iliac graft + osteogenic protein-1 (OP-1) vs. Allogenic iliac graft + OP-1	Follow up at 2, 4, 5, 9, 12, and 24 months.	OP-1 improved performance of autologous graft healing (4 vs. 9 weeks in control). OP-1 improved functional performance of both groups vs. autologous graft alone. Sclerotic	“Recombinant human OP-1 supports proximal pole scaphoid non-union healing via increased bone vascularization and replacement of preexisting proximal pole sclerotic bone as a	Small sample size; study suggests significant potential benefit from using OP-1 in healing time, functional improvement, and avoiding

				the previous 3 months.				bone replaced by vascularized bone as assessed by CT 3 months after operation vs. 24 months after operation (sclerotic area mm2): Autograft only: 138.3± 15.1* vs. 111.5±8.6; Autograft + OP-1: 74.0*±14.1 vs. 31.7±6.8***; Allograft + OP-1: 103.6 ±13.2* vs. 55.6± 11.7*** *p <0.05 vs. before operation ***p <0.05 vs. autograft only	consequence of avascular necrosis. The addition of OP-1 to allogenic bone implant equalised the clinical outcome with the autologous graft procedure. Consequently the harvesting of autologous graft can be avoided.”	autologous grafting.
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Evidence for the Use of X-rays for Diagnosing Tuft Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: X-Ray, radiography, radiograph, roentgenogram, Distal Phalanx Fractures, Tuft Fractures subungual hematoma, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 51 articles in PubMed, 46 in Scopus, 0 in CINAHL, 2 in Cochrane Library, and 382 from Google Scholar. We considered for inclusion Zero from PubMed, Zero from Scopus, Zero from CINAHL, Zero from Cochrane Library, Zero from Google Scholar, and Zero from other sources. Zero articles met the inclusion criteria. *Evidence for the Use of MRI/CT/Ultrasound/Bone Scan Imaging for Diagnosing Tuft Fractures*

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: MRI, CT, CAT, Ultrasound, Bone scan imaging, Distal Phalanx Fractures, Subungual Hematoma, Tuft Fractures, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 20 articles in PubMed, 10 in Scopus, 0 in CINAHL, 6 Cochrane Library, and 60 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Trephination and Nail Removal or Laceration Repair

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Trephination; nail removal; laceration repair (subungual hematoma) / Distal Phalanx Fractures and Subungual Hematoma, Tuft Fractures ;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 6 articles in PubMed, 1 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 180 in Google Scholar, and 1 from other sources. We considered for inclusion 3 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 1 from other sources. Of the 6 articles considered for inclusion, 0 randomized trials and 2 systematic studies met the inclusion criteria.

Evidence for the Use of NSAIDs or Acetaminophen for Tuft Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDS, Anti-Inflammatory Agents, Non-Steroidal, non-steroidal anti-inflammatory Agents, Non-Steroidal agents; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, and 0 in Cochrane Library, 719 in Google Scholar. Zero articles met the inclusion criteria.

Evidence for the Use of Antibiotic Prophylaxis for Open Fractures

There is 1 high-quality RCT incorporated into this analysis.(1275) (Stevenson 03) There is 1 low-quality RCT in Appendix 2.(1276) (Sloan 87)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Antibiotic prophylaxis, Distal Phalanx Fractures and Subungual Hematoma, Tuft Fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 12 in Scopus, zero in CINAHL, and 2 in Cochrane Library. We considered for inclusion 2 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the 2 articles considered for inclusion, 2 randomized trials and zero systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Stevenson 2003 RCT Sponsored by the Research Network,	8.5	N = 193 (159 males; 34 females) with an open fracture of the distal phalanx; Age range 16 – 88.	Antibiotic four times a day for five days (N = 98) vs Placebo four times a day for five days (N = 95).	Infection rate (antibiotic vs. placebo): 3% vs 4% (p>0.05).	“[T]he addition of prophylactic flucloxacillin to thorough would toilet and careful soft-tissue repair of open fracture of the distal phalanx	Data suggest no benefit of addition of prophylactic flucloxacillin for treating distal phalanx fractures

Ayrshire and Arran Health Board. No COI			Follow-up 4 or 5 days, 14 days and 8 weeks following injury unless wound was healed and patient is asymptomatic.		confers no benefit.”	compared to placebo.
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Evidence for the Use of Tetanus Immunization

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Tetanus immunization, Distal Phalanx Fractures and Subungual Hematoma, Tuft Fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 10 in Scopus, 0 in CINAHL, 0 in Cochrane Library and 0 in other sources. Zero articles met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: tetanus immunization, distal phalanx or tuft, fractures or fracture or subungual hematoma; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.*

Evidence for the Use of Immobilization for Tuft Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Immobilization, Splinting, Tight, circumferential, taping, Distal, Phalanx, Tuft, Fractures, fracture, Subungual, Hematoma; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 0 in Scopus 0 in CINAHL, 1 in Google Scholar, and 1 in Cochrane Library. We considered for inclusion 15 from PubMed, 5 from Scopus, 11856 from CINAHL, 24 in Google Scholar, 91 from Cochrane Library, and 0 from other sources. Of the 11986 articles considered for inclusion, 0 randomized trials and 4 systematic studies met the inclusion criteria.

Evidence for the Use of Physical or Occupational Therpay for tuft fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Exercise, Physical Therapy, Occupational Therapy, Distal Phalanx Fractures and Subungual Hematoma, Tuft Fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random

allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 12 articles in PubMed, 3 in Scopus, 0 in CINAHL, 2 in Cochrane Library, 167 in Google Scholar, and 0 in other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Surgery for Distal phalangeal diaphyseal fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Retrograde percutaneous Kirschner-wire fixation, Bone Wires, Distal Phalanx Fractures and Subungual Hematoma, Tuft Fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 6 in Scopus, 0 in CINAHL, and 12 in Cochrane Library, 136 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 1 articles considered for inclusion, 0 randomized trials and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: retrograde percutaneous Kirschner-wire fixation, distal phalanx or tuft, fractures or fracture or subungual hematoma; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 20 articles. Zero articles met the inclusion criteria.*

Evidence for the Use of X-rays for Diagnosing Phalangeal or Metacarpal Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: X-Ray, Metacarpal, Middle, Proximal, Phalangeal, boxer's, Fracture, Bone, Diagnostic, Diagnosis, Sensitivity, Specificity, positive, predictive, value, negative, predictive, Predictive, Value, of, Tests, efficacy, efficiency. We found, reviewed and considered for inclusion 251 articles in PubMed, 2 in Scopus, 7 in CINAHL, 0 in Cochrane Library, 1080 in Google Scholar and 0 in other sources. Zero articles met the inclusion criteria.

Metacarpal Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: MRI, CT, Ultrasound, bone, scan, imaging; Metacarpal, Middle, Proximal, Phalangeal, boxer's, Fracture, Bone, Diagnostic, Diagnosis, Sensitivity, Specificity, positive, predictive, value, negative, predictive, Predictive, Value, of, Tests, efficacy, efficiency. We found and reviewed 90 articles in PubMed, 1 in Scopus, 5 in CINAHL, 647 in Google Scholar, and 1 in Cochrane Library. We considered for inclusion 2 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 744 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria

Evidence for the Use of Digital Block for Middle and Proximal Phalangeal or Metacarpal Fractures

There are 2 high-(99, 1285) and 7 moderate-quality(1283, 1284, 1286-1290) RCTs or crossover trials incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Digital block, digital anesthesia, ring block technique, palmar subcutaneous block, middle, proximal, phalangeal, metacarpal, fractures, bone fractures, boxers; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 41 in Scopus, 1 in CINAHL, 0 in Cochrane Library, 60 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Nine articles met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Digital Block						
Yin 2006 RCT No mention of sponsorship or COI.	8.5	N = 91 (23 female/68 male) with injuries to 1-2 fingers distal to basal crease of finger. Age 14- 60.	Traditional digital block (n = 50) vs single subcutaneous palmar block (n = 41). Follow-up for 1 month.	No differences between 2 groups per time to onset of anesthesia and injection pain score with per protocol or ITT analyses.	“The palmar techniques, including single subcutaneous palmar block and transthecal block carry a risk of not anesthetizing the dorsum of the digit adequately, particularly the dorsum of the thumb and the proximal phalanx of the fingers.”	Study included RCT as well as meta-analysis of other digital anesthesia RCTs.
Hung 2005 RCT Crossover Trial Sponsored by funds from American Foundation of Surgery of Hand, Raymond M. Curtis Research Foundation and MedStar Research Institute. No	8.0	N = 50 (gender not specified) healthy volunteers. Age not given.	Digital (metacarpal) block vs. single subcutaneous palmar block vs. transthecal block	Overall significant difference (p <0.001) between methods evaluated with digital metacarpal block taking significantly longer to abolish sensation (265 seconds vs. 187 seconds vs. 176 seconds) as compared with other 2 methods. No significant difference between average pain scores by patients; 43% chose subcutaneous block as their first choice vs. metacarpal block vs. transthecal block.	“Subcutaneous block is effective and preferred by healthy volunteers for digital anesthesia.”	Study conducted in non- injured hands. Volume of anesthetic was limited to 2ml. All subject received all blocks in different fingers. Results are opposite those found by Knoop.

mention of COI.						
Hill 1995 RCT Crossover Trial No mention of sponsorship or COI.	7.0	N = 81 (gender not specified) healthy adults. Age 18-45 years.	TT or transthecal block vsTD or traditional digital block or ring block.	Blocks completed with 2ml 1 % lidocaine at each site. All blocks successful without complications. Mean VAS pain scores favored traditional block (1.4 ± .13 vs. 1.7 ± .17, p = 0.02). Time to loss of pinprick sensation was faster for ring block (188 vs. 152 seconds).	Transthecal digital block is clinically equal to the traditional method in terms of time to anesthesia and associated pain.	Study included 162 blocks on 81 subjects. Patients were healthy without injury and served as their own control.
Williams 2006 Crossover Trial No mention of sponsorship or COI.	7.0	N = 27 (16 female/11 male) volunteers. Mean age 31 years.	Digital block vs. single subcutaneous palmar block.	No difference in median pain scores with respect to volar and dorsal injection techniques (VAS 4.06 vs. 4.52). Volunteers preferred palmar block (22 of 27) if required to have another in the future.	“Our results demonstrated that there was more pain experienced with the use of the two-injection dorsal technique, but the difference in pain scores was not statistically significant.”	Lack of blinding; study conducted on healthy volunteer population. Both techniques had incomplete anesthesia in some subjects (palmar – dorsum of phalanges, digit – hemidigit anesthesia).
Cummings 2004 Crossover Trial Sponsored by University of Illinois College of Medicine and Department of Emergency Medicine at OSF St. Francis Medical Center. No mention of COI.	6.5	N = 25 Paid volunteers Mean age of 31 years old. 13 Females, 12 Males	Transthecal (modified) (N=25) vs. Traditional digital block (N = 25) (All 25 volunteers received both treatments.) No mention of follow up.	No difference in pain rating from the block procedures (p = 0.579). Average time to complete block was faster in all measured dermal zones (average of 1.38 to 5.46 minutes faster) for traditional block vs. transthecal block (p <0.05).	“The effect of modified transthecal block is equal to that of traditional block in terms of pain perception. For the dorsal and radial proximal zones, the traditional block appears to have better distribution of anesthesia.”	Subjects served as both comparison groups. Author states study was double-blind, but appears questionable as number and location of puncture was different for each method.

<p>Low & Wong 1997</p> <p>Crossover Trial</p> <p>No mention of Sponsorship or COI.</p>	6.5	<p>N = 142</p> <p>Mean age of 33.5 years old.</p> <p>14 Females, 128 Males</p>	<p>Transthecal (N = 71)</p> <p>vs.</p> <p>Single injection subcutaneous (superficial to A-1 pulley) digital block (N=71)</p> <p>No mention of follow up.</p>	<p>Blocks performed with 3cc 1% lignocaine/ bupivacaine mixture. No differences between 2 techniques with regards to effectiveness, distribution, onset, and duration of anesthesia.</p>	<p>“The subcutaneous block would appear to be a better choice as it is easier to administer and has no risk of intraarticular injection.”</p>	<p>Study compared single injection techniques in subjects with actual injuries. Randomization and allocation is unclear.</p>
<p>Knoop 1994</p> <p>Crossover Trial</p> <p>No mention of sponsorship or COI.</p>	5.5	<p>N = 30 patients that required digital anesthesia.</p> <p>No mention of mean age. Range 19-64 years old.</p> <p>9 Females, 21 Males</p>	<p>Digital block (N = 30)</p> <p>vs.</p> <p>Single subcutaneous palmar block (N = 30)</p> <p>(All patients had both treatments.)</p> <p>No mention of follow up.</p>	<p>Digital block not statistically less painful than metacarpal block (VAS 2.53±1.98cm vs. 3.35±2.77cm, p = 0.18). Digital block more efficacious as metacarpal block failed anesthesia to pinprick in 23% vs. 3% (p = 0.023). Time to anesthesia shorter for digital block 2.82 minutes ± 1.01 vs. 6.35 minutes ± 2.94 (p <0.001).</p>	<p>“Digital block and metacarpal block, as described in this study, are equally painful procedures. Digital block, however, is more efficacious and requires significantly less time to onset of anesthesia for the injured finger.”</p>	<p>Subjects served as both comparison groups with both procedures being completed on half of same finger, which is major weakness. Lack of methodology details.</p>
<p>Keramidas 2004</p> <p>Crossover Trial</p> <p>No mention of sponsorship or COI.</p>	5.5	<p>N = 50 patients with a finger(s) injury.</p> <p>Mean age of 35 years old.</p> <p>15 Females, 35 Males</p>	<p>Transthecal Digital Block (N = 50)</p> <p>vs.</p> <p>Traditional digital block (N = 50)</p> <p>No mention of follow up.</p>	<p>Subjects had 2 or more injured fingers. Blocks performed with 2cc 1% lidocaine transthecaly. All blocks successful without complications. Mean time to pinprick sensation faster for traditional block (100± 6.2 s vs. 165±9.3 s, p <0.05). At 24 hours post block, 18 of 52 transthecal blocks had residual pain; none of subcutaneous blocks had pain. Patients preferred subcutaneous block 46 vs. 4.</p>	<p>“The transthecal digital block is comparable to the traditional subcutaneous infiltration technique with respect to the time and effectiveness of anesthesia but not with respect to the associated pain following anesthesia. Patients seem to prefer the subcutaneous infiltration technique because it is less painful.”</p>	<p>Randomization and allocation unclear, although patients served as both intervention arms. States study double blinded but only described blinding of assessor.</p>

<p>Low & Vartany 1997</p> <p>Crossover Trial</p> <p>No mention of sponsorship. No COI.</p>	<p>5.5</p>	<p>N = 20 healthy volunteers.</p> <p>No mention of age/sex.</p>	<p>Transthecal (N = 20)</p> <p>vs.</p> <p>Single injection subcutaneous (superficial to A-1 pulley) digital block (N = 20)</p> <p>Follow up 24 hrs after experiment.</p>	<p>Blocks performed with 2ml 1% lidocaine; 40% of transthecal group and 45% of subcutaneous group achieved entire finger anesthesia. No differences based on injection method. No differences in magnitude of sensory nerve action potentials. Injector subjectively rated subcutaneous injections as easier to perform than transthecal.</p>	<p>“Transthecal and subcutaneous techniques showed no differences in terms of distribution, onset, and duration of anesthesia. Although both techniques give similar levels of anesthesia, subcutaneous block is believed to be superior because the transthecal technique has more dis-advantages.”</p>	<p>Lack of study details, including randomization and allocation methods. Subjects were own control, and had no injuries.</p>
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Evidence for the Use of NSAIDs or Acetaminophen for Phalangeal or Metacarpal Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAID, aspirin, acetaminophen, Middle, Proximal, Phalangeal, Metacarpal, Fractures, bone Fractures, boxer's; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 56 in Scopus, 0 in CINAHL, 4 in Cochrane Library, 60 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Antibiotic Prophylaxis for open phalangeal fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, and Cochrane Library without date limits using the following terms: Anti-bacterial agents, antibiotics, antibiotic prophylaxis, and antibiotic; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed zero articles in PubMed, 1 in Scopus, zero in CINAHL, and 1 in Cochrane Library. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Tetanus Immunization for Open Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: Tetanus, Tetanus immunization, Tetanus Toxin, Tetanus antitoxin, Tetanus Toxoid and tetanus; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library and 417 in other sources. Zero articles met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: tetanus immunization status, tetanus, tetanus toxoid, middle phalangeal factures, proximal phalangeal fractures, metacarpal fractures, bone fractures, boxer's fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.

Evidence for the Use of Functional Therapies vs. Casting or Splinting for Metacarpal Fractures

There are 13 moderate-quality RCTs incorporated into this analysis.(1294-1304, 1314, 1315) (Horton 03; Sletten 15) There are 3 low-quality RCTs in Appendix 2.(1316-1318)

Taping:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Taping, functional bracing, strapping vs. casting or splinting (fifth metacarpal neck fractures only), Middle and Proximal Phalangeal and Metacarpal Fractures (fifth metacarpal neck fractures, boxer's fracture, shaft metacarpal

fractures - transverse, oblique, spiral, comminuted); controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 17 articles in PubMed, 4 in Scopus, zero in CINAHL, zero in Cochrane Library, 27 in Google Scholar, and zero from other sources. We considered for inclusion 11 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library, zero from Google Scholar, and zero from other sources. Of the 11 articles considered for inclusion, 11 randomized trials and zero systematic studies met the inclusion criteria.

Fixation:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: percutaneous fixation, bone screws, plates, internal fixation, external fixation, closed reduction, middle, proximal, phalangeal, metacarpal, fractures, bone fractures, boxer's, condylar fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 244 articles in PubMed, 301 in Scopus, 11 in CINAHL, 1 in Cochrane Library, 282 in Google Scholar, and 0 from other sources. We considered for inclusion 3 from PubMed, 2 from Scopus, 0 from CINAHL, Cochrane Library, and Google Scholar, and 1 from other sources. Of the 6 articles considered for inclusion, 5 randomized trials and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: percutaneous fixation, bone screws, plates, internal fixation, external fixation, closed reduction, metacarpal, metacarpal fractures, middle or proximal, phalangeal or boxer's, and bone fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 144 articles. Of the 144 articles we considered for inclusion 6. Of the 6 considered for inclusion, 1 are randomized controlled trials and 5 systematic reviews.*

Immobilization:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms Immobilization: padded aluminum splints, buddy tape, functional splinting, gutter casting, splinting (closed reduction), Middle, Proximal, Phalangeal, Metacarpal, Fractures, bone Fractures, boxer's; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 2 in Scopus, 4 in CINAHL, 19 in Cochrane Library, 100 in Google Scholar, and 1 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 1 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 2 articles considered for inclusion, 0 randomized trials and 2 systematic studies met the inclusion criteria

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Fixation										
Kim 2015 (score=7.0)	Percutaneous Fixation	RCT	No mention of sponsorship. NO COI.	N = 46 with displaced fifth metacarpal neck fractures with apex dorsal angulation >30°.	Mean age: 29 years; 46 males, 0 females	Antegrade intramedullary K-wire pinning (n=23) vs percutaneous retrograde intramedullary K-wire pinning (n=23). All patients received an ulnar gutter	Follow-up at 3 and 6 months postoperatively.	Postoperative outcomes at 3 months: ROM antegrade 80 vs. retrograde 69 (p<0.001); VAS points antegrade 2 vs. retrograde 4 (p<0.001); grip strength % antegrade 81 vs.	“[T]reatment of a displaced fifth metacarpal neck fracture by antegrade intramedullary pinning produces better clinical outcomes at 3 months postoperatively in	Data suggest antegrade intramedullary pinning had some clinical benefit to retrograde intramedullary pinning during recovery phase but these

						short-arm splint post-surgery to be worn for 5 weeks.		retrograde 71 (p<0.001); DASH score, points, antegrade 4.3 vs. retrograde 10.3 (p<0.001). Postoperative outcomes at 6 months: ROM (p=0.35); VAS (p=0.67); grip strength (p=0.41); DASH score (p=0.48).	terms of ROM, VAS, grip strength, and DASH score of the fifth metacarpophalangeal joint than percutaneous retrograde intramedullary pinning, but that the differences in clinical parameters are not sustained at 6 months postoperatively.”	benefits are not present at 6 months.
Winter 2007 (score=5.5)	Percutaneous Fixation	RCT	No mention of sponsorship or COI.	N = 36 males with fracture of neck of 5th metacarpal, recent and closed fracture.	Mean age 31.4 years; 36 males, 0 females	Transverse pinning with 2 K-wires 1.5mm diameter (n=18) vs intramedullary pinning with 3 K-wires 1mm diameter (n=18). Both groups wore palmar splint for 1 week after procedure then physiotherapy 3x a week for 30 days. K-wires removed 6 weeks after surgery.	Follow-up at days 8, 15, 30, 45, 60, and 90 after surgery.	Total active motion (TAM) at final follow-up: intramedullary 279±11.9° vs. transverse 261±36.5° (p=0.02). Active ROM MCPj at final follow-up: intramedullary 94±5.9° vs. transverse 81.5±19.4° (p=0.0037). Percentage of contralateral grip strength: intramedullary 92% vs. transverse 83% (p=0.06).	“This study suggests that intramedullary pinning is a particularly efficient procedure for treatment of the boxer’s fracture.”	Small sample. Data suggest better functional outcomes with intramedullary pinning group unclear if patients were informed of surgical treatment.
Krukhaug 2009 (score=5.0)	Closed Reduction Fixation	RCT	No mention of sponsorship. No COI.	N = 75 with unstable distal radius fractures (AO-type A3) suitable for non-bridging	Mean age 62 years; 6 males, 64 females	H group: Hoffman compact II fixator (n=37) vs D group: Dynawrist fixator (n=38).	Follow-up post-op, 6, 12, 24, and 52 weeks.	Median radial tilt (degrees): post-op Hoffman 8 volar vs. Dynawrist 2 volar (p = 0.002); at removal of fixators Hoffman 9 volar vs.	“The Dynawrist bridging but dynamic fixator gives radiographic and functional outcome similar to that of the Hoffman	Data suggest comparable efficacy in both groups for radial tilt, inclination and radial length.

				external fixation; >10° of dorsal angulation and/or radial shortening of >2mm vs. uninjured wrist.		All patients treated with closed reduction.		Dynawrist 4 (p = 0.04). Mean loss of flexion (degrees): 6 weeks Hoffman 34 vs. Dynawrist 24 (p = 0.001).	II compact non-bridging fixator.”	
Horton 2003 (score=5.0)	Percutaneous Fixation	RCT	Sponsored by a grant from the AO foundation. No mention of COI.	N = 32 with an isolated spiral or long oblique fracture of the shaft of the proximal phalanx.	Mean age 26 years; 14 males, 14 females	Treated by closed reduction and Kirschner wire fixation (n=17) vs Treated by open reduction and lag screw fixation (n=15).	Follow-up for a median of 40 (range 15-76) months.	18/28 achieved a full recovery and 9/10 complained only of niggling or minor problems. No significant difference between the functional recoveries of the two groups, (p = 0.3). The median pain VAS for the whole study group was 0 (range 0–7).	“There was no significant difference in the functional recovery rates or in the pain scores for the two groups.”	Small sample size. Data suggest comparable results.
Sletten 2015 (score=5.5)	Percutaneous Fixation	RCT	Sponsored by a grant from Sofies Mindes Ortopedi AS, Oslo, Norway. No COI.	N = 85 with little finger metacarpal neck fractures with ≥30° palmar angulation in the lateral view.	Mean age: 27.0 years; 61 males, 24 females	Conservative treatment without reduction of the fracture (n=43) vs Closed reduction and bouquet pinning (n=42).	Follow-up at 1 week, 6 weeks, 3 months, and 1 year.	Median operative time 30 minute. The palmar angulation was a median of 41° (range 30–58) in the conservative group at inclusion. In the operative group, palmar angulation was reduced from a median of 40° (range 30–59) – 17° (range –9–31). At 1 year, The QuickDASH score was median 0 in both groups. No statistically significant or	“There was a trend versus better satisfaction with hand appearance (p = 0.06), but longer sick leave (p < 0.001) and more complications (p = 0.02) in the operative group.”	Data suggest comparable efficacy between conservative treatment vs. bouquet pinning of little finger metacarpal neck fractures for pain, finger ROM, grip strength, and quality of life. However, there was better patient satisfaction with hand appearance

								clinical relevant differences in QuickDASH scores at any time, but a worse QuickDASH Work score in the operative group at 6 weeks before pin removal, (25 versus 6 points, p = 0.07).		but longer sick leave in the surgical group.
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Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Immobilization						
Hofmeister 2008 RCT No mention of sponsorship. NO COI.	6.0	N=81 with an acute (<7 days old) isolated fracture of the 5th metacarpal neck. Mean age 25 years. No mention of gender.	Casting with the MCP joint in flexion in a short-arm cast with volar outriggers with ring and small finger interphalangeal joints in extension, SAC-VOR (N=40) vs. casting with MCP joint in neutral extension and a cast with a 3-point mold about the fracture site, MCP-ext (N=41). All patients underwent a fracture reduction prior to cast placement. Cast was removed after 4 weeks. Assessments at 1 week, 4 weeks, and 3 months after the start of treatment.	Postreduction AP plane: SAC-VOR 5° vs. MCP-ext 14° (p<0.05).	“[W]e found that both methods of immobilization were equally effective in maintaining fracture reduction.”	Data suggest comparable efficacy between (SAC VOR) and (MPC-ext) with a slight advantage to MCP-ext in terms of grip strength, patient tolerability and ROM.
Harding 2001 No mention of sponsorship or COI	5.5	N = 73 (3 females, 62 males) Patients with minimally angulated (<40°), closed fractures of the little finger metacarpal neck with no rotational deformity or associated injury. Mean age was 26.5 years	Molded metacarpal brace (N=37) vs. neighbor strapping for 5th metacarpal neck fracture (N=28) Follow up at 3 weeks.	Patients treated with brace complained of less pain (p = 0.001) and had slightly better range of finger movement (p = 0.03). More returned to work by 3 weeks (p = 0.007). None developed rotational or significant angular deformity.	“The results of our study... showed a clear benefit over neighbor strapping for mean range of active range of motion of MCP joint, mean pain score, and return to work by 3 weeks.”	There was no mention of control for co-interventions. For working populations this study suggests earlier return to work.

<p>Kuokkanen 1999</p> <p>No mention of sponsorship or COI.</p>	<p>5.5</p>	<p>N = 29 (26 males, 3 females) Patients treated for subcapital fractures of the fifth metacarpal bone.</p> <p>Mean age: 29 years.</p>	<p>Compression bandage for 1 week vs. splint immobilization (MCP 60° of flexion)</p>	<p>Angulation of fracture remained practically at same level compared with primary angulation in both groups. ROM of MCP (p = 0.02) and PIP (p = 0.01) joints higher in functional group at 4 weeks, but no difference at 3 months. Grip force was better in functional group at 4 weeks (p = 0.002).</p>	<p>“We suggest that at least subcapital fractures of the fifth MC that are modestly and slightly angulated should be treated functionally, without reduction and splinting. Based on the present findings the correction achieved by closed reduction does not persist...”</p>	<p>Small sample size. Patients in functional group had higher degree of pre-treatment angulation but still had equal or better functional outcomes in this population.</p>
<p>Braakman 1998</p> <p>No mention of sponsorship or COI.</p>	<p>5.0</p>	<p>N = 50 (43 males, 5 females) patients with a fracture of the 5th metacarpal</p> <p>Mean age was 26 years.</p>	<p>Ulnar gutter plaster cast vs. functional tape of 5th metacarpal fracture.</p> <p>Follow up period was 6 month.</p>	<p>In both groups, fracture reduction partially lost at 1 week follow-up for all patients who had reduction. No relation between functional recovery and existence of residual symptoms based on initial fracture angulation. Normal mobility restored in all patients in tape group, whereas mobility limited in 44% of cast group at 4 weeks and 8% at 3 months.</p>	<p>The patients in the tape group showed a quicker and superior functional recovery than those in the cast group. After 6 months, there were no significant differences between the groups with regard to functional and anatomical results or the number of patients with residual symptoms.</p>	<p>Lack of randomization and allocation details. No blinding of assessor.</p>
<p>Stadius Muller 2003</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>5.0</p>	<p>N= 40 (38 males, 2 females) with a fracture of the subcapital MC-V ≤ 3 days old and angulated ≤70°. Mean age 29 years.</p>	<p>Ulnar gutter plaster cast for 3 weeks followed by mobilization within pain limits (N=20) vs. 1 week of pressure bandage (N=20). Follow-up 6 and 12 weeks after fracture.</p>	<p>There were no significant differences between groups at 6 and 12 weeks follow-up.</p>	<p>“[A] pressure bandage for 1 week and immediate mobilization is a sufficient alternative treatment</p>	<p>Small sample size. Data suggest comparable efficacy between groups.</p>

					of a boxer's fracture, if this is not angulated greater than 70° and not rotated."	
McMahon 1994 RCT No mention of sponsorship or COI.	4.5	N=42 with unilateral fresh closed stable fractures (displaced <50% of width of shaft, angulated less than 40° and showed an angle of over 60° between plane of fracture and axis of shaft) of the shaft of single finger metacarpal Mean age plaster 27 years, compression glove 35 years. No mention of gender.	Compression glove worn on injured hand and early mobilization (N=21) vs. immobilization in plaster splint (N=21). Treatment lasted between 6-14 days after entry. All patients received hand exercises between 6-13 days after injury. Follow-up began at week 2, weekly intervals for 3 weeks.	Mean loss of total active motion (degrees): week 2 glove 56±26 vs. splint 84±33 (p=0.0036); week 3 glove 23±17 vs. splint 46±23 (p=0.0010); week 4 NS (p=0.15). Mean increase in circumference of PIP joint (mm): week 2 glove 2.2±2.8 vs. splint 4.5±3.2 (p=0.019); week 3 glove 0.5±2.5 vs. splint 2.1±2.8 (p=0.059); week 4 NS (p=0.27). Mean increase in hand volume (cm ³): week 2 glove 19±31 vs. splint 42±36 (p=0.029); week 3 NS (p=0.13); week 4 NS (p=0.69).	"Use of a compression glove avoided the loss of function imposed by splintage and was associated with a greater range of movement during the second and third weeks."	Small sample size (N=42). Data suggest glove group experienced less pain and prevented loss of function and better range of motion during second and third weeks.
Randall 1992 RCT No mention of sponsorship or COI.	4.5	N=18 (13 males, 5 females) undergoing treatment of metacarpal fracture and hand has been immobilized for ≥2 weeks. Mean age 28.7 years.	Joint mobilization using traction and palmar/dorsal glide techniques (N=9) vs. control, no mobilization (N=9). Both groups received home exercises. Three appointments on alternate days over a 1 week period.	Mean torque range of motion (TROM): treatment 73.6 vs. control 58.7 (no p-value reported).	"The joint mobilization treatment given to the subjects in this study resulted in a significant gain in AROM and decrease in joint stiffness within a treatment	Small sample (18). Data suggest significant increase in metacarpal phalangeal joint motion after joint mobilization

					session when compared to the control group.”	when compared to controls.
Konradsen 1990 RCT No mention of sponsorship or COI.	4.0	N=100 with shaft or neck fracture of the 2nd-5th metacarpal bone. Median age plaster cast 22 years, functional cast 22.5 years. No mention of gender.	Immobilization by plaster cast as ulnar gutter cast for 5th metacarpal or as dorsal cast for 2nd-4th metacarpals (N=) vs. immobilization by functional cast, Delta-Lite® allowing free ROM of wrist and digit joints (N=). Reduction was performed in all patients. Casts removed after 3 weeks. Assessments at 1 week, 3 weeks, and 3 months after injury.	Fracture angulation after cast removal (median degrees): subcapital – plaster cast 25 vs. functional cast 16 (p<0.05); diaphyseal – plaster cast 14 vs. functional cast 5 (p<0.01). Return to work in occupations where use of hands could be avoided (time in days): plaster cast 7 vs. functional cast 1 (p<0.05).	“Functionally treated patients returned to work faster than did patients in studies of nonimmobilization (Hunter and Cowen 1970, Arafa et al. 1986, Ford et al. 1989), perhaps because the short, but solid, bandage gave a feeling of security and provided pain relief.”	Data suggest functional cast group returned to work in 1/3 the time compared to plantar cast group. Functional casting reduced volar angulation by 2/3 in metacarpal shaft fractures and 1/3 in metacarpal neck fractures as compared to plantar cast group.

Evidence for the Use of Surgery for Malrotated Phalangeal Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: operative fixation, middle, proximal phalangeal, metacarpal fractures, metacarpal, neck fractures, boxer's fracture, shaft metacarpal fractures, transverse, oblique, spiral, comminuted; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 69 articles in PubMed, 90 in Scopus, 0 in CINAHL, 18 in Cochrane Library, 175 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, Cochrane Library, Google Scholar, and from other sources. Zero articles were included.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: operative fixation, metacarpal, metacarpal fractures, middle or proximal, phalangeal or boxer's, and bone fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies, closed reduction and bouquet pinning to find 91 articles. Of the 91 articles we considered for inclusion 2. Of the 2 considered for inclusion, 0 are randomized controlled trials and 2 systematic reviews.*

Evidence for the Use of Joint Mobilization for Acute Metacarpal Fractures

There are 3 moderate-quality RCTs incorporated into this analysis.(1296, 1297, 1315) (Kuokkanen 99; Statius Muller 03; Sletten 15)

Ice:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Ice, Compression, Elevation, Metacarpal, Middle, Proximal, Phalangeal, boxer's, Fractures, Bone; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 0 in Google Scholar and 0 in other sources. Zero articles met the inclusion criteria.

Joint mobilization:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Joint mobilization, early ambulation, Middle and Proximal Phalangeal and Metacarpal Fractures (fifth metacarpal neck fractures, boxer's fracture, shaft metacarpal fractures - transverse, oblique, spiral, comminuted) ;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 4 articles in PubMed, 56 in Scopus, 380 in CINAHL, 3 in Cochrane Library, and 3 in Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 1 from Cochrane Library and 1 from Google Scholar. Of the 4 articles considered for inclusion, 3 randomized trials and 1 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Kuokkanen 1999 No mention of sponsorship or COI.	5.5	N = 29 (26 males, 3 females) Patients treated for subcapital fractures of the fifth metacarpal bone. Mean age: 29 years.	Compression bandage for 1 week vs. splint immobilization (MCP 60° of flexion)	Angulation of fracture remained practically at same level compared with primary angulation in both groups. ROM of MCP (p = 0.02) and PIP (p = 0.01) joints higher in functional group at 4 weeks, but no difference at 3 months. Grip force was better in functional group at 4 weeks (p = 0.002).	“We suggest that at least subcapital fractures of the fifth MC that are modestly and slightly angulated should be treated functionally, without reduction and splinting. Based on the present findings the correction achieved by closed reduction does not persist...”	Small sample size. Patients in functional group had higher degree of pre- treatment angulation but still had equal or better functional outcomes in this population.
Stadius Muller 2003 RCT No mention of sponsorship or COI.	5.0	N= 40 (38 males, 2 females)with a fracture of the subcapital MC-V ≤ 3 days old and angulated ≤70°. Mean age 29 years.	Ulnar gutter plaster cast for 3 weeks followed by mobilization within pain limits (N=20) vs. 1 week of pressure bandage (N=20). Follow-up 6 and 12 weeks after fracture.	There were no significant differences between groups at 6 and 12 weeks follow-up.	“[A] pressure bandage for 1 week and immediate mobilization is a sufficient alternative treatment of a boxer’s fracture, if this is not angulated greater than 70° and not rotated.”	Small sample size. Data suggest comparable efficacy between groups.
Sletten 2015 RCT This work was supported by a grant from Sofies Mindes Ortopedi AS, Oslo, Norway. NO COI.	5.5	N = 85 patients with little finger metacarpal neck fractures with ≥ 30 ° palmar angulation in the lateral view. Mean age Conservative Group 29 (18– 67) and Operative group 25 (18–68)	Conservative group, received an initial plaster-of-Paris applied for pain for one week, then buddy strapping was applied over the proximal phalanges of the little and ring fingers, and the patients started active exercises. N = 43	For conservative vs. operative; QuickDASH (0 vs. 0 (p=0.54)), VAS overall Satisfaction (97 vs 100 (p=0.17)), TAM (°) (261 vs 260 (p=0.68)), Grip strength (kg) (49 vs 49 (p=0.78)),	“After 1 year, there were no statistical differences between the groups in QuickDASH score, pain, satisfaction, finger range of motion, grip strength, or quality of life. There was a trend versus better satisfaction with hand appearance (p = 0.06), but longer	Data suggest comparable efficacy between conservative treatment vs. bouquet pinning of little finger metacarpal neck fractures for pain, finger ROM, grip strength, and quality of life. However, there was better patient

		<p>Gender (M:F) Conservative group (39:4) Operative (39:3)</p>	<p>Operative Group underwent closed reduction and internal fixation by antegrade, intramedullary bouquet pinning then The postoperative regime. was identical to the conservative regime N = 42</p> <p>Follow up at at 1 week, 6 weeks, 3 months, and 1 year</p>		<p>sick leave ($p < 0.001$) and more complications ($p = 0.02$) in the operative group.”</p>	<p>satisfaction with hand appearance but longer sick leave in the surgical group.</p>
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Evidence for the Use of X-rays for Suspected Distal Forearm Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Distal Forearm Fracture, xray, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 22 articles in PubMed, 3 in Scopus, 24 in CINAHL, 0 Cochrane Library, and 11,100 from Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles were included.

Evidence for the Use of MRI for Diagnosing Distal Forearm Fractures

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: magnetic resonance imaging, MRI, distal forearm fracture, distal forearm fractures, colles' fracture, colles fracture, colles fractures, dinner fork deformity, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 19 articles in PubMed, 117 in Scopus, 1 in CINAHL, 4 in Cochrane Library, and 640 from Google Scholar. Zero articles met the inclusion criteria.

Evidence for the Use of CT for Diagnosis and Classification of Occult and Complex Distal Forearm Fractures

There are 3 quality studies incorporated into this analysis.(1327, 1330) (Johnstons 92; Harness 06; Avery 14)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: CT, CAT, computed tomography, distal, Forearm, radial, Radius fractures, bone Fractures, Colles' Fracture, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 302 articles in PubMed, 20 in Scopus, 3 in CINAHL, 16 Cochrane Library, and 20 from Google Scholar. We considered for inclusion 1 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 3 articles considered for inclusion 3 diagnostic studies met the inclusion criteria.

Author/Year Study Type	Score	Number	Area of Body	Diagnoses	Type of CT	X-ray used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Avery III 2014 Retrospective Study	5.5	17 sets of images No mention of how many patients, mean age, or gender.	Wrist	Distal Radial Fracture	GE LightSpeed VCT	+	-	+	+	-	-	-	-	CT and traction radiographs had the about the same ability to identify fracture fragments, except for the volar rim fragment. The volar rim was correctly identified 72% of the time on traction radiography compared to CT's 60% (p<0.01). CT correctly identified the radial column more often than traction radiographs (71.8% vs 65.8%, p=0.04)	"The information obtained from the traction radiographs compared with CT imaging showed little significant difference with regard to fracture fragment characterization and led surgeons to consistent treatment recommendations with both imaging modalities"	Small sample. Data suggest use of traction radiographs may be an alternative to CT imaging for diagnosing and assessing distal radial fractures.

Harness 2006 Retrospective	7.5	30 No mention of mean age, or gender	Wrist	Wrist Fracture	GE Advantage 3.1 Workstation	+	-	+	+	-	-	+	-	Pertaining to a coronal fracture line, 3D CT imaging resulted in a sensitivity of 0.82, a specificity of 0.50, and accuracy of 0.77. 2D CT imaging resulted in values of 0.81, 0.56, and 0.77, respectively. When combined, the two images had slightly better results: a sensitivity of 0.87, a specificity of 0.56, and an accuracy of 0.82.	“Three-dimensional computed tomography improves both the reliability and the accuracy of radiographic characterization of articular fractures of the distal part of the radius and influences treatment decisions”	Dats suggest use of 3-D CT for analyzing complex intra-articular distal radius fractures.
Johnstons 1992	5.5	22 Mean age = 31.5 13 men 9 women	Wrist/Hand	Acute distal radial and/or carpal injury	GE 9800 scanner	+	-	+	- (No mention)	-	-	-	-	Only 19 of the 22 patients had a radial distal fracture. 3 sets of plain film were interpreted as normal. However, a CT scan revealed that all three were fractures. CT scan enhanced the details of the fractures. In one case, a “innocent lip fracture” on plain film turned into an intra-articular compress of the scaphoid fossa on the CT.	“CT has an advantage over conventional tomography in lending itself to potential three-dimensional reconstruction.”	Data suggest CT visualizes more detail in evaluating acute distal radial fractures compared to plain radiographs.

Evidence for the Use of NSAIDs for Distal Forearm Fractures

There are 4 moderate-quality RCTs or prospective studies incorporated into this analysis.(1331-1334) (Thomas 86)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: anti-inflammatory agents, non-steroidal, NSAIDS, non-steroidal anti-inflammatory, ibuprofen, acetaminophen, distal, forearm, radial, radius, fractures, bone fractures, Colles' fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 13 articles in PubMed, 25 in Scopus, 0 in CINAHL, 18 in Cochrane Library, 5,993 in Google Scholar, and 3 from other sources. We considered for inclusion 4 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Davis 1988 Prospective study	7.0	N = 100 (gender not specified) with Colles' fractures. Average age for groups I and II; 55.7 and 64.1.	Group 1, 50mg flurbiprofen (f) (n = 53) vs. Group 2 or placebo (p) randomized after dividing into group 1 (displaced fracture requiring Bier's block and manipulative reduction) or group 2, no reduction (n = 45).	Mean grip strength (mmHg) Group 1 f/p: Week 2: 59/53, Week 6: 92/93, 1 year: 192/189. Mean grip strength (mmHg) Group 2 f/p: Week 2: 88/82, Week 6: 112/149, 1 year: 195/207. One-year assessment results (percentages) Group 1 f/p: patients who needed physiotherapy 11(45)/7(35), patients with residual pain 10(40)/9(45), patients with restricted activities 10(40)/7(35). 1-year assessment results (percentages) Group 2 f/p: who needed physiotherapy 5(27)/2(12), patients with residual pain 9(50)/3(19), patients with restricted activities 6(33)/2(12). Garland and Werley's functional assessment, 1 year, Group 1 excellent or good/total: f 19/24, p 18/20. Group 2 f 17/18, p 16/16.	"[F]lurbiprofen provides significant pain relief and does not significantly delay union of Colles' fractures."	Data suggest efficacy without delaying union.
Adolphson 1993 RCT Sponsored by a grant from Pfizer AB. No mention of COI.	6.0	N = 42 (42 female). Mean age and range 63 (52-79).	20mg a day per os piroxicam (Feldene®) for 8 weeks after initial 48 hours vs. 500mg paracetamol as rescue drug.	7% mean decrease in bone mineral content in radius after 8 weeks for piroxicam; 10% decrease in control (p = NS). Pain piroxicam/ placebo 10 days: 2.1/3.1, 4 weeks 1.0/2.5, 8 weeks 1.0/0.9 (p <0.05). Grip Strength piroxicam/ placebo 10 days/4 weeks 10/6, 8 weeks 32/26 (p = NS).	"The patients who received piroxicam had significantly less pain during plaster treatment, but there was no difference in the rate of functional recovery between the groups."	Study population limited to post-menopausal women affecting generalizability of results.
Barrington 1980 RCT Trials drugs were provided by the Pharmacy at the Royal Infirmary. No mention of COI.	4.5	N = 52 (47 female, 5 male) with pain due to Colles' fracture Mean age of 62.7 years.	5 days of either 500mg diflunisal (Dolobid®) BID or 500mg mefenamic acid (Ponstel®) TID.	"Both treatments were effective in relieving pain, night pain, and limitation of movement by pain, and there was no significant difference between the response in the two groups."	"No statistical significant differences in the effectiveness or tolerability between the two drugs." Authors suggest twice daily dosage may be regarded as an advantage for diflunisal treatment helping to ensure patient compliance.	Blinding mode unclear. Data suggest comparable efficacy.
Thomas 1986 RCT	5.0	N = 55 (21 males, 34 females) with	Normal treatment of fracture plus receiving three 50 mg tablets of diclofenac, a	Comparison of loss of total range of movement between diclofenac vs. placebo groups – Student's t test (0.05 < P < 0.1),	"Both subjective and objective tests of recovery at 2 weeks after removal of splintage following fractures of the distal end of the radius showed that those patients	Data suggest prostaglandin groups had improved ROM, a more rapid recovery stronger grip and less pain.

<p>No mention of sponsorship or COI.</p>		<p>fracture of distal end of radius, parallel to the wrist joint and with a tendency to dorsal displacement, treated in the normal way with no external skeletal fixation, fracture splinted in below-elbow plaster cast for between 4 to 6 weeks; mean age of both groups = 55 [no mean average listed for entire study population]</p>	<p>prostaglandin inhibitor, a day for seven days (N = 29, Men = 10, Women = 19) vs Normal treatment of fracture plus receiving three 50 mg placebo tablets a day for seven days (N = 26, Men = 11, Women = 15). Follow-up at two weeks after removal of cast</p>	<p>Patients' perception of pain between diclofenac vs. placebo groups – ratings from none (11 vs 6), improved (15 vs 17), no change (2 vs 2), worse (1 vs 1) – Chi squared (X2 = 1.44, 0.05 < P < 0.1), Patients' perception of stiffness between diclofenac vs. placebo groups – none (12 vs 3), improved (13 vs 20), no change (4 vs 3), worse (0 vs 0) – Chi squared (X2 = 6.88, 0.05 < P < 0.1) Comparison between diclofenac vs placebo groups on percentage loss of grip strength (Mann – Whitney U test, 0.02 < P < 0.05)</p>	<p>treated with a prostaglandin inhibitor recovered better than those who received placebo. This form of treatment may prove most valuable in patients who might otherwise be slow to recover or in whom a rapid recovery is especially desirable.”</p>	
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Evidence for Immobilization/Fixation for Non-displaced Colles' Fracture

There are 26 moderate-quality RCTs and 1 prospective study incorporated into this analysis.(106, 1231, 1335-1339, 1344-1348, 1350-1364) (Tumia 03; Bunker 84; Arora 11; Wik 09; Bong 06; Sarmiento 80; Gupta 91; Rosetzky 82; Wahlstrom 82; Uzzaman 08; Ismatullah 12) There are 2 low-quality RCT in Appendix .(1362, 1365) (Gupta 11)

Early Immobilization:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Early Immobilization & Mobilization & Colles' Fracture Or Distal Radial Fracture ;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 76 articles in PubMed, 30 in Scopus, 8 in CINAHL, 12,970 in Google Scholar, 18 in Cochrane Library, and 0 from other sources. We considered for inclusion 5 from PubMed, 5 from Scopus, 3 from CINAHL, 1 from Cochrane Library, 3 from Google Scholar, and 0 from other sources. Of the 17 articles considered for inclusion, 9 randomized trials and 8 systematic studies met the inclusion criteria.

Functional Bracing:A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Functional Bracing & Casting, Distal Radial Fractures or Colles' Fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed ? articles in PubMed, 4 in Scopus, 1 in CINAHL, 5 in Cochrane Library, 11,230 in Google Scholar, and 0 from other sources. We considered for inclusion 4 from PubMed, 1 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 7 articles considered for inclusion, 6 randomized trials and 1 systematic studies met the inclusion criteria.

Casting:A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Casting and Bracing and Colles' Fractures Or distal Radial Fractures; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed ? articles in PubMed, 35 in Scopus, 7 in CINAHL, 14 in Cochrane Library, 8830 in Google Scholar, and 0 from other sources. We considered for inclusion ? from PubMed, 17 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 4 from Google Scholar, and 0 from other sources. Of the 22 articles considered for inclusion, 18 randomized trials and 4 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Functional Bracing						
Moir 1995 RCT No mention of sponsorship or COI.	6.5	N = 85 (70 females/9 males) individuals with distal Colles' fracture; Median age. Group 1: 55 (22-86) Group 2: 60 (21-84)	Functional brace vs. control (dorsal plaster splint for 2 weeks followed by casting). Follow up at 10-14 days, 5-6 weeks, and 8, 13, and 26 weeks.	Functional score results; brace vs. control (lower score is better): 8 weeks 10 vs. 14 (p = 0.02); 13 weeks 4 vs. 11 (p = 0.003); 26 weeks 2 vs. 5 (p = 0.02). Grip strength as % of uninjured side: 8 weeks 50 vs. 35 (p = 0.0006); 26 weeks, 73 vs. 71 (p = 0.6). Analogue pain score (0-10); median: Splint removal 1 vs. 2 (p = 0.02); 8 weeks 1 vs. 2 (p = 0.048)	"The brace gave better functional results than conventional plaster treatment. The improved function was apparent up to 6 months after injury. Finger function and pinch strength were also better in the brace-treated patients. Anatomical results were similar in the two groups."	The brace-treated fractures were initially less severely displaced than control fractures. "The improved functional results, particularly in terms of pinch and grip strength, are particularly important in the group of elderly patients who live alone."
Stewart 1984 RCT No mention of sponsorship and COI.	5.0	N = 243 (No mention of Gender) patients with fractures of the distal radius; No mention of Mean age.	Conventional Colles' plaster vs. (Sarmiento) supinated cast-brace vs. below elbow cast-brace. Follow-Up at 6 weeks, and 3, 6 months.	Anatomical assessment excellent or good/total: plaster 45/93; supinated brace 43/70; short brace 43/72. Functional results mean score at 3 months/6 months: plaster 10.0/6.3; supinated brace 9.5/6.7; short brace 10.7/6.9. Incidence of carpal tunnel compression symptoms was 17% at 3 months and 12% at 6 months. No statistical significance between groups for incidence of symptoms.	"Early hand function and the supinated position advocated by Sarmiento were found to confer no anatomical or functional advantage; we could see no reason to change from the use of conventional plaster casts in the treatment of uncomplicated Colles' fractures."	Author suggests 4 indications for use of below-elbow cast brace: request by patient for complete freedom of movement of fingers and thumb; pre-existing finger stiffness or painful arthritis of carpometacarpal joint of thumb; the possibility that patient may develop Sudeck's osteodystrophy; and to all direct access to the hand for dressings in patients with soft-tissue injuries.
Tumia 2003 RCT No mention of sponsorship. One or more of the authors will receive or have received benefits for personal or	5.0	N = 339 (31 male and 139 female) categorized into minimally displaced and displaced requiring manipulation groups. Mean age of 58.4 years.	Conventional Colles' plaster cast (N = 163) vs Prefabricated functional brace or the Aberdeen Colles' fracture brace (N = 166). Follow-up for 14 weeks.	Functional scores cast/brace non-manipulated group Week 8: 6.7/5.5; Week 24: 2.6/2.7 manipulated group Week 8: 11.4/10.6; Week 24: 5.4/5.8. Mean pain score cast/brace non-manipulated group 10 d: 2.2/2.4 p = 0.27; Week 24: 1.0/1.0 p = 0.96; manipulated group 10 d: 1.8/2.1 p = 0.19; Week 24: 0.5/0.5 p = 0.043.	"There was no significant difference in the functional outcome between the two treatment groups."	Author comment on younger patients having better functional results not presented in body of study results. There appears to be no advantage to flexible brace over cast.

profession use from commercial party related directly or indirectly to the subject of this article.						
Bünger 1984 RCT Sponsored by the Danish Medical Research Council grant, and the Medical Research Council for the countries of Sonderjylland, Ribe and Ringkbing grant. No mention of COI.	4.5	N = 145 (20 male and 125 female) with Colles' fracture. Age not given.	Functional bracing in supination or FUSU (N = 68) vs Dorsal Plaster Immobilization or DPI (N = 77). Follow-up after 7 weeks and 3 months.	Primary treatment; DPI vs. FUSU: Anatomic end results (excellent/good)/total 65/72 vs. 59/64 (p <0.05). Functional results at 6 months (excellent/good)/total 62/72 vs. 59/62 (p <0.5)	"Functional bracing in supination provided superior results in the treatment of particularly displaced intra-articular Colles' fracture."	Suggests the functional benefit from FUSU is primarily secondary to decreased fracture redislocation.
Abbaszadegan 1989 RCT No mention of sponsorship or COI.	4.0	N = 80 (No mention of gender)"un-displaced or minimally displaced Colles' fractures"; No mention of mean age.	4 weeks in dorsal plaster cast vs. an elastic bandage. Follow up at 10-12 days, 1, 2, 3, and 6 months.	Follow up time: pain plaster cast/elastic bandage 11 d 4.7/4.0 (p = 0.09), 8 wk 3.2/1.8 (p ≤0.001), 1 year 1.9/1.3 (p = 0.06). Strength plaster/elastic 1 year 78/94 (p = 0.045). Lidstrom grading 1 year: plaster/total, elastic/total, Excellent 23/34, 31/34; Good 9/34, 3/34; Fair 2/34, 0/34. P <0.05	"Elastic bandage treatment resulted in less pain, improved grip strength and better subjective satisfaction at one year. It did not result in increased fracture displacement when compared to conventional plaster splints. Functional treatment of the minimally displaced Colles' fracture is recommended."	Applicable to non or minimally displaced fractures in mostly female population with mean age of 62 (19-81)
Early Immobilization						
Christensen 1995	5.5	N = 33 patients with undisplaced	Immobilizing plaster splints at either 3 or 5 weeks for undisplaced fractures.	Differences in modified median Gartland and Werley scores at 3, 9 months insignificant (3	No difference in "radiological healing at 3 months or in the functional scores after 3 and 9 months."	Early mobilization at 3 weeks appears to have no negative or positive impact on nondisplaced fractures.

RCT No mention of sponsorship or COI.		fractures of the distal radius; Mean Age 3 wk group : 61 (29-78). 5 wk group: 64 (40-84).	Follow Up for 3 months and 9 months.	weeks/5 weeks): Score-3 months 2.0/3-0; Score: 9 months 1.0/1.0.		
Davis 1987 RCT No mention of sponsorship or COI.	5.0	N = 55 (11 males/44 females) patients with slightly displaced fractures of the distal radius; Mean age, Group 1: 56.6 Group 2: 55.6	After 2-week period of posterior splinting, patients randomized to tubigrip vs. below elbow cast for 3 additional weeks. Follow-up at 2, 5, and 7 weeks.	No significant difference of pain between groups. Gartland and Werley's functional assessment (excellent or good) total: Week 5 cast 11/25; Week 5 tubigrip (tg) 23/27 p <0.05; Wk 7 cast 22/25 p <0.01, p <0.05; Week 7 tg 25/27 p <0.01. Complications of treatment cast/tg: Fracture displaced 3/2; Physiotherapy needed 3/1.	"Unnecessary to splint slightly displaced fracture of the distal radial metaphysis for 4 weeks... a faster functional recovery will be obtained [if fractures are in an unrestrained tubigrip support] in a manner that had been shown to be acceptable to most patients."	No blinding in this study.
Dias 1987 RCT No mention of sponsorship or COI.	5.0	N = 187 (no mention of gender) patients with unilateral Colles' fractures that were older than 55; No mean age.	Undisplaced fractures treated either with conventional 5 weeks cast (Group 1) or crêpe bandage (Group 2) and early mobilization. Displaced fractures were treated either with conventional 5 week cast (Group 3) or modified 5 week cast (Group 4). Follow-Up at weeks 1, 5, 9, and 13.	Early mobilization more resolution of wrist swelling first 5 weeks. At 9 and 13 weeks, wrist girth was similar. Deterioration rate of radiological deformity was similar in conventionally treated groups as with mobilization groups. Grip strength recovery expressed as a percentage of strength of contralateral hand much better in early mobilization groups. Undisplaced fractures Group 1/Group 2: Week 5 36.1/45.7 p <0.001; Week 9 51.7/63.5 p <0.005; Week 13 58.3/76.2 p <0.001. Displaced fractures Group 3/Group 4: Week 5 25.0/33.4 p = 0.016; Week 9 44.0/48.8 p = 0.215; Week 13 60.1/62.7 p = 0.540.	"Early wrist movement hastened functional recovery and led to earlier resolution of wrist swelling. Discomfort was no greater than in patients who were treated conventionally. The bony deformity, which recurred irrespective of the method of treatment, was not adversely affected by early mobilization."	This study includes weaknesses in randomization and baseline comparability.
Arora 2011 RCT	4.5	N = 73 (18 male and 55 female) with distal radial	Group 1, operative group that underwent Open reduction and internal fixation (ORIF) 12 weeks after injury	Disabilities of the Arm, Shoulder and Hand Score (DASH) at 6 weeks group 1 vs 2; 18.8±17.9 vs 34.4±22.5 (p =	"[H]owever, at twelve months after surgery, the active range of motion, the pain level, and the PRWE and the DASH scores were not different between the operative and nonoperative treatment groups."	Data suggest at 12 months, ROM, pain level and PRWE and DASH scores equivalent. Patients in surgical group

No sponsorship or COI.		fracture; mean age 76.7 (65-89).	(N = 36) vs Group 2, immobilized in short arm cast for 5 weeks (N = 37). Follow-up at baseline, 6, 12 weeks, 6 and 12 months.	0.00). At 12 weeks; 13.3±14.8 vs 23.2±19.3 (p = 0.02). Patient-Rated Wrist Evaluation (PRWE) group 1 vs 2, at 6 weeks; 36.4±28.7 vs 64.9±29.0 (p = 0.00), at 12 weeks; 33.7±32.0 vs 54.4±31.8 (p = 0.01). Grip Strength (kg) group 1 vs 2, 6 weeks; 14.1±10.7±5.6 (p = 0.01). At 12 weeks; 15.7±6.2 vs 2.5±4.4 (p = 0.02). At 6 months; 19.8±7.4 vs. 16.1±5.6 (p=0.02). At 12 months; 22.2±6.3 vs 18.8±5.8 (p = 0.02). Significantly more complications in operative group, 13 vs 5 (p<0.05).		reported better grip strength throughout trial.
McAuliffe 1987 Prospective RCT No mention of sponsorship or COI.	4.5	N = 108 (All Women) who had a Colles' fractures.	Plaster immobilization for 3 (Group A) or 5 (Group B) weeks. Follow Up baseline, 3 months, and 1 year.	72% of Group A reported good or excellent results relating to pain, disability, and range of movement at 3 months while 66% of Group B did; after 1 year 85% of Group A had a good or excellent result and 77 % did in Group B. Group A showed statistical significance for pronation after 1 year, less pain at time of plaster removal, 3 months and 1-year follow up as well as stronger grip strength after 1 year.	“Early mobilization produced less pain and a stronger grip. It did not lead to any greater loss of reduction of the fracture. However, there was no significant improvement in the final range of movement of the wrist.”	In this elderly population, mobilization after 3 weeks may lead to less short-term disability.
Millet 1995 Prospective Study No mention of sponsorship or COI.	4.0	N = 90 female with unilateral Colles' fracture; Mean age of 61 years.	5 week below elbow plaster cast (N = 45) vs 3 week plaster cast with 2 week flexible cast. Displaced fractures in both groups were manipulated. (N = 45). Patients followed for 3 years.	All patients in early mobilization reported greater comfort after switching from plaster to flexible casting. Mean grip scores and joint mobilities higher at all time points with early mobilization, reaching levels of statistical significance at 6, (p < 0.01) months for grip score and 3 months for joint mobility, (p = 0.04).	“Early mobilization is a satisfactory treatment option for Colles' fracture and may, in fact, hasten functional recovery.”	No significant clinical differences found between the treatment groups.

Stoffelen 1998 RCT No mention of sponsorship or COI.	4.0	N = 52	Plaster immobilization for 1 week vs. plaster immobilization for 3 weeks in minimally displaced fractures.	Functional Cooney score; 1 week (SD) vs. 3 weeks (SD): 6 weeks 61.6 (12.1) vs. 56.8 (19.7) 3 months 77.4 (13.8) vs. 71.5 (19.2); 1 year 86.8 (10.9) vs. 82.2 (18.6). One-week group Cooney score generally higher at every re-evaluation period than 3-week plaster group. Differences, however, not statistically significant.	“No dislocations occurred. All patients experienced eventful healing with good or excellent results in 92% of cases. We believe, therefore, that only minimal immobilization is required in these fractures and that they should be mobilized as soon as comfort allows.”	Higher number of complex regional pain syndrome (CRPS) cases in 3-week group than 1-week group (5 vs.1).
Casting/Bracing						
Wong 2010 Prospective RCT No mention of sponsorship or COI.	6.5	N=60 (Predominately female) elderly Chinese people with dorsal angulated fracture of the distal radius; Mean Age Group 1 71 (65-76) Group 2 70 (66-76)	Group 1 (N=30) Patients given plaster of Paris cast preceded by closed reduction. Vs Group 2 (N=30) Patients were treated with K-Wire Follow up at 2 weeks prior to injury and then 1, 2, 4, 6 weeks, 3, 6 months and 1 year after assessment of radiographs.	No statistically significant differences between the K-Wire treatment and the plaster of Paris group.	“Although our study showed that the ‘tripod technique’ [K-Wire] is safe without significant complications, there is an Cochrane review of wiring for distal radial fractures... We do not provide a biomechanical rationale to explain our ‘tripod technique’ but we feel that it is a better construct to prevent collapse of the fracture/”	Data suggest casting alone not better than pinning for extra-articular fractures of the distal radius in elderly Chinese (predominantly female) patients.
O’Connor 2003 RCT No mention of sponsorship or COI.	6.5	N = 66 (22 males/44 females) adult patients with minimally displaced radial fractures; Mean Age, Group 1: 56.6 (16-81). Group 2: 57 (18-79)	(N=32) Below-the-elbow plaster of Paris cast vs. (N=34) lightweight removable “Futuro” splint for minimally displaced Colles’ fractures; Follow-up at 1, 2, 6, and 12 weeks.	No significant differences in pain scores. Cast satisfaction higher in splint group at weeks 1, 2, and 6. No difference in anatomical outcome. Functional scores and wrist range of motion were better at 6 weeks, but the differences disappeared at 12 weeks.	“A lightweight splint provides an acceptable, comfortable and economic alternative to plaster of Paris and allows faster restoration of function without an increased risk of malunion.”	Patients in splint group were educated on rationale for splint use as authors found cultural bias toward the traditional cast.
Ledingham 1991	5.5	N = 60 (50 females/10 males);	(N=30) Plaster-of-Paris functional brace (brace)	Final radiological result; Brace vs. Control: Overall, brace group had better radiological results	“With the Plaster-of-Paris brace described in this paper, we have shown improved final radiological and early functional results compared to the standard below-elbow cast.”	Authors demonstrated in radiographic and functional grading that patients over 60

RCT No Mention of sponsorship or COI.		Mean Age- Group 1: 60.2. Group 2: 61.3.	vs. (N=30) Standard below-elbow cast (control). Follow-Up at baseline, 24 hrs, 7-14 days, and 35-42 days.	than control (lower score better) mean score 2.5 vs. 4.3 (p <0.05). No significant differences between <60-years-old brace and control or between brace under and over 60 years old. Significant difference in controls vs. under 60 years (12.7 vs. 4.4, p <0.005). Functional grading results (Excellent + Good) using modified Gartland and Werley significant difference of brace vs. control at 12 weeks, but not at 26 weeks.		years old may benefit the most, although sample sizes were small.
Grafstein 2010 RCT Sponsored through an unrestricted grant in aid from Smith & Nephew, manufacturers of both the splint and cast material used in this study. No COIs.	4.5	N = 101 (78 females/23 Males) with a displaced fracture of the distal radius requiring closed reduction.	Circumferential casting or CC (N = 40) vs Volar–dorsal splinting or VDS (N = 31) vs Modified sugar-tong splinting or MST (N = 30). Follow-up at 8 weeks and 6 months.	Median pain scores were not statistically different between the groups. 22 patients (22%, 95% CI: 13.9%–30.1%) had radiographic loss of reduction: VDS= 5 patients (16%, 95% CI 3.1%-28.9%), CC= 8 patients (20%, 95% CI: 7.6%–32.4%), and MST= 9 patients (30%, 95% CI: 13.6%–46.4%) (p = 0.17).	“Rates of loss in anatomic position were not statistically significant among the 3 types of dressings used. However, there was a clinically important trend of increased loss of reduction with the use of MST splinting.”	Sparse methods. Data suggest all three immobilization methods comparable as there was no statistically significant difference between groups.
Moroni 2004 RCT No mention of sponsorship or COI.	4.0	N=40 (All female) Osteoporotic patients who are 65 years of age or older; Mean Age >65 years old	Group 1 (N=??) Patients who received plaster cast eith closed reduction. Vs Group 2 (N=??) Received external fixation Follow up at 2 weeks, 6 weeks, and 3 months.	Redisplacements Group 1 vs Group 2; 4 vs 0. Volar Angle at post opgroup 1 vs group 2; 8.6±5.8 vs 3.4±1.8. At 6 weeks; -1.9±9.4 vs 1.9 ±3.4 (p<0.0005). Radials Angle at post op, group 1 vs 2; 20.6±4.9 vs 23.5±3.5. At 6 weeks, 17.1±6.3 vs 23.3±3.5 (p=0.008). Horesh Demerit Point Score at 3 months, Group 1 vs	“In conclusion, our study supports the use of external fixation in the treatment of osteoporotic wrist fractures. Both radiographic and clinical results were better in the external fixation group than in the plaster cast group.”	Study of elderly females with osteoporotic wrist fractures. Data suggest that external fixation is superior to casting as both the volar angle deformities and radial angle deformities were lowered.

				Group 1; 7.7±3.3 vs 6.6±3.4 (p<0.006).		
Cohen 1997 Prospective RCT No mention of sponsorship or COI.	4.0	N=30 (22 females/8 female) who had varying degrees of Radial distal fractures; Mean Age Group 1 56 (33-89) Group 2 58 (19-86)	Group 1 (N=10) Non displaced fractures, 5 fiberglass tape, 5 QuickCast tape. Vs Group 2 (N=10) (Displaced but stable after reduction fractures) 5 in QuickCast, 5 with fiberglass tape. Vs Group 3 (N=10) (Displaced fractures requiring Pin fixation) 5 with quick cast, 5 with fiberglass. Follow up at cast removal 5.5 weeks to 6.5 weeks	Number of cast Applications, Group 1, 2, and 3, Fiberglass vs QuickCast: Group 1; 2.2 vs 1.2, Group 2; 2.2 vs 1.0, Group 3; 3.0 vs 2.0. (p<0.001). Problems with cast answer (1-10) Fiberglass vs Quickcast: 1.0±0.8 vs 0.5±0.4 (p<0.001). Some cast complications within both groups, not significant.	“In sum, a short-arm cast constructed of the Quick-Cast does save approximately on cast change in the treatment of distal radius fractures with no apparent effect on fracture healing. The QuickCast does, however, cost more in materials alone. This financial differential must be weighed against the labor saved of a single cast application with additional savings of time for the applicator and patient.”	Small sample size, sparse methods. Data suggest Quick Cast eliminates approximately one cast change without compromise of fracture healing but Quick Cast is more costly.
Cohen 2001 RCT No mention of sponsorship or COI.	4.0	N=200 (No mention of gender) patients who sustained arm or leg injuries required cast support (N=29 individuals with Radial Distal fracture); Mean Age (no Mention?)	Group 1 (N=14) patients with Forced Rigidity Casting (FRC) Vs Group 2 (N=15) patients treated with Complete Plaster of Paris synthetic cast (Standard) Follow-Up while in the cast and after cast removal. No specific time frame stated.	Increase in Ability FRC vs Standard: favored group 1 (p=0.0002). Satisfaction better in FRC group (p=0.00009).	“The technique of focused rigidity casting can be recommended in the treatment of fractures of the fifth metatarsal and distal radius in preference to standard casts. Focused rigidity casting provides greater ability in the cast and patient satisfaction during treatment without loss of clinical effectiveness.”	Data suggest increased patient satisfaction with FRC vs. conventional plaster of Paris cast with comparable efficacy.
Wik 2009 RCT No mention of industry sponsorship.	4.0	(N=72) (all women) over the age of 50 who sustained low-energy trauma and a displaced Colles’ fractures	Reduction and a complete plaster cast (N=34) v. reduction and a dorsal plaster splint (N=38). Immobilization for 5 weeks with follow-up at 1 and 10 days and 5 weeks after reduction.	Mean dorsal angulation 10 days after reduction: slightly better in the dorsal plaster splint group, p=0.04. Radial length at 5 weeks was better in the complete plaster group, p=0.02.	“[S]urgeons caring for such cases may choose the immobilization method for the first 10 days following reduction according to their individual preferences and those of the injured person.”	Data suggest dorsal splinting 10 days after Colles’ fracture reductions resulted in a mean difference of 3.4 degrees of dorsal angulation but at 5 weeks, casting was better for a difference of 1.6 mm of radial length. Pain ratings between the two methods were comparable.

The authors declare no COI.		initially considered suitable for closed reduction and immobilization in a plaster cast.				
Bong 2006 Prospective RCT No sponsorship or COI.	4.0	N = 85 (85 fractures, 26 male and 59 female) who were used had acquired a displaced distal radial fracture; mean age 64 (27-91).	Group 1 immobilized using short-arm radial gutter splint (N = 38) vs Group 2 immobilized with sugar tong splint. Follow-up 7-10 days after initial injury (N = 47). Radiographs taken in respective splint.	No significant difference between loss of fracture reduction, volar tilt, radial height, radial inclination. Disabilities of the ARM, Shoulder, and Hand (DASH) scores, Group 1 vs group 1 at 1 week; 62±19 vs 70±15 (p=0.044).	“Based on our study we recommend that surgeons consider using a short-arm radial gutter splint for the initial immobilization of displaced distal radius fractures.”	Sparse baseline comparability details. Data suggest both long and short arm splints are effective in maintaining the reduction of distal radius fractures but the short arm splint was preferred by patients.
Sarmiento 1980 RCT No mention of sponsorship or COI.	4.0	N = 156 (50 male and 106 female) with Colles’ fractures. A median age of 49 years.	Bracing in either pronation, fractures were immobilized in a long-arm cast with the wrist at 20° of volar flexion and ulnar deviation; the elbow at 90° of flexion and the forearm in either pronation (N = 78) vs Supination the elbow at 90° of flexion and the forearm in supination (N = 78). Follow-up for 15 weeks.	In the Type II category, in the supinated fractures, there were 9 excellent, 4 good and no fair or poor results; in the pronated group, 9 excellent, 8 good and 1 fair result. In combining the results for all types of braced Colles’ fractures, (I-IV) 93% of the supination group and 87% of the pronation group achieved excellent or good functional results.	“Treatment with functional bracing in supination position yielded 90% excellent or good functional results.”	This paper is quoted in most subsequent research pertaining to bracing.
Gupta 1991 RCT No sponsorship. No mention of COI.	4.0	N = 204 (82 male and 122 female) with displaced Colles’ fractures. Mean age 46 years.	Plaster immobilization with either: Palmar flexion or PF (N = 60) vs Neutral or NP (N = 75) vs Dorsiflexion or DF wrist position (N = 69).	Functional results excellent or good/total: Type III PF 20/28; NP 26/34; DF 28/32 Type IV PF 10/17; NP 8/19; DF 15/17; Type V PF 9/15; NP 13/22; DF 16/20	“After manipulation of a Colles’ fracture, immobilization of the wrist in dorsiflexion would appear to provide better maintenance of reduction.”	Immobilization of wrist in palmar flexion had detrimental effect on hand function.

			Follow-up for 15 months.			
Rosetzsky 1982 RCT No mention of sponsorship or COI.	4.0	N = 46 (15 male and 35 female) with Colles' fractures of the forearm. Mean age was 45 years.	Polyurethane casts (N = unknown) vs Traditional plaster-of-Paris braces (N = unknown). Follow-up at 6 weeks.	No significant difference for secondary adjustment of casts between groups, (p > 0.90). No significant differences for failure of retaining fracture reduction, (p > 0.50).	"Polyurethane braces are a good supplement to plaster-of-Paris bandage in such fractures and recommended in selected cases."	Alternative to plaster of Paris in 1980s.
Wahlström 1982 RCT No mention of sponsorship or COI.	4.0	N = 42 (all women) with extra articular fractures. Mean age 65 years.	Immobilization in pronation (N = 14) vs Supination (N = 12) vs Midway position (N = 16). Follow-up at 10 days and 1-4 months after reduction.	Five fractures had to be re-reduced, one from pronation, one from midway and three from supination group. Patients with redislocation ≥10° number pronation 2/14, midway 6/12, and supination 8/16.	"The position of the forearm during immobilization is of importance for the degree of redislocation."	Applicable to cast application rather than long-term functional results.
Uzzaman 2008 RCT No mention of industry sponsorship or COI.	4.0	(N=40) (19 females/11 males) patients with displaced Colles fracture at the emergency of outpatient department within 7 days of injury.	Closed reduction and two crossed percutaneous Kirschner wire fixation combined with plaster cast support (Arm A, N=20) v. conventional method-reduction by closed manipulation and maintained by plaster cast immobilization (Arm B, N=20). Plaster was removed at week 6. K-wires were removed at 6-8 weeks. Rehabilitation was recommended until near or full functional recovery. Follow period was 6-14 months.	Anatomic end result of Arm A was better than Arm B, p<0.05. There was a significant Satisfactory result in Arm A compared Arm B, p<0.05.	"Closed reduction and Percutaneous kirschner wire fixation combined with plaster cast immobilization is better method than the conventional plaster cast immobilization – in restoration of preinjury anatomical alignment and there by the functional outcome – in the management of colles' fracture."	Data suggest percutaneous fixation group superior to cast alone group for maintaining radial length and angulation resulting in better function and also had less reported complications.
Ismatullah 2012 Prospective RCT	4.0	(N=30, 13 males/17 females) adult patients with a comminuted distal radius fracture;	Group 1 (N=15) Treated with plaster casting. Vs. Group 2	Green & O'Brien Criteria rankings, Group 1 v 2, 12 weeks; Group 1: 4 were excellent, 3 were good, 4 were fair, 4 were poor. Group 2: 5 were excellent, 6 good, 2 fair, and 2 poor.	"We recommend external fixation in comminuted fractures of the distal radius, which are potentially unstable fractures. It decreases the complications of re-displacement and shortening which may occur when these fractures are managed with closed reduction and casting."	Data suggest external fixation in comminuted distal radius fractures better than casting.

No mention of sponsorship or COI.		Mean Age 49.8 ±16.05	(N=15) Treated with external fixation. Follow-Up at baseline and 12 weeks.			
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Evidence for the Use of Closed Reduction Technique for Distal Radial Fractures

There are 4 moderate-quality RCTs incorporated into this analysis.(1341, 1366-1368)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: closed reduction technique, distal, forearm, radial, radius fractures, bone fractures, colles' fracture, displaced; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 14 articles in PubMed, 24 in Scopus, 13 in CINAHL, 0 in Cochrane Library, 19930 in Google Scholar, and 0 from other sources. We considered for inclusion 4 from PubMed, 0 from Scopus, CINAHL, Cochrane Library, Google Scholar, and from other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Earnshaw 2002 RCT No sponsorship or COI.	7.5	N = 225 (53 male and 172 female) displaced Colles-type fractures. Median age 65 years.	Closed reduction with either finger-trap (N = 112) vs Manual manipulation (N = 111). Follow-up for 5 weeks.	87% of fractures were successfully reduced. "By five weeks, fifty-six (25%) of the 225 fractures had been treated with surgical intervention because of failed closed treatment and only sixty-five (29%) remained in a satisfactory position."	"The two methods of fracture reduction did not differ with regard to the eventual position of the fracture or the rate of failure."	All reductions performed post Bier's block. Loss of reduction during the period of cast immobilization is common in this study.
Kongsholm J Orthop Trauma 1987 RCT No mention of sponsorship or COI.	5.5	N = 116 (6 male and 56 female) with acute displaced Colles' fracture. Mean age 61.6 years (range 35-86).	Group A dynamic reduction device with no anesthesia (N = 62) vs Group B 8-10ml of 1% lidocaine with plaster cast (N = 54). Follow-up for 12.8 months.	2/62 patients in Group A displayed symptoms and signs of neurological impairment at 5 weeks compared to 11/54 patients in Group B, p <0.01. 1 year follow up resulted in figures of 4/62 and 8/54 with, (p < 0.05).	"The dynamic reduction technique without local anesthesia results in a significantly lower frequency of neurological complication than manual reduction after injection of local anesthetic into the fracture hematoma."	The neurologic complications included subjective paresthesia, positive Tinel's sign or 2 point discrimination >4mm. Authors note "nerve damage" was mild and in no case in either group did it lead to surgical neurolysis.
Kelly 1997 RCT No mention of sponsorship or COI.	5.0	N = 30 (3 male and 27 female) with moderately displaced distal radial fractures. Mean age for Group 1 and 2: 75.4 ± 7.3 and 74.3 ± 7.3.	Group 1, reduction of the fracture under Bier's block (N = 15) vs Group 2, immobilized in dorsoradial plaster of Paris slab compared to plaster immobilization only in elderly population (N = 15). Follow-up at 3 and 5 weeks.	11/15 in Bier's block group and 9/15 in immobilization only group considered that their wrist was of normal appearance or had only slight deformity visible. Functional outcome Bier's block/ immobilization: Gartland and Werley score 5.8/6.6. Grip strength % predicted 48.8±17% / 55.8±19%.	"There was no detectable difference between the groups in any of the outcome measures."	Study suggests reduction does not provide any benefit over risk of Bier's block to the elderly population within the parameters of 30° of dorsal angulation and 5mm of radial shortening.

<p>Kongsholm Injury 1987</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>4.0</p>	<p>N = 116 (5 male and 49 female) with Colles' fractures. Mean age of 61.7 years.</p>	<p>Group A, dynamic bone alignment device compared without anesthesia to (N = 62) vs Group B, traditional manual reduction using local infiltration anesthesia (N = 54).</p> <p>Follow-up not clear.</p>	<p>No differences between the groups in “no pain” or “slight pain.” However, for severe pain Group B had 19 vs. 5 patients, (p <0.001).</p>	<p>“Dynamic reduction without anesthesia seems to be a less painful method for the patients than traditional manual reduction under local anesthesia.”</p>	<p>Study did not follow longitudinal results of reduction.</p>
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Evidence for the Use of Casting/Functional Bracing for Displaced Forearm Fractures

There are 10 moderate-quality RCTs or prospective studies incorporated into this analysis.(1339, 1354-1362) There is 1 low-quality RCT in Appendix 2.(1369)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: casting or functional bracing, displaced distal radial fracture, distal, forearm, radial, radius fractures, bone fractures, colles' fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 30 articles in PubMed, 13 in Scopus, 1 in CINAHL, 41 in Cochrane Library, 3174 in Google Scholar, and 7 from other sources. We considered for inclusion 4 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 7 from other sources. Of the 11 articles considered for inclusion, 11 randomized trials and 1 systematic studies met the inclusion criteria.

Author/ Year Study Type (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Casting or Functional Bracing						
Tumia 2003 RCT No mention of sponsorship. One or more of the authors will received or have received benefits for personal or profession use from commercial party related directly or indirectly to the subject of this article.	5.0	N = 339 (31 male and 139 female) categorized into minimally displaced and displaced requiring manipulation groups. Mean age of 58.4 years.	Conventional Colles' plaster cast (N = 163) vs Prefabricated functional brace or the Aberdeen Colles' fracture brace (N = 166). Follow-up for 14 weeks.	Functional scores cast/brace non-manipulated group Week 8: 6.7/5.5; Week 24: 2.6/2.7 manipulated group Week 8: 11.4/10.6; Week 24: 5.4/5.8. Mean pain score cast/brace non-manipulated group 10 d: 2.2/2.4 p = 0.27; Week 24: 1.0/1.0 p = 0.96; manipulated group 10 d: 1.8/2.1 p = 0.19; Week 24: 0.5/0.5 p = 0.043.	"There was no significant difference in the functional outcome between the two treatment groups."	Author comment on younger patients having better functional results not presented in body of study results. There appears to be no advantage to flexible brace over cast.
Arora 2011 RCT No sponsorship or COI.	4.5	N = 73 (18 male and 55 female) with distal radial fracture; mean age 76.7 (65-89).	Group 1, operative group that underwent Open reduction and internal fixation (ORIF) 12 weeks after injury (N = 36) vs Group 2, immobilized in short arm cast for 5 weeks (N = 37). Follow-up at baseline, 6, 12 weeks, 6 and 12 months.	Disabilities of the Arm, Shoulder and Hand Score (DASH) at 6 weeks group 1 vs 2; 18.8±17.9 vs 34.4±22.5 (p = 0.00). At 12 weeks; 13.3±14.8 vs 23.2±19.3 (p = 0.02). Patient-Rated Wrist Evaluation (PRWE) group 1 vs 2, at 6 weeks; 36.4±28.7 vs 64.9±29.0 (p = 0.00), at 12 weeks; 33.7±32.0 vs 54.4±31.8 (p = 0.01). Grip Strength (kg) group 1 vs 2, 6 weeks; 14.1±10.7±5.6 (p = 0.01). At 12 weeks; 15.7±6.2 vs 2.5±4.4 (p = 0.02). At 6 months; 19.8±7.4 vs. 16.1±5.6 (p=0.02). At 12 months; 22.2±6.3 vs 18.8±5.8 (p = 0.02). Significantly more complications in operative group, 13 vs 5 (p<0.05).	"[H]owever, at twelve months after surgery, the active range of motion, the pain level, and the PRWE and the DASH scores were not different between the operative and nonoperative treatment groups."	Data suggest at 12 months, ROM, pain level and PRWE and DASH scores equivalent. Patients in surgical group reported better grip strength throughout trial.
Bünger 1984 RCT Sponsored by the Danish Medical Research Council grant, and the Medical Research Council for the countries of Sonderjylland, Ribe and	4.5	N = 145 (20 male and 125 female) with Colles' fracture. Age not given.	Functional bracing in supination or FUSU (N = 68) vs Dorsal Plaster Immobilization orDPI (N = 77).	Primary treatment; DPI vs. FUSU: Anatomic end results (excellent/good)/total 65/72 vs. 59/64 (p <0.05). Functional results at 6 months (excellent/good)/total 62/72 vs. 59/62 (p <0.5)	"Functional bracing in supination provided superior results in the treatment of particularly displaced intra-articular Colles' fracture."	Suggests the functional benefit from FUSU is primarily secondary to decreased fracture redislocation.

Ringkbing grant. No mention of COI.			Follow-up after 7 weeks and 3 months.			
Wik 2009 RCT No mention of sponsorship. No COI.	4.0	N = 72 females who sustained low-energy trauma and displaced Colles' fractures initially suitable for closed reduction and immobilization in plaster cast. Age >50.	Reduction and a complete plaster cast (N = 34) vs Reduction and dorsal plaster splint (N = 38). Immobilization for 5 weeks with follow-up at 1 and 10 days and 5 weeks after reduction.	Mean dorsal angulation 10 days after reduction: slightly better in the dorsal plaster splint group, (p = 0.04). Radial length at 5 weeks was better in the complete plaster group, (p = 0.02).	"[S]urgeons caring for such cases may choose the immobilization method for the first 10 days following reduction according to their individual preferences and those of the injured person."	Data suggest dorsal splinting 10 days after Colles' fracture reductions resulted in a mean difference of n3.4 degrees of dorsal angulation but at 5 weeks, casting was better for a difference of 1.6 mm of radial length. Pain ratings between the two methods were comparable.
Bong 2006 Prospective RCT No sponsorship or COI.	4.0	N = 85 (85 fractures, 26 male and 59 female) who were used had acquired a displaced distal radial fracture; mean age 64 (27-91).	Group 1 immobilized using short-arm radial gutter splint (N = 38) vs Group 2 immobilized with sugar tong splint. Follow-up 7-10 days after initial injury (N = 47). Radiographs taken in respective splint.	No significant difference between loss of fracture reduction, volar tilt, radial height, radial inclination. Disabilities of the ARM, Shoulder, and Hand (DASH) scores, Group 1 vs group 1 at 1 week; 62±19 vs 70±15 (p=0.044).	"Based on our study we recommend that surgeons consider using a short-arm radial gutter splint for the initial immobilization of displaced distal radius fractures."	Sparse baseline comparability details. Data suggest both long and short arm splints are effective in maintaining the reduction of distal radius fractures but the short arm splint was preferred by patients.
Millet 1995 Prospective Study No mention of sponsorship or COI.	4.0	N = 90 female with unilateral Colles' fracture. Mean age of 61 years.	5 week below elbow plaster cast (N = 45) vs 3 week plaster cast with 2 week flexible cast. Displaced fractures in both groups were manipulated. (N = 45). Patients followed for 3 years.	All patients in early mobilization reported greater comfort after switching from plaster to flexible casting. Mean grip scores and joint mobilities higher at all time points with early mobilization, reaching levels of statistical significance at 6, (p < 0.01) months for grip score and 3 months for joint mobility, (p = 0.04).	"Early mobilization is a satisfactory treatment option for Colles' fracture and may, in fact, hasten functional recovery."	No significant clinical differences found between the treatment groups.
Rosetzsky 1982 RCT No mention of sponsorship or COI.	4.0	N = 46 (15 male and 35 female) with Colles' fractures of the forearm. Mean age was 45 years.	Polyurethane casts (N = unknown) vs Traditional plaster-of-Paris braces (N = unknown). Follow-up at 6 weeks.	No significant difference for secondary adjustment of casts between groups, (p > 0.90). No significant differences for failure of retaining fracture reduction, (p > 0.50).	"Polyurethane braces are a good supplement to plaster-of-Paris bandage in such fractures and recommended in selected cases."	Alternative to plaster of Paris in 1980s.

<p>Sarmiento 1980</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>4.0</p>	<p>N = 156 (50 male and 106 female) with Colles' fractures. A median age of 49 years.</p>	<p>Bracing in either pronation, fractures were immobilized in a long-arm cast with the wrist at 20" of volar flexion and ulnar deviation; the elbow at 90" of flexion and the forearm in either pronation (N = 78) vs Supination the elbow at 90" of flexion and the forearm in supination (N = 78).</p> <p>Follow-up for 15 weeks.</p>	<p>In the Type II category, in the supinated fractures, there were 9 excellent, 4 good and no fair or poor results; in the pronated group, 9 excellent, 8 good and 1 fair result. In combining the results for all types of braced Colles' fractures, (I-IV) 93% of the supination group and 87% of the pronation group achieved excellent or good functional results.</p>	<p>"Treatment with functional bracing in supination position yielded 90% excellent or good functional results."</p>	<p>This paper is quoted in most subsequent research pertaining to bracing.</p>
<p>Gupta 1991</p> <p>RCT</p> <p>No sponsorship. No mention of COI.</p>	<p>4.0</p>	<p>N = 204 (82 male and 122 female) with displaced Colles' fractures. Mean age 46 years.</p>	<p>Plaster immobilization with either: Palmar flexion or PF (N = 60) vs Neutral or NP (N = 75) vs Dorsiflexion or DF wrist position (N = 69).</p> <p>Follow-up for 15 months.</p>	<p>Functional results excellent or good/total: Type III PF 20/28; NP 26/34; DF 28/32 Type IV PF 10/17; NP 8/19; DF 15/17; Type V PF 9/15; NP 13/22; DF 16/20</p>	<p>"After manipulation of a Colles' fracture, immobilization of the wrist in dorsiflexion would appear to provide better maintenance of reduction."</p>	<p>Immobilization of wrist in palmar flexion had detrimental effect on hand function.</p>
<p>Wahlström 1982</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>4.0</p>	<p>N = 42 with extra articular fractures. Mean age 65 years.</p>	<p>Immobilization in pronation (N = 14) vs Supination (N = 12) vs Midway position (N = 16).</p> <p>Follow-up at 10 days and 1-4 months after reduction.</p>	<p>Five fractures had to be re-reduced, one from pronation, one from midway and three from supination group. Patients with redislocation $\geq 10^\circ$ number pronation 2/14, midway 6/12, and supination 8/16.</p>	<p>"The position of the forearm during immobilization is of importance for the degree of redislocation."</p>	<p>Applicable to cast application rather than long-term functional results.</p>

Evidence for Reduction Analgesia for Displaced Distal Forearm Fractures

There is 1 high-(1373) and 7 moderate-quality(1366, 1367, 1370-1372, 1374, 1375) (Fathi 15) RCTs incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: reduction analgesia, bier block, analgesia, hematoma block analgesia, dynamic reduction, distal, forearm, radial, radius fractures, bone fractures, Colles' fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 11 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 100 in Google Scholar, and 3 from other sources. We considered for inclusion 3 from PubMed, 1 from Scopus, 0 from CINAHL, Cochrane Library, and from Google Scholar, and 4 from other sources. Of the 8 articles considered for inclusion, 8 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Singh 1992 RCT No mention of sponsorship or COI.	9.0	N = 66 (46 male and 20 female) with Colles' fracture. Mean age groups A and B; 36±16 and 39±15.	Group A, received 30mg pentazocine with 5mg diazepam (N = 33) vs 20cc or 20cc of 1.5% Xylocaine (N = 33). Follow-up for 15 hours.	"The pain scores during reduction in the local anesthetic group were markedly lower (mean 2.7, median 1.8) than the scores in the sedation group (mean 8.2, median 8.7), p < 0.001."	"Hematoma block by local anesthetic is a safe and effective alternative to sedation in reduction of Colles fracture."	Patients receiving local anesthesia had lower pain and quicker reductions than those receiving sedation.
Kendall 1997 RCT No mention of sponsorship or COI.	5.5	N = 142 (17 male and 125 female) with Colles' fracture. Mean age for Bier's block and Haematoma groups: 65 and 6 years.	Bier's block (N = 72) vs Haematoma block with either alkalinized non-alkalinized local anesthetic (N = 70). Follow-up not specified.	Mean pain scores Bier's block/hematoma: administration of anesthetic 2.8/5.3 p <0.001; manipulation of fracture 1.5/3.0 p <0.01. Alkalinized vs. non-alkalinized hematoma block alkalinized/non-alkalinized: median pain score on administration 4.4/5.9 p = 0.08; median pain score on manipulation 3.5/3.0 p = NS. More remanipulations in hematoma block (17/ 70) than Bier's block (4/72) (p = 0.003).	"Bier's block is superior to hematoma block in terms of efficacy, radiological result, and remanipulation rate."	Trend to decreased pain with alkalinized v non-alkalinized group but did not reach significance.
Kongsholm J Orthop Trauma 1987	5.5	N = 116 (6 male and 56 female) with acute displaced Colles' fracture. Mean age 61.6 years.	Group A, dynamic reduction device with no anesthesia (N = 62) vs	2/62 in Group A displayed symptoms and signs of neurological impairment at 5 weeks vs. 11/54 in Group B, p	"The dynamic reduction technique without local anesthesia results in a significantly lower	Neurologic complications included subjective paresthesia, positive Tinel's sign or 2 point discrimination > 4mm. Authors

RCT No mention of sponsorship or COI.			Group B, 8 to 10ml of 1% lidocaine with plaster cast (N = 54). Follow-up for 1 year.	</0.01. 1 year follow up resulted in figures of 4/62 and 8/54 with p <0.05.	frequency of neurological complication than manual reduction after injection of local anesthetic into the fracture hematoma.” authors speculate “that the mechanism for such nerve damage is scarring and fibrosis in the vicinity of the nerves, which is secondary to elevated pressure in the tissues probably caused by the increased volume load due to the injection.”	note that “nerve damage was mild and in no case in either group did it lead to surgical neurolysis.”
Haasio 1990 RCT No mention of sponsorship or COI.	4.5	N = 35 (gender not specified) with fresh Colles’ fractures. Mean age 62 ± 3 years.	Group 1, or conduction block cubital nerve, 15 ml of 10 mg/ml prilocaine used (N = 16) vs Group 2, hematoma block, 15 ml of 10 mg/ml prilocaine (N = 19). Follow-up at 5, 10, and 20 minutes after the injection.	44% (7/16) in Conduction group and 68% (13/19) in hematoma block were painless. Difference between study groups with respect to pain not statistically significant.	“Neither of the block techniques for the manipulation of Colles' fracture can be regarded as ideal because of the considerable number of patients feeling pain during the maneuver.”	Lack of blinding. Prilocaine used in both interventions.
Abbasza-degan Acta Orthop Scand 1990;61:348-9 RCT No mention of sponsorship or COI.	4.0	N = 99 (11 male and 88 female) with displaced Colles’ fractures. Mean age of 64 years.	Fractures reduced with local anesthesia (L) of 15 to 20ml prilocaine (N = 49) vs Compared to 3mg prilocaine/kg regional intravenous block (N = 50). Follow-up after 6 months.	Pain and strength as percentage of the uninjured wrist R/L: Pain initially 1/2.5 p = 0.002; 8 weeks 3/3/ p = 0.7; 24 weeks 0/2 p = 0.005. Strength initially not measured; 8 weeks 25/18 p = 0.2; 24 weeks 65/53 p = 0.01.	“Patients treated with regional intravenous block had less pain during the manipulation of the fracture and better grip strength at the 6-month follow-up. The anatomic end result (dorsal angulation) was better after regional anesthesia.”	Authors noted study did not support findings of neurologic complications from local anesthesia as reported by Kongsholm.
Kongsholm Injury 1987 RCT No mention of sponsorship or COI.	4.0	N = 116 (11 male and 110 female) with an acute displaced Colles’ fracture. Mean age 61.6 years.	Group A dynamic bone alignment device compared without anesthesia (N = 62) vs Group B traditional manual reduction using local infiltration anesthesia (N = 54). Follow-up at 5 weeks and 1 year.	No differences between the groups in “no pain” or “slight pain.” However, for severe pain, Group B had 19 vs. 5 patients, (p < 0.001).	“Dynamic reduction without anesthesia seems to be a less painful method for the patients than traditional manual reduction under local anesthesia. The reduction with the dynamic and manual methods is similar.”	Study did not follow longitudinal results of reduction.

<p>Cobb 1985</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>4.0</p>	<p>N = 100 with Colles' fractures. Aged over 15 years.</p>	<p>Bier's block, fracture was manipulated 10 minutes after injection (N = 44) vs Local infiltration, fracture was manipulated 10 minutes after injection (N = 56).</p> <p>Follow-up for 20 minutes.</p>	<p>"Pain scores during manipulation were higher for patients receiving local infiltration vs. Bier block (mean 5.53/10 vs. 3.67/10, P, 0.003). No difference was noticed in the period of postoperative painlessness between the groups: Bier's block 3-7 (3-0) hours; local infiltration 4-0 (3-0) hours."</p>	<p>Despite findings, author states "For patients with fresh Colles' fracture local anesthetic infiltration was more popular among accident service staff (table), giving satisfactory anesthesia, being simpler and quicker to perform, and avoiding risks of a large intravenous dose of local anesthetic agent reaching the general circulation."</p>	<p>Paper highlights difference in staff perception (thought local was better) vs. patient's own perception (preferred Bier's).</p>
<p>NEW Fathi 2015</p> <p>RCT</p> <p>No mention of sponsorship. No COI.</p>	<p>5.0</p>	<p>N = 143 (76 male and 67 female) with distal radial fracture. Mean age for PSA and US-HB groups: 41.1(15.3) / 38.9 (14.7).</p>	<p>Procedural sedation and analgesia or PSA group, received 0.05 mg/kg midazolam, plus 2 mcg/kg fentanyl (N = 72) vs Ultrasound-guided haematoma block or US-HB group, sterile injection of 10-15 cc 1% lidocaine (N = 7).</p> <p>Follow-up for 1 week after manipulation.</p>	<p>Pain numeric rating scale before / 5 / 10 / and 15 minutes after treatment: p = 0.98 / 0.84 / 0.19 / 0.01 / and 0.07. Overall mean time of reduction-to-discharge 131.85 (±46.45) minutes with a minimum of 60 and a maximum of 300 minutes. Time-to-discharge in the PSA and US-HB groups: 142.15 (±34.05) and 121.39 (±54.60) minutes, respectively. Time-to-discharge was significantly lower in the US-HB group, (p = 0.007).</p>	<p>"Ultrasound guided haematoma block may be a safe and effective method in distal radial fracture reduction pain control, especially during overcrowded shifts when close patient monitoring during intravenous PSA is not optimally possible."</p>	<p>Data suggest comparable efficacy in both groups but time to discharge was lower in US group.</p>

Evidence for the Use of Electromagnetic Fields for Distal Radial Fractures

There are 3 moderate-quality RCTs incorporated with this analysis.(1376-1378) (Cheing 05; Lazovic 12)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Electromagnetic field therapy, electromagnetic therapy, PEMFT, Pulsed electromagnetic field therapy, magnetic therapy, magnet therapy, distal, Forearm, radial, Radius Fractures, bone Fractures, Colles' Fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 60 in Scopus, 0 in CINAHL, 14 in Cochrane Library, 100 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 2

from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 3 articles considered for inclusion, 3 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Wahlström 1984 RCT No mention of sponsorship or COI.	5.5	N = 30 Mean age of 60.9 years old. 30 Females, 0 Males	Electromagnetic fields of extremely low frequency (N = 15) – Received treatment vs. Control (N = 15) – Did not receive treatment	Scintimetric exam treated group/ control group: Week 1: 23.9±6.4/ 18.5±6.5 p <0.05; Week 4: 44.6±13.6/ 41.6±15.0.	“The clinical relevance of the results is not known, but one interpretation of the data is that the stimulation with EMF of ELF improves (accelerates) the early phase of fracture healing. The data warrant further investigation of fresh fracture treatment with this method.”	Magnitude of differences disappeared at 4 weeks, thus importance of results unclear.

<p>Cheing 2005</p> <p>RTC</p> <p>No mention of sponsorship of COI.</p>	<p>5.0</p>	<p>N = 83 patients diagnosed with stable distal radius fracture(s).</p> <p>Mean age = 63.1</p> <p>55 Women 28 Men</p>	<p>Group A (N=23) Ice plus PEMF 30 min of ice plus PEMF</p> <p>vs</p> <p>Group B (N=22) Ice plus sham PEMF 30 min of ice plus sham PEMF</p> <p>Vs</p> <p>Group C (N=22) PEMF. No ice. PEMF alone</p> <p>Vs</p> <p>Group D, Control (N=16) Sham PEMF. No Ice. Sham PEMF alone.</p> <p>All treatment were done for 5 consecutive days</p> <p>Visual analogue scale pain scores, volumetric measurements and ROM were measured on days 1, 3, and 5.</p>	<p>VAS: The VAS score on day 1 was ranging from low to medium. On day 3, there was no significant drops between the groups. But the sham PEMF with no ice had the least amount of reduction. On day 5, the score for Ice plus PEMF was significantly higher than the other three groups.</p> <p>Volumetric Measurement: Day one, baseline, measurements were comparable between the groups. On day 3, the sham PEMF and no ice group decreased less than the others. Day 5 revealed that Ice plus PEMF was better than the PEMF/no ice and sham PEMF/ no ice group. Also the ice/sham PEMF group was better than the shame PEFM/no ice group.</p> <p>ROM: Flexion improved significantly in the two PEMF (ice/no ice) group compared to the sham PEMF on day 3. Day 5 yielded similar results, but the differences was not significant. Pronation</p>	<p>“The addition of pulsed electromagnetic field to ice therapy produces better overall treatment outcomes than ice alone, or pulsed electromagnetic field alone in pain reduction and range of joint motion in ulnar deviation and flexion for a distal radius fracture after an immobilization period of 6 weeks”</p>	<p>Data suggest pain was significantly reduced via VAS as well as ulnar ROM deviation with the addition of PEMF to ice or PEMF alone compared to sham groups.</p>
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				was the exact opposite. The difference between day 1 and 3 were not significant. But the difference between day 3 and 5 were.		
Lazovic 2012 RTC No mention of sponsorship or COI	4.0	N = 60 women who sustained unilateral extra-articular displaced stable DRF	PEMF Group (N=30) PEMF therapy 5 days a week for 2 weeks Vs Control Group (N=30)	PEMF yielded better mean results for edema, pain, and function scores compared to the control. However, only the edema score was significant (p=0.000). PEMF resulted in	“During immobilization PEMF therapy in DRF patients gave better results immediately after cast removal in terms of edema and wrist range of motion (ROM).”	Some baseline differences between groups which could cause PEMF group to show worse outcomes. PEMF group was older. Data suggest PEMF for distal radius fracture beneficial for increased ROM and decreased edema post cast removal.

	<p>Mean age PEMF = 67.90 ± 5.56</p> <p>Mean age Control = 64.50 ± 6.02</p> <p>60 women 0 men</p>	<p>No therapy</p> <p>Follow up at 2-3 days after removal of cast.</p>	<p>significant values, when comparing ROM to the control, for flexion (p=0.003), extension (p=0.009) and supination (0.004). Other ROM values were high in the PEMF group except for radial deviation.</p>		
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Evidence for the Use of Physical or Occupational Therapy for Colles' Fracture

There are 8 moderate-quality RCTs incorporated into this analysis.(1379, 1380, 1383-1388) (Wakefield 00; Kay 00; Filipova 15; Valdes 05; Magnus 13; Kay 08) There are 2 low-quality RCTs and one other study (1342, 1381, 1382) in Appendix 2.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Education, Cast removal, Colles' Fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 64 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: physical therapy, occupational therapy distal, Forearm, radial, Radius Fractures, bone Fractures, Colles' Fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 4 articles in PubMed, 5 in Scopus, 2 in CINAHL, 1 in Cochrane Library, 79 in Google Scholar, and 1 from other sources. We considered for inclusion 4 from PubMed, 2 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 6 articles considered for inclusion, 4 randomized trials and 2 systematic studies met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Exercise; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 21 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 146 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 2 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Watt 2000 RCT No mention of COI or sponsorship	4.0	N = 18 patients with Colles' Fractures; mean age physiotherapy group 74.4, Non physiotherapy group 77.3; Gender (M:F) 1:17	Physiotherapy vs. non-physiotherapy following cast removal. Follow up at six weeks after cast removal	Clinical significant increase in wrist extension and grip strength after 6 weeks physiotherapy (passive joint mobilization).	"Routine referral of Colles' fracture patients to physiotherapy following cast removal is beneficial."	Small sample size, no blinding, no long term outcomes measures.
Christensen 2001 RCT No mention of COI or Sponsorship	5.0	N = 30 with distal radius colles' type fracture; mean age 66 years; Gender (M:F) 3:27	Home exercise instructions for shoulder, elbow, wrist and fingers with and without occupational therapy.	No statistical significance between groups in dorsal angulation, radial angulation, axial radial length, or functional scores.	"For non-surgically treated patients with a distal radius fracture only instructions are necessary."	No blinding or control of compliance.
Wakefield 2000 RCT No COI or Sponsorship	6.5	N = 96 patients over the age of 55 with a distal radius fracture treated with immobilization in plaster; mean age 72 (55-90). Gender (M:F); 9:87	Group 1 which was taught and given home exercises by a physiotherapist in a fracture clinic and referred to a course of physiotherapy (N = 49) vs Group 2 which was instructed in home exercises only (N=47). Follow-up at plaster cast removal, three months, and six months.	Mean difference (95% CI) for group 1 vs. group 2 at 6 months. Flexion/Extension: 12.2 (5.4 to 19.2), (p =0.001). All data (collected at 3months and 6months) comparing JAMAR grip strength, Pronation/Supination, Radial/Ulnar Deviation, and Functional Scores were not statistically significant.	"Home exercises are adequate rehabilitation after uncomplicated fracture of the distal radius, and routine referral for a course of physiotherapy should be discouraged."	Data suggest home exercises for uncomplicated fractures are beneficial.
Kay 2000 RCT No mention of sponsorship or COI	4.5	N = 39 patients with fractures involving the distal radius, and after removal of pins and/or cast. ; mean age for non-mobilisation group 51.6, mobilization group 54.7. Gender (M:F); 12:27	Non-mobilisation group received advice and home exercises from a physiotherapist. (N = 20) vs Mobilisation group received advice, home exercises, and a six week course of passive mobilisation. (N = 19)	Mean difference (95% CI) for non-mobilisation group vs mobilisation group at initial, three weeks, six weeks: Flexion : (-0.6 , -5.0, -1.3), (p = 0.02). All data collected comparing extension, flexion, radial deviation, ulnar deviation,	" This study found that passive mobilisation did not add to the effectiveness of a regimen of advice and exercise for patients following fractures involving the distal radius managed with pins and/or plaster casts. "	Data suggest comparable efficacy

			Follow-up at initial appointment, three weeks, and six weeks.	pronation, supination, web space, thumb motion scale, and grip strength were not statistically significant.		
Filipova 2015 RCT No COI or sponsorship	4.0	N = 61 patients who were treated conservatively for distal radius fracture; mean age 60 ; Gender (M:F) 14:47	Group A received 9 PT sessions consisting of 20min galvanic baths, and 30 min individual kinesiotherapy. (N = 31) vs Group B received 9 combined therapy sessions. 30 minutes FOT combined with the same PT program as group A. (N = 30) Follow-up at first week of cast removal (T1) , immediately after the end of rehabilitation (T2, 8-12 weeks after fracture) and 1 month after completion of rehabilitation (T3, 12-16 weeks after fracture)	Rehabilitation outcomes p values for a two-way (Time and Therapy) mixed ANOVA Time was statistically significant (p < 0.001) for all outcomes; wrist flexion, forearm rotation, hand grip strength, DASH. Therapy was statically significant for grip strength (p = 0.038) Interaction effect was significant for rotation (p = 0.034), grip strength (p = 0.021) Grip strength was statistically different among group B vs Group A comparing time periods T3:T1 (67% vs 53% (CI 95%)), (p = 0.024)	“The combined therapy resulted in a statistically significant increase of grip strength in comparison with isolated physical therapy in the period of 12–16 weeks after the fracture. This effectiveness was not confirmed with DASH score results.”	Data suggest significant increased grip strength with combination therapy in conservatively treated distal radial fracture patients.
Valdes 2015 RCT No sponsorship or COI	4.5	N = 50 patients with DRF and underwent volar plate fixation; Mean age Therapy group (28-81) Non therapy (23-92); Gender (M:F) 8:42	Therapy group received instruction from a standard pictorial home exercise program (HEP) and therapy with certified hand therapists. 2visits/wk for 16 visits N = 26 Non therapy group received standard pictorial HEP N = 24 Follow-up at 2,4,6,8, 12 for secondary outcomes and 6 months for primary outcomes	No statistically significant differences between scores of PRWHE, wrist/forearm motion, pain or grip strength between groups.	“Supervised clinic-based therapy is equally beneficial for patients without complications. Clinic-based therapy may be preferable for patients with noteworthy complications after a distal radius fracture with volar plate fixation.”	Data suggest no difference between groups.
Exercise						
Magnus 2013 RCT Sponsored by Royal	4.0	N = 51 women with unilateral DRF; Mean Age Training group 63.3 ± 10 Control group 62.7 ± 10.2	Training group received strength training in non-fractured arm during casting and through follow up and standard clinical rehabilitation (N = 27) vs	Fracture hand strength Training vs control at 12wks (17.3± 7.4 kg vs 11.8 ± 5.8kg (p < 0.017)) No significant differences in strength at 9, 12 or 26 wks.	“Strength training for the nonfractured limb after a distal radius fracture was associated with improved strength and ROM in the fractured limb at 12 weeks postfracture. These results	All subjects were female. Data suggest at 12 weeks, strength training for non-fractured extremity after distal radius fracture was associated with improved strength and ROM.

University Hospital Grant NO COI		Gender (M:F) 0:51	Control group, received standard clinical rehabilitation (N = 24). Follow-up at week 1, 3, 6, 9, 12, 26	Fractured hand ROM training vs control group at 12 weeks (100.5 ± 19.2 vs 80.2 ± 18.7 (p < 0.017)) Not significant differences in ROM at 9 , 12, 26 weeks No significant differences in patient rated wrist questionnaires at week 9 or 26.	have important implications for rehabilitation strategies after unilateral injuries.”	
Kay 2008 RCT Sponsored by RAH Allied Health Research Grant No mention of COI	6.5	N = 56 patients with DRF managed with pins and/or a cast; Mean age Experimental group 55 control group 55.8 Gender (M:F) 17:39	Experimental group received a physiotherapist directed program of advice and exercise. (N = 28) vs. Control group who did not receive any physiotherapy intervention. Follow-up at three and six weeks	No significant difference found between groups comparing wrist extension, ROM or strength.	“An advice and exercise program provided some benefits over no intervention for adults following distal radius fracture.”	Data suggests that passive mobilization does not seem to add any benefit for distal radial fractures as both groups showed comparable efficacy.

Evidence for Surgery for Displaced Distal Forearm Fractures

There are 39 moderate-quality RCTs or prospective studies incorporated into this analysis.(1343, 1354, 1389-1424) (Rozenal 09; Foldhazy 10; Grewal 05; Grewal 11; Karantana 13; Kreder 05; Cassidy 03; Jeyam 02; Krishnan 03; Leung 08; Wei 09; Atroshi 06; Arora 11; Abramo 09; Egol 08)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: **Bone Cement** / Distal Forearm Fractures & Colles’ Fractures ;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 12 in Scopus, 2 in CINAHL, 0 in Cochrane Library, and 6037 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 2 randomized trials and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: bone cement, distal, fractures, bone, forearm, radius, radial, “colles” fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.*

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: **Cast Immobilization / Distal Forearm Fractures & Colles' Fractures**; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 5 in Scopus, 1 in CINAHL, and 2 in Cochrane Library, 6558 from Google Scholar, and 2 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 2 from other sources. Of the 5 articles considered for inclusion, 5 randomized trials and 0 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: cast immobilization, distal, fractures, bone, forearm, radius, radial, "colles" fracture.; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 190 articles. Of the 190 articles we considered for inclusion 27. Of the 27 considered for inclusion, 13 are randomized controlled trials and 14 systematic reviews.*

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: **Closed Reduction / Distal Forearm Fractures & Colles' Fractures**; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 10 in Scopus, 2 in CINAHL, and 4 in Cochrane Library, 15380 from Google Scholar. We considered for inclusion 0 from PubMed, 3 from Scopus, 0 from CINAHL, 2 from Cochrane Library, 8 from Google Scholar, and 0 from other sources. Of the 13 articles considered for inclusion, 6 randomized trials and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: closed reduction, distal, fractures, bone, forearm, radius, radial, "colles" fracture.; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 162 articles. Of the 162 articles we considered for inclusion 4. Of the 4 considered for inclusion, 4 are randomized controlled trials and 0 systematic reviews.*

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: **Medullary Pinning / Distal Forearm Fractures & Colles' Fractures**; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, and 0 in Cochrane Library, 2175 from Google Scholar, and 5 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 2 articles considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: medullary pinning, distal, fractures, bone, forearm, radius, radial, "colles" fracture.; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 5 articles. Zero articles met the inclusion criteria.*

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: **Open Reduction / Distal Forearm Fractures, Colles' Fracture**; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 6 in Scopus, 2 in CINAHL, and 2 in Cochrane Library, 5425 from Google Scholar, and 10 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 1 from CINAHL, 1 from Cochrane Library, 3 from Google Scholar, and 3 from other sources. Of the 9 articles considered for inclusion, 7 randomized trials and 2 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: open reduction, internal fixation, distal, fractures, bone, forearm, radius, radial, “colles” fracture.; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 325 articles. Of the 325 articles we considered for inclusion 10. Of the 10 considered for inclusion, 7 are randomized controlled trials and 3 systematic reviews.*

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: **Triangular Fibrocartilage Complex Repair (TFCC) / Distal Forearm Fractures & Colles’ Fractures**; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 968 from Google Scholar, and 0 in other sources. Zero articles met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: triangular fibrocartilage complex, distal, fractures, bone, forearm, radius, radial, “colles” fracture; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 5 articles. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
External Fixation vs. Casting										
Kreder 2006 (score=7.5)	External Fixation/Casting	RCT	Sponsored by a grant from the Orthopaedic Research and Education Fundation. No mention of COI.	N = 113 skeletally mature with distal radius fractures.	Mean age: 52.9 years; 39 males, 74 females	Closed reduction casting (n = 59) vs. Closed reduction and external fixation (n = 54).	Follow-up for 2 years.	No statistically significant differences in functional, clinical, or radiographic outcomes found; 19 patients in external fixator group had additional percutaneous pin fixation; 5 patients initially randomized to cast group actually received external fixations within 3 weeks of surgery (within 2 weeks of initiating cast treatment) because their fractures displaced or acceptable closed reduction could not be achieved (n = 5; 8.5%).	“For distal radius fractures with metaphysical displacement but with a congruous joint, there exists a trend for better functional, clinical, and radiographic outcomes when treated by immediate external fixation and optional K-wire fixation.”	Author notes to achieve statistically significant results, a sample of n = 600 would be necessary. “...simply not enough patients or resources to definitively answer this functional question.”
McQueen 1996 (score=6.0)	External Fixation/Casting	RCT	No sponsorship or COI.	N = 120 patients with unstable fractures of distal radius	Mean age: 63 years; 13 males, 107 females	Closed re-reduction with forearm cast (Group 1) vs. Open reduction and bone grafting (Group 2) vs. Closed re-reduction and application of Pennig external fixator (Group 3) vs. Closed re-reduction and	Follow up at 6 weeks and one year.	Mean dorsal angulation correction better in open reduction and grafting group (Group 2) vs. control and external fixation groups at 6 weeks and 1 year. Groups 3 and 4 better than control, but no statistical difference between fixation and fixation	“Functional results at 6 weeks, 3 and 6 months, and at one year showed no difference between any of the four groups despite anatomical disparity. The main influence on final outcome was carpal	Despite differences in the final anatomical appearance of the distal radius, the incidence of carpal malalignment was similar in all groups. Authors state correction of palmar tilt is most important to reduce carpal

						application of Pennig external fixator, but at three weeks the ball joint was released to allow wrist movement (Group 4).		with early mobilization. Mean mass grip strength as a percentage of normal side showed sequential improvement, but no statistical analyses done. Carpal malalignment had a significant association with diminished recovery of strength of mass grip (p = 0.02), chuck grip (p = 0.02) and key grip (p = 0.05) after 1 year. Similar association with recovery of range of rotation at 3 months (p = 0.005), 6 months (p = 0.002) and 1 year (p = 0.01). After 1 year radial shortening had a significant negative association with recovery of chuck (p 0.005), key (p = 0.01) and pinch (p = 0.001) grip strengths.	malalignment which had statistically significant negative effect on function.”	malalignment. The four techniques in the study are equivocal in this study for improving palmar tilt.
Abramo 2009 (score=5.5)	Internal Fixation/External Fixation/Cast	RCT	Sponsored by Region Skane, Lund University Hospital, the Swedish Medical Research Council, Alfred Osterlund	N=50 patients with unstable of comminute distal radius fractures	Mean Age 48 years; 14 males, 36 females	Group 1 (n=25) who were treated with Open reduction and internal fixation Vs Group 2 (n=25) who were treated with closed reduction	Follow up at 2, 5, and 7 weeks, and 3, 6, and 12 months.	Grip strength (% vs uninjured arm), group 1 vs 2, 7 weeks; 47% vs 34% (p=0.01). Forearm rotation (deg), group 1 vs 2, 7 weeks; 129 vs 104 (p=0.006). Grip	“[T]he two methods we compared will both give a good result with good DASH values, good grip strength, and good range of motion	At 1 year, data suggest internal fixation group had better ROM, grip strength and fewer malunions than external fixation group.

			foundation, the Great and Johan Kock Foundation, Maggie Stephens Foundation, Thure Carlsson Foundation, faculty of Medicine at Lund University. No mention of COI.			and external fixation.		strength (% vs uninjured arm), group 1 vs 2, 1 year; 90 vs 78 (p=0.03). Forearm rotation (deg), group 1 vs 2, 7 weeks; 149 vs 136 (p=0.03). No significant differences found between groups in regards to DASH scores. Patients with moderate-heavy manual work had more days at home in group 2 vs group 1, (p=0.04).	after a year. Overall, considering the subjective and objective results as well as the rate of major complications and the sick-leave, we believe that internal fixation gives a superior result and in our opinion it would be the method of choice;”	
Jenkins 1987 (score=6.0)	External Fixation/Casting	RCT	No mention of sponsorship or COI.	N = 58 patients with a displaced Colles’ fracture	No mention of mean age (17-59 years); no mention of sex.	Forearm plaster (n=26) vs. external fixator (n=32) in patients with displaced Colles’ fractures.	Follow-up at 4, 8, and 16 weeks.	Mean loss of position significantly worse for plaster vs. fixator in dorsal angle 10.5° v 0.1° (p <0.01), radial angle 6.5° vs. 0.7° (p <0.01), radial length 3.7 vs. 0.3° (p <0.01). Using a positional grading scale to rate changes between post-manipulation and union, 22 of 24 in plaster group had good or excellent post-manipulation, falling to 12 of 24 at union. In fixator group, no decrease, as all 30/32 with good or excellent post-manipulation	“The external fixator proved more effective at holding the manipulated position, and the radiological loss of position during fracture union was minimal compared with that seen in patients treated in plaster.”	External fixation is more effective than plaster in radiological scoring. There were no measurements of function in this study.

								patients remained at 30 of 32.		
Abbaszadegan 1990 (score=5.0)	External Fixation/Casting	RCT	No mention of sponsorship or COI.	N = 47 with severely displaced Colles' fractures types 3 and 4	Mean age: 63 years; 11 males, 36 females	Prospective 1-year study of plaster cast or primary external fixation.	Follow up at 4, 8, 12, and 24 weeks, and 1 year.	Follow-up according to pain and subjective function: Pain cast/fixation (VAS 0-10); 8 weeks 3/2 (p = 0.04); 12 weeks 2/1 (p = 0.1); 24 weeks 2/0.5 (p = 0.009); 1 year 1/0 (p = 0.0002). Function cast/fixation (VAS 0-10); 8 weeks 5/7 (p = 0.1); 12 weeks 7/7 (p = 0.7); 24 weeks 8/9 (p = 0.1); 1 year 9/10 (p = 0.02). Functional outcome excellent or good/total: Plaster 12/19; Fixation 19/22.	"Primary external fixation for severely malpositioned Colles' fractures might lead to a better radiographic and functional end result than conventional plaster-cast treatment."	5 fractures in plaster cast group redislocated after 11 days, and re-reduction and external fixation were required, with 3/5 reporting good or excellent results.
Merchan 1992 (score=5.0)	External Fixation/Casting	RCT	No mention of sponsorship or COI.	N = 70 with comminuted intra-articular fractures of the distal radius of types III to VIII;	Mean age: 36 years; 58 males, 12 females	Closed reduction and forearm plaster (n=35) vs. application of a Clyburn dynamic external fixator (n=35)	Follow up at 1, 3, and 7 weeks	"Significant loss of position occurred in 27 (77%) of the plaster group at the 7-day examination... Patients stabilized with an external fixator had maintained their reduced position." In fixator group, 54.3% had excellent reduction, 34.3% good reduction, 8.7% fair	"It does appear that a good anatomic position combined with early rehabilitation of wrist function produces very favorable functional results in patients under 45 years of age."	Study labeled as double blind; however, only an independent assessor could be blinded which was not well described.

								reduction and 2.7 poor reduction compared to plaster group where 37.2% had excellent reduction, 17.2% had good reduction, 34.2% had fair reduction, and 11.4% had poor reduction. 4 occurrences of pin tract infection were found, however they were superficial and responded to treatment by cleansing and antibiotics. 3 encounters of pin loosening occurred. Reflex sympathetic dystrophy did not develop with Clyburn fixator however, severe Sudeck's atrophy developed in 2 plaster-treated patients.		
Stein 1990 (score=5.0)	External Fixation/Casting	RCT	No mention of sponsorship or COI.	N = 126 with distal radius fracture	Mean age: 55.4 years; no mention of sex.	Fixation with above-the-elbow cast immobilization (n=80) vs. external fixation (n=40)	Follow up at 1, 2, 4, and 6 weeks, then at 6 months and 4 years.	Patients categorized on 4 grade severity scale based on deformity, dorsal angulation, and shortening. Garland and Werley	"Extraarticular fractures of the distal radius should be treated with cast immobilization. Comminuted	Study randomizes by day of admission and apparently resulted in a 72:1 ratio of allocations to

								objective and subjective results showed 71 of 88 Grade I, II cast group had excellent or good results. In types II, IV fracture, external fixation had better scores 36 of 40 vs. 15 of 22 (p <0.001).	intraarticular fractures of the distal radius should be treated with external fixation, which maintains accurate anatomic position until solid fracture healing is achieved.”	casting and a randomization failure.
Pring 1988 (score=4.5)	External Fixation/Casting	RCT	No mention of sponsorship or COI.	N = 75 patients with Colles’ fractures	Mean age: 61.7 years; 14 males, 61 females	Forearm cast alone (n=39) vs. bipolar fixation of displaced fracture (n=36)	Follow up at 1, 2, 5, and 12 weeks and 6 months	Mean percentage grip cast/Bipolar: 7 weeks 28.5/21.6, 12 weeks 46.2/48.5, 6 months 63.8/67.6. “Nine fractures treated with plaster alone redisplaced and required manipulation. No patient initially treated with bipolar fixation required remanipulation. Functional results at 6 months did not reach statistical significance.”	“A good final position (functional position) is desirable, even in the elderly; that bipolar fixation provides a method of achieving this, and that it is applicable to all but open fractures of the distal radius.”	Conclusions are based on trend and not statistical significance.
Lagerström 1999 (score=4.5)	External Fixation/Casting	RCT	Sponsored by County Council of Uppsala, and the Trygg-Hansa Foundation Fund, Stockholm, Sweden. No mention of COI.	N = 33 patients with displaced Colles’ fracture involving the distal radio-ulnar joint	Mean age: 58.3±8.4 years; 5 males, 28 females	Plaster cast (P-group) (n=16) vs. external fixation using AO External Fixator® (E-group) (n=12) vs. secondary fixator group (PE Group).	Follow up at 2 years	Differences between uninjured and injured sides; P-group vs. E-group in Maximum Voluntary Contraction (MVC) (Newtons) (Higher difference is weaker); 6 weeks: 190.7*** SD = 49.0 vs. 206.7 *** SD = 77.5; 10 weeks: 126.4** SD = 48.8	“For injured side patients with plaster casts showed significantly higher MVC (stronger) than patients with primary external fixation on day immobilization device removed until between 18 weeks and 1 year	Author suggests slower rates for MCV recovery as basis for early intervention with physiotherapy, particularly in the external fixation and secondary external fixation groups.

								vs. 155.6** SD = 59.6; 52 weeks: 32.6 SD = 38.1 vs. 34.2* SD = 35.0. *p<0.05; **p<0.01; ***p<0.001	when groups equalized. Patients that failed casting and had external fixation had slower recovery trends.”	
Jenkins 1988 (score=4.0)	External Fixation/Casting	RCT	No mention of sponsorship or COI.	N = 106 who had sustained a Colles’ fracture sufficiently displaced to require manipulative reduction	Mean age: 37.0 years; no mention of sex.	Forearm plaster (n=47) vs. external fixator in patients (n=59) (AO/ASIF minifixator)	Follow up at baseline, 1 week, 4 weeks, 3 months, and 12 months.	Comparison of excellent and good outcomes/total: Subjective: external fixator 44/59, plaster 32/41. Objective external fixator 57/59, objective 40/41. Fixator group had much greater proportion of excellent than the plaster group. At 12 months, the plaster group had significantly reduced grip strength than externally fixated group (93.9% SD±9.4% vs. 84.1% ± 19.6 (p = 0.05).	“The wrist’s immobilization does nothing to retard its early recovery. External fixation of these fractures is indicated solely for the purpose of improving long-term function by virtue of the improved anatomy that the treatment affords, and for this reason methods of treatment that permit early wrist mobilization at the possible expense of the anatomical position are not justified.”	Study accounted for grip strength in dominant vs. non-dominant contralateral comparisons.
Howard 1989 (score=4.0)	External Fixation/Casting	RCT	No sponsorship or COI.	N = 50 patients with severely displaced comminuted Colles’ Fractures;	No mention of mean age or sex.	Plaster with fracture manipulated under Bier’s block and supported by molded below-elbow plaster backslab vs. external fixation with 2 pairs self	Follow up at 3 and 6 months	For overall anatomical result, 14/25 fixator cases graded excellent compared with 2/25 plaster treated cases (p <0.001). No significant differences in functional results when combining	“External fixation produces significantly better anatomical results than plaster in severely displaced comminuted Colles’ fractures and a significant	Most other studies reviewed reported functional results as excellent and good combined (considered satisfactory).

						tapping 2.0mm Hoffman pins inserted into radius, proximal to line of crossing of radial nerve.		excellent or good outcome/total: 3 months Plaster 12/25, External fixation 14/25 6 months plaster 18/25, External fixation 19/25. However, a significant difference in excellent only at 6 months. 16/25 vs. 9/25 (p <0.05).	improvement in function.”	
Young 2003 (score=4.0)	External Fixation/Casting	Prospective Study	No mention of sponsorship or COI.	N = 125 with dorsally angulated fractures of the distal radius;	Mean age: 57.5 years; 28 males, 97 females	Group 1: primary bridging external fixation (n=36) vs. Group 2: manipulation of the fracture with dorsal plaster slab converted to below-elbow plaster cast at 1 week (n=49)	Follow up at 6 weeks, 3, 6, and 12 months	At 7-year follow-up, 17 died, 22 lost to follow-up, leaving 86. “There were no difference between groups for ranges of flexion, extension, pronation, supination and ulnar and radial deviation or grip strength.” Gartland and Werley scores similar with 34/36 of external fixation group and 47/49 of casting group reporting excellent or good scores. Residual wrist pain low with no differences between groups. Patients showing arthritic changes ext. fix n = 11/36, cast n = 9/49 not significant. Incidence of 14% reported for occurrence of	“Radiographic result after distal radial fracture is significantly better if patients are treated by external fixation rather than by plaster immobilization. However, after 7 years, the outcome measures that the patient notices, such as range of movement and function, are no different between the two treatment methods.”	High dropout rate at long-term follow-up.

								radiological post-traumatic arthritis following intra-articular fractures.		
Roumen 1991 (score=4.0)	External Fixation/Casting	RCT	No sponsorship or COI.	N = 101 with displaced Colles' fracture;	Mean Age 70.1 years; 8 males, 93 females	External fixator or conventional cast treatment (control) in patients that failed manipulation and splinting after 2 weeks vs. primary group that did not fail initial treatment (p).	Follow up at 26 weeks	Elderly patients with displaced Colles' fractures treated with initial reduction and plaster backslab. At Week 1 and 2, patients with dorsal angulation >10° or radial shortening >5mm re-manipulated and held by external fixator or conventional cast treatment. Anatomical results excellent or good outcome/total: primary 44/58, external fixator 16/21, control 0/22. Functional end-result excellent or good outcome/total: Primary 41/58, External fixator 12/21, control 19/22. No clear correlation between final anatomical result and functional result (Spearman coefficient 0.18, p >0.05).	"External fixation is not indicated for the treatment of redisplacement of a Colles' fracture in an elderly patient. Even severe secondary displacement can be accepted."	No correlation between anatomic and functional outcomes in elderly patients.
K-Wire										
Egol 2008 (score=7.0)	K-Wire	Prospective Randomized Trial	No sponsorship or COI.	N=88 patients with a distal radius	Mean Age Group 1: 49.9 (18-78).	Group 1: (n=38) patients that received	Follow up at 2 and 6 weeks, and	The mean DASH score in any of the intervals. For all	"None of the improvements was associated	Data suggest similar efficacy between groups

				fracture that needed operative repair	Group 2: 52.2 (19-87); 41 males, 47 females	external fixation and supplementary K-Wire fixation Vs Group 2 (n=39) who were treated with volar plating.)	at 3, 6, and 12 months.	parameters, as a percentage of the injured side, the range of movement was better in internally-fixed group; pronation (p<0.001), supination (p=0.05), extension (p=0.05), radial deviation (p=0.002), reached statistical difference at 3 months. Similar complications.	with a better outcome. Furthermore, while the number of complications between the two methods was similar, there was a greater incidence for re-operation in the plating group. Despite this finding, our study showed no evidence for the superiority of one treatment over the other.”	but less re-operations were required in the external fixation group.
Allain 1999 (score=7.0)	K-Wire Fixation	RCT	No mention of sponsorship or COI.	N = 60 with dorsally displaced extra-articular or non-comminuted intra-articular fractures of distal radius after trans-styloid K-wire fixation.	Mean age: 75 years; 15 males, 45 females	Postoperative immobilization for 1 week (Group 1) (n=30) vs 6 weeks (Group 2) (n=30)	Follow up at 1 and 6 weeks, 45 days and 1 year	Patients followed at 1-year post-op. One reflex sympathetic dystrophy in Group 1, none in Group 2. Ulnar deviation statistically significant (p = 0.03) after early mobilization (mean difference between normal and impaired wrist). No significant differences in grip strength, (25 kg in Group 1 and 21 kg in Group 2), sick leave, functional discomfort, or outcome satisfaction.	“Addition of plaster cast immobilization of wrist after trans-styloid fixation with two K-wires, in Colles’ fractures may not be necessary if styloid fragment large enough to allow good K-wire fixation, as well as if fracture does not consist of more than 2 articular fragments.”	No differences found in radiographic outcomes between groups.
Grewal 2011 (score=5.5)	K-Wire/Internal and	RCT	No sponsorship or COI.	N=50 Patients with fractures	Mean age: 55.9 years;	Group 1 (n=26) patients treated with open	Follow up at baseline, 6 weeks,	Group 1 scored 11 points lower on Patient-Rated Wrist	“[O]ur trial suggests that ORIF (Group 1)	Data suggest ORIF group better than

	External Fixation			of the distal radius	12 males, 38 females	reduction and internal fixation. Vs Group 2 (n=24) patients with external fixation procedures.	and 3, 6, and 12 months.	Evaluation (PRWE) throughout whole study, except at 12 months (p=0.03). Group 1 vs 2 (specifically Volar locking plates) had significantly lower PRWE scores at baseline (p=0.03) and 6 weeks (p=0.06). No difference in radiological parameters, range of motion, grip strength, and complications.	provides a short-term advantage over external fixation, but these differences do not persist over time. Our results are viewed with caution, given that the ORIF group also reported lower pain and disability at the initial preoperative assessment and because the trial had a small sample size.”	external fixation in short term but at 1 year, the results equalize among groups.
Kreder 2005 (score=5.0)	Internal Fixation/K-Wire	RCT	Sponsored by a Grant from the Orthopaedic Research and Education Foundation, Orthopaedic Trauma Association and Sunnybrook Trust Fund. No mention of COI.	N=179 skeletally mature patients with displaced intra-articular fractures of the distal radius;	Mean Age Group 1: 40 (20-78). Group 2: 39 (20-81); 109 males, 70 females	Group 1 (n=88) patients treated with Closed reduction and K-Wire Fixation Vs Group 2 (n=91) Patients treated with open reduction and internal fixation.	Follow up at 6 weeks, 12 and 24 months.	Patients in group 1 had better function overall, scoring a mean of 6 points (95% CI: 4.1-33.0) in Musculoskeletal Functional Assessment (MFA). Pain scores were better overall for group 1 (p=0.052) NS. MFA, group 1 vs 2, 6 months; 15.1 vs 37.9 Difference: -12.8 (95% CI: -23.7 - -1.9). Grip Strength, group 1 vs 2, improved throughout study by 10.1 lb (p=0.05).	“[W]e recommend that open reduction be preceded by an attempt at minimally invasive percutaneous reduction. If an acceptable reduction is achieved then open reduction is unnecessary and function will be superior.”	Significant loss to follow up. Data suggest that at 2 years of the intra-articular step and gap were minimized, the indirect reduction and percutaneous fixation group had a quicker return of function with better functional outcomes.
Jeyam 2002 (score=4.0)	K-Wire/Bone Cement	RCT	No mention of sponsorship. COI: One of the	N=21 with distal radial Melone	Mean age Group 1: 74. Group 2: 71;	(N=9) fracture was stabilized by K-wire using	Follow-Up at 1 day, and 1, 2, 3,	Group 2, 1 week all three radiological parameters had	“The results of this small study clearly indicate	Data suggest that at 12 and 26 weeks, the

			authors was supported by funding from Orthofix PLC.	fractures type 1 and 2;	0 males, 21 females	intrafocal technique, then casted for 4 weeks. (Group 1) vs (N=9) fracture site was cleaned and injected with Orthofix Bone source bone cement (Group 2).	6, 12, and 26 weeks.	deteriorated. Group 1 Vs 2, dorsal angle at 1 week, -7 (-19-6) and 6 (-5-15) (p<0.05) remained significant throughout the entire study. Radial angle worse in group 2, not significant. Group 1 vs Group 2, Grip strength at 6 months: 11 (6-17) vs 8 (4-10) (p<0.03).	that hydroxyapatite cement (Bonesource) does not provide adequate fracture stability when used alone.”	hydroxyapatite group performed worse on grip strength, palmar flexion and dorsal flexion. There were no outcome measures where this group performed better.
Grewal 2005 (score=4.0)	K-Wire/External Fixation/Internal Fixation	Prospective Randomized Trial	Sponsored by award from Zimmer Canada. No COI.	N=62 with AO type C intra-articular distal radius fractures	Mean age: 45.5 years; 33 males, 29 females	Group 1 (n=29) were treated with Open reduction and internal fixation Vs Group 2 (n=33) were treated by mini open reduction with percutaneous K-Wire fixation.	Follow up at 2, 4, 6, 10-12 weeks, 6 months, and 1, 2 years.	Complication Rate, Group 1 vs 2; 72.4% vs 24.2% (p=0.004). Grip Strength (% vs uninjured arm), group 1 vs 2, 86% vs 97% (p=0.019). Range of motion not significantly different. Radiographic outcomes not statistically different. Pain scores (DASH), group 1 vs 2, at 1 year; 22.1 vs 10.0 (p=0.02). After hardware taken out in some of the group 1 patients pain scores equalized at 2 years.	“Although dorsal Pi plates still may have a role in treating intra-articular distal radius fractures we have shown that mini open reduction with percutaneous K-wire and external fixation is a technique that provides a safe and effective alternative to open reduction and dorsal Pi plating when treating comminuted intra-articular distal radius fractures.”	Data suggest comparable efficacy between groups with the dorsal plate groups having greater numbers of complications.
Strohm 2004 (score=4.0)	Kirschner Wire	RCT	No sponsorship or COI.	N = 100 patients with Colles-type	Mean Age: 65 years; 15 males, 85 females	Kirschner wire osteosynthesis via Kapanndji procedure vs.	Follow up from 6-20 months	Martini scores; Kapandji vs. Willenegger. Average 4 (range,	Conventional Kirschner wire fixation remains good method of	Study intervention included both different fixation

				fracture of distal radius;		Willenegger procedure.		16-38 points) vs. 28 (range, 11-36 points) (p <0.005). Difference in the modified Martini score between the treatment group was found for type-A2 (p = 1.004) and A3 (p = 0.007) fractures but not for type-C1 fractures (p = 0.6).	osteosynthesis for treating displaced fractures of distal part of radius. "We found both the functional and radiographic outcomes of the Kapandji method to be significantly better than those of the Willenegger technique."	and different length of casting. Follow-up times differ among patients.
Kapoor 2000 (score=4.0)	K-Wire Fixation	RCT	No mention of sponsorship or COI.	N = 90 adult cases of acute displaced intra-articular fractures of the distal end of the radius;	Mean age 39 years; no mention of sex.	Closed reduction and plaster immobilization vs. external fixation (Roger and Anderson type) vs. Open reduction and external fixation (Kirschner wires, small T plates or both) in patients with displaced intra-articular fractures.	Follow up at 4 years	Final functional assessment (%); Plaster vs. Fixator vs. Open reduction: Good and excellent 43 vs. 80 vs. 63. Fair and poor 57 vs. 20 vs. 37. Average loss of arc with plaster 37° in comparison with 19° by external fixator. Average grip strength (in comparison with normal side) in groups was fixator 70%, open reduction and internal fixation 68% and plaster 63%.	"Displaced severely comminuted intra-articular fractures should be treated with an external fixator."	Study intervention is different for fixation vs. internal fixation related to mobilization and physiotherapy. Follow-up times differ not clearly stated for each patient group.
External Fixation vs. Pinning										
Ludvigsen 1997 (score=6.0)	External Fixation/Percutaneous Pinning	RCT	Sponsored by a grant from the Norwegian Orthopaedic Society. No mention of COI.	N = 60 with Colles' Fracture type Older 3;	Mean Age: 59.5 years; 7 males, 53 females	External fixation (n=29) vs. percutaneous pinning (n=31)	Follow up at 6 weeks and 6 months	Patients immobilized for 6 weeks; outcome assessed after 6 months. Groups showed similar	Most unstable distal radial fractures, classified as Older's type 3 and 4, can be treated	With equivocal results, author justification for conclusion is based on other studies that loss

								results with respect to radiographic parameters and function. All fractures healed and no difference in complication rate was observed.	with percutaneous pinning and a plaster cast, which is simpler and cheaper than external fixation.	of reduction may occur if external fixator is removed before 8 weeks, as radial shortening occurring during this time may result in loss of reduction.
Krishnan 2003 (score=5.5)	External Fixation/Pinning	Prospective RCT	No mention of sponsorship or COI.	N=60 patients with intra-articular fractures of the distal radius;	Mean age: 56 years; 19 males, 41 females	Group 1 (n=30) pinned with a "Delta" frame and instructed to do wrist exercises Vs Group 2 (n=30) pinned in the "Hoffman" style and were not able to move wrist.	Follow Up at 1, 6, 12, 26, 52 weeks.	No statistical difference between groups in extension, ulnar deviation, pronation and supination, grip strength, comparable complications in both groups except for rupture of extensor pollicis brevis tendon. Flexion, Group 1 vs Group 2 at 6, 26, and 52 weeks median (range) in deg; 28 (10-60) vs 35 (10-90) (p,0.02), 45 (30-95) vs 55 (40-95) (p=0.008), 50 (25-100) vs 60 (45-100) (p=0.02). Radial deviation, group 1 vs Group 2, at 6 weeks; favored group 1 (p=0.002). Completing daily activities was better in group 2 than group 1 (p=0.034) at week 2.	"In conclusion, this study demonstrated that the outcomes of patients with complex unstable intraarticular fractures of the distal radius are similar, regardless of whether they are treated with a static bridging external fixator or a dynamic non-bridging external fixator."	Data suggest comparable efficacy between groups.

Pritchett 1995 (score=4.5)	External Fixation/Percutaneous Pinning	RCT	No sponsorship or COI.	N = 100 with distal radial fractures;	Median Age Group 1: 65.3 years. Group 2: 66.7 years; 45 males, 55 females	External fixation (n=50) vs. medullary pinning (n=50)	Follow up at 6 weeks	Excellent or good outcome/total: external fixation 42/50, medullary pinning 48/50. Loss of ROM and grip strength slight and not significantly different between groups. Treatment outcomes of mean operating time, office visit numbers, use of more than 1 prescription drug, device removal, bathing and dressing problems, and other operation all favored medullary pinning.	“The two most important measures of outcome, patients complaints and cost, were significantly lower with pinning than with external fixation and we now believe that medullary fixation is the treatment of choice for these fractures.”	Non-clinical outcomes favor medullary pinning.
Leung 2008 (score=4.0)	External Fixation/Pinning	RCT	Sponsored by the AO Research Institute. COI, one or more of the authors have received or will receive benefits for personal or professional use.	N= 137 with an acute intra-articular of distal radial fracture;	Mean Age 44 years; 85 males, 52 females	Group 1 (n=74) fractures that were treated using external fixation and percutaneous pinning. Vs Group 2 (n=70) fractures that were stabilized with plates.	Follow-Up at 6, 12, and 24 months.	Gartland and Werley point system results, group 1 vs group 2 at 24 months; 39% excellent, 55% good, 6% fair, 0% poor, vs 67% excellent, 30% good, 3% fair, 0% poor (p=0.04). Arthritis grade, group 1 vs group 2, at 24 months; 24% grade-0, 65% grade-1, 15% grade-2. Vs 44% grade-0, 52% grade-1, 4% grade-2 arthritis (p=0.001).	“[W]e have demonstrated that open reduction and plate fixation is a better way to treat intra-articular distal radial Fractures than is external fixation and percutaneous fixation.”	Data suggest plate fixation at 2 years was better than external fixation plus percutaneous pin fixation for the treatment of intraarticular distal radial fractures.
Internal Fixation										

Rozenal 2009 (score=6.5)	Internal Fixation	Prospective Randomized Trial	No sponsorship or COI.	N=45 patients with an unstable fracture of the distal radius;	Mean Age Group 1: 51 (19-77). Group 2: 52 (24-79).	Group 1 (n=23) patients treated with open reduction and internal fixation Vs Group 2 (n=22) patients treated with Closed reduction and percutaneous pinning.	Follow up at 6, 9, 12 weeks, and 1 year.	Range of Motion Parameters (deg), group 1 vs 2, 6 weeks; Extension: 45±20 vs 16±13 (p<0.01). Flexion: 50±12 vs 26±16 p<0.01). Supination: 79±21 vs 40±29 (p<0.01). Pronation: 77±17 vs 63±26 (p=0.04). Ulnar Deviation: 27±10 vs 15±11 (p<0.01). Radial Deviation: 15± vs 7±6 (p<0.01). Grip Strength (% vs uninjured arm), group 1 vs 2, 6 weeks; 49.3±20.9 vs 25.6±30.1 (p<0.01). Pinch Strength (% vs uninjured arm), group 1 vs 2, 6 weeks; 59.1±25.8 vs 38.8±27.0 (p=0.01). DASH Score, group 1 vs 2, 6 weeks; 27±17 vs 53±28 (p<0.01). 9 weeks; 17±17 vs 39±25 (p<0.01). 12 weeks: 11±13 vs 26±23 (p=0.01). No significant difference between radiological outcome, return to work/life activities, or complications.	“The present study confirms the hypothesis that volar plate fixation results in less functional disability in the first few months after treatment than does percutaneous pin fixation. At one year after the injury, we did not identify a difference between the treatment groups with regard to functional or radiographic outcomes.”	Data suggest similar efficacy between groups but better early outcome results in the open reduction external fixation group with fewer overall numbness of complications.
Hahnloser 1999 (score=6.0)	Internal Fixation	RCT	No mention of sponsorship or COI.	N = 46 with unstable comminuted	Mean Age: 55.8 years;	Internal fixation via two 1/4 tube	Follow up at 1, 3, and 6 months	43% of [pi]-plates were too large and 19% could not be	“With open reduction, cancellous bone	Recommendation against pi-plate

				fracture of distal radius;	11 males, 35 females	plates (n=25) vs. [pi]-plate (n=21)		matched properly to distal radius. Range of wrist motion of the operative wrist expressed in percentage of the normal contralateral side: [pi]-plaster/tube plates Flexion 68 (\pm 26 SD)/ 85 (\pm 15); Extension 67 (\pm 23)/ 86 (\pm 12).	grafting, and internal plate fixation in comminuted distal radial fractures, excellent results can be achieved. In our experience, we cannot recommend the [pi]-plate in its current shape and prefer to stabilize distal radius fractures and dorsal fragment dislocations with two 1/4 tube plates.”	for internal fixation.
Földhazy 2010 (score=5.0)	External or Internal Fixation	RCT	No mention of sponsorship or COI.	N=59 with displaced fractures of the distal radius	Mean Age Group 1: 70 (62-81) Group 2: 73 (60-85); 6 males, 53 females	Group 1: (n=29) patients treated with open reduction and internal fixation with plaster casting. Vs Group 2: (n=22) Patients treated with closed reduction and external fixation.	Follow up at 2, and 5 weeks, 2, 6, and 12 months.	No significant difference in Clinical outcomes, and complications. Slightly better dorsal extension and radial deviation in group 1 at final follow up (p=0.036 and p=0.043, respectively). Final dorsal angulation, group 2 vs 1, 1 year; 11 \pm 9 vs 20 \pm 14 (p=0.001).	“[W]e believe that the results of this prospective, randomized and comparative study are that in 60--85 year old patients, with a displaced distal radial fracture after low energy trauma, no obvious clinical benefit could be demonstrated using closed reduction and external fixation as compared with closed reduction and plaster treatment.”	Data suggest comparable efficacy between groups although primary external fixation group showed a positive radiographical effect. However, one third of the external fixation group had a complication.

Ekenstam 1989 (score=5.0)	Internal Fixation	RCT	Sponsored by the Disabilities Committee of the Swedish insurance companies. No mention of COI.	N = 41 with Lidström Group Iia+c or Frykman Groups II and VI;	Mean Age: 51.1 years; 10 males, 31 females	Triangular ligament was repaired after closed reduction (Group A) (n=19) vs. closed manipulation and above- elbow cast (Group B) (n=22).	Follow up at 1 week and 2 years	Clinical examination results controls/group B/group A mean (SD): Strength 60(22)/58 (18)/59(25); Flexion 68(11)/58(11)/57(15) . No difference for any part of clinical exam for 2 treatment methods.	“Repair of the ruptured triangular ligament in extraarticular fractures of the distal radius is not better than conventional treatment.”	Dropout rate unclear. Randomization and baseline comparability not clear.
External Fixation vs. Bone Cement										
Schmalholz 1989 (score=6.0)	External Fixation/Bo ne Cement	RCT	No mention of Sponsorship or COI.	N = 47 with Frykman Types 1 and 2 that redislo- cated after two reduct- ions;	Median Age Group 1: 66 years. Group 2: 70 years; 0 males, 47 females	Bone cement (methylnhacry- late) (Group 1) vs. plaster cast (Group 2).	Follow up at 2 weeks, 1, 2, 3, and 6 months and 2 years	21/24 patients in Group 1 and 10/23 in Group 2 recovered full dorsiflexion; 8 in Group 1 and 1 in Group 2 regained full strength. Wrist appearance satisfactory for all in Group 1/none in Group 2 at 8 weeks. Group 1 function excellent in 6, good in 17, and fair in 1; Group 2 saw good in 2, fair in 12, and poor in 9. (p <0.001).	“The operated on group were better with regard to all objectively measurable characteristics; all operated on fractures had healed radiographically, and the cement was surrounded by cortical bone.”	Description of 2nd study sounds similar. Unclear if these 2 reports represent one trial with 3 arms split into 2 reports.
Schmalholz 1990 (score=6.0)	External Fixation/Bo ne Cement	RCT	No mention of Sponsorship or COI.	N = 48 with redislocated Colles Fractures;	Median Age Group 1: 67 (50-75). Group 2: 66 (50-81); 2 males, 46 females	Group 1: received Dorsal bone deficiency filled with bone cement (methylnhacryl- ate) (n=23) vs. Group 2: received external fixation (n=25).	Follow up at 2 weeks, 1, 2, 3, and 6 months and 1 year	Surgery on day 16 (median 16, range 14-18) in both groups. Group 1 (cement) had significant improvement in volar flexion, supination, pronation, and grip strength first 2-4 months post	Final results equal in the 2 groups, but Group I improved earlier and had no complications.	Open reduction and bone cement appears more effective than external fixation.

								treatment. At 6 months all differences equalized. Group II, 24% had complications; none in Group I.		
Cassidy 2003 (score=5.0)	Norian SRS Cement	Randomized Prospective Trial	Sponsored by the Norian Corporation. COI, three authors were employees of Norian.	N=323 patients who had sustained a displaced and/or unstable distal radial fracture;	Mean Age Group 1: 63.5 ± 11. Group 2: 63.7 ± 12; 51 males, 272 females	Group 1: patients treated with Norian SRS cement and a closed reduction. (n=161) Vs Group 2: patients treated only with closed reduction and either external fixation or cast immobilization (n=162).	Follow up at 1, 2, 4, and 6 weeks and at 3, 6, and 12 months.	Group 1 v Group 2 subjective pain rating difference; Group 1 lower at 2 and 4 weeks, (p=0.02, p=0.02, respectively). Group 1 required less pain medicine at 2 weeks (p=0.004). Group 1 vs Group 2 grip hand strength at 6-8 weeks, 18 lb vs 10 lb (p<0.0001). Group 1 at 6-8 weeks had better digital range of motion (p<0.01). Group 1 had significantly less swelling of forearm at 2 weeks, (p=0.0146), and various digits at 6-8 weeks. Jebsen dexterity test, Group 1 dominant hand fracture at 6-8 weeks took less time to pick up small objects (p=0.0023). Group 1 vs group 2, ulnar variance at 12 months. 2.0 vs 1.4 (p=0.02). Complications largely due to loss	“Our data suggest that Norian SRS cement provides adequate fixation for the majority of distal radial fractures to permit early wrist mobilization.”	Data suggest Norian SRS cement is beneficial for most distal radial fractures and may allow faster recovery due to accelerated rehabilitation. The control group experienced a significantly higher number of post procedure infections.

								of reduction, no significant difference in complications between groups.		
Sanchez-Sotelo 2000 (score=5.0)	External Fixation/Bone Cement	RCT	No sponsorship or COI.	N = 110 with distal radius fractures;	Mean Age: 66.0 years; 13 males, 97 females	Remodellable bone cement (Norian SRS) and cast for 2 weeks (n=55) vs closed reduction and cast for 6 weeks (n=55)	Follow up at 6 weeks, 3, 6, and 12 months	Mean ranges of movement and mass grip strength as percentages of normal side. Norian SRS/Control: Extension 6 weeks 65.09±8.26/40.67±6.06 (p <0.001); 1 year 95.7±3.2/ 90.1±3.4 (p <0.01). Flexion 6 weeks 53.84±5.51/43.60±5.93 (p <0.001); 1 year 86.2±3.41/77.8±4.2 (p <0.01). Grip Strength 6 weeks 38±4.43/21.42±4.87 (p <0.001); 1 year 92.3±4.32/80.3±7.3 (p <0.001). Radio-ulnar pain Norian SRS/ Control: 3 months 45 (81.8 %)/ 30(54.5%); 12 months none 49 (89.1%)/ 38 (69.1%). Complication Norian SRS/ Control: Malunion 10 (18.2%)/23(41.8%); Reflex sympathetic dystrophy 3(5.4%)/4 (7.3%).	“The injection of a remodellable bone cement into the trabecular defect of fractures of the distal radius provides a better clinical and radiological result than conventional treatment.”	Positive study for the use of remodellable bone cement over immobilization.
Kopylov 2001 (score=4.0)	External Fixation/Bone Cement	RCT	Sponsored by Norian Corp., Greta and Johan Kocks Stifelse,	N = 23 osteoporotic patients with	Mean Age: 66.6 years; no mention of sex.	External fixation: received immobilization	No mention of follow-up.	Clinical findings reported in 1999 study. Stereometric findings are	“Stereometric analysis showed that 5 weeks of immobilization is	Second report on population.

			the Medical Faculty of Lund University and the Swedish Medical Research Council. No mention of COI.	distal radial fracture;		for 5 weeks with an external fixator (n=11) vs. Norian SRS: received a self-setting hydroxyapatite called Norian SRS injected into the fracture and the wrist was immobilized for 2 weeks with a dorsal splint (n=12)		reported here. In all fractures there was a good correlation ($r^2 = 0.93$, $p = 0.0001$) between longitudinal radiostereometric analysis displacement from the first to last investigation.	sufficient for healing with external fixation in this age group. Treatment of the fracture with Norian SRS might reduce the immobilization time to 2 weeks but additional hardware may have to be used to ensure stability of the fracture system.”	
Kopylov 1999 (score=4.0)	External Fixation/Bone Cement	RCT	Sponsored by Norian Corp. and the Swedish Medical Research Council. No mention of COI.	N = 40 with distal radial fractures	Mean age 67.5 years; 36 males, 4 females	Stabilized with SRS injection and immobilized with cast for 2 weeks vs. externally fixed with Hoffman’s bar for 5 weeks	Follow up at 2, 5, and 7 weeks, 3, 6, and 12 months	“SRS can be used in the treatment of unstable distal radial fractures. The more rapid recovery of grip strength and wrist mobility in the SRS group appears to be due to the shorter immobilization time.”	“The shorter immobilization time with SRS permitted earlier return of hand function. The question remains whether early mobilization by itself is enough to reach a good final result, even in the absence of fixation with SRS. That question is addressed in an ongoing study.”	No differences were found at 2 years in grip strength or mobility.
External Fixation vs Plates										
Atroshi 2006 (score=7.5)	External Fixation	RCT	Sponsored by grants from Region Skane, Sweden. No COI.	N=38 dorsally displaced distal radius fracture;	Mean Age: 71 years; 7 males, 31 females	Group 1: (n=19) patients treated with wrist-bridging fixation. Vs Group 2 (n=19) patients treated with non-	Follow Up at 10, 26, and 52 weeks after surgery.	No significantly different results in the mean DASH scores between both groups. No difference in patient satisfaction, or pain between groups. No	“The lack of a clear clinically relevant advantage does not support non-bridging fixation instead of bridging fixation	Data suggest similar efficacy between groups but non-bridging external fixation group better for maintaining radial length in

						bridging external fixation.		difference in range of motion between groups, No significant different between grip strength.	for older patients with distal Radius fracture.”	several displaced radial fractures in the elderly.
Wei 2009 (score=7.0)	External Fixation	Prospective Randomized trial	Sponsored by the Doris Duke Clinical Research Fellowship and BiometEBI. COI, one or more of the authors have received or will receive benefits for personal or professional use.	N=46 patients with an unstable distal radial fracture	Mean Age Group 1: 58 ± 17 years; 13 males, 33 females	Group 1 (n=22) patients treated with external fixation Vs Group 2 (n=12) patients treated with a radial column plate Vs Group 3 (n=12) patients treated with a volar plate.	Follow up at 10-14 days, 6 weeks, and 3, 6, and 12 months post-op.	Disabilities of the Arm, Shoulder and Hand (DASH) results, 6 weeks, group 3 vs group 1; 41 ± 23 vs 56 ± 19 (p=0.037). DASH 3 months group3 vs group 2 and vs group 1; 7 ± 5 vs 28 ± 17 (p=0.027), and 29 ± 18 (p=0.028). DASH at 1 year, group 3 vs 1 and 2; 4 ± 5 vs 18 ± 14 (p=0.025) and 18 ± 12 (p=0.056). Grip Strength (percentage value compared to uninjured side, at 6 months, group 1 vs 2; 75 ± 21 vs 53 ± 9 (p=0.042). Lateral pinch (% vs uninjured side); group 2 vs 3, at 3 months and 12 months. 66±14 vs 86±13 (p<0.042), 73±8 vs 94±5 (p<0.036). Range of motion; Extension, group 1 vs group 3 and 2 (degrees), 6 weeks; 10 vs 38 & 32 (1 v 3 p=0.023), (1 v 2 p=0.032),	“In conclusion, this study provides new evidence supporting the trend toward fixation of distal radial fractures with locked volar plates.”	Data suggest the use of a locked volar plate resulted in better patient reported outcomes at 3 months but at 6 months and 12 months, all 3 groups had good outcomes in terms of ROM, strength and radiographic alignment but the radial column plate group had significantly better radial inclination and length compared to other 2 groups.

								<p>respectively. Supination (degrees), group 1 vs 2 and 3, 6 weeks; 34 vs 57 and 55 (1 v 2 p=0.041), (1 vs 3 p=0.049) respectively. Radiographic Measurements; Radial inclination (deg), group 2 v 3, 6 weeks; 25.0±5.2 vs 21.1±7.0 (p=0.003). Radial Length (mm), group 1 vs 2, 6 weeks; 11.4±2.1 vs 13.0±3.5 (p=0.038). Radial Inclination (deg), group 2 vs 1, at 12 months; 29.5±5.2 vs 20.9±3.4 (p=0.007). Group 2 vs 3; 29.5±5.2 vs 17.6±2.1 (p=0.003). Radial Length (mm), group 2 vs 1, 12 months; 16.5±3.5 vs 10.8±2.1 (p=0.002). Group 2 vs 3; 16.5±3.5 vs 9.5±2.7 (p=0.027).</p>		
Karantana 2013 (score=4.5)	External Fixation/Plate	RCT	No sponsorship or COI.	N=130 patients with a distal radial fracture;	No mention of mean age or sex.	Group 1 (n=64) patients treated with open reduction and volar plating Vs Group 2 (n=66) patients treated with closed reduction and external fixation	Follow-Up at 6, and 12 weeks, also at 1 year.	<p>Patient evaluation measure (PEM), group 1 vs 2, 6 weeks; 34±13 vs 45±12 (p<0.001). Quick Dash, group 1 vs 2, 6 weeks; 41±21 vs 52±20 (p=0.002). Grip Strength (% vs uninjured arm),</p>	“In conclusion, use of a volar locking plate resulted in a faster early postoperative recovery of function compared with that following closed reduction	Data suggest comparable efficacy at 3 months and 1 year post procedure. The volar locking plate group did demonstrate some increased grip strength as

								group 1 vs 2, 6 weeks; 40±23 vs 10±12 (p<0.001). 12 weeks; 65±26 vs 45±22 (p=0.002). 1 year; 95±22 vs 84±19 (p=0.005). Range of Motion, group 1 vs 2, 6 weeks; Extension (deg): 57±22 vs 17±30 (p<0.001). Flexion (deg): 59±18 vs 47±22 (p=0.001). Pronation (deg): 80±17 vs 65±28 (p=0.001). Supination (deg): 73±23 vs 37±26 (p<0.001). More complications within group 2; (p=0.047).	and percutaneous wire fixation. However, there was no significant difference at or after twelve weeks.”	well as anatomical improvement but these results were not significant.
Arora 2011 (score=4.5)	External Fixation	Prospective Randomized Trial	No sponsorship or COI.	N=73 with distal radial fracture that were unstable;	Mean Age 76.7 years; 18 males, 55 females	Group 1 (n=36) individuals who were treated with open surgery and fixed with K-Wire, volar locking plate, or DVR. Vs Group 2 (n=37) individuals casted for 5 weeks.	Follow up at 6 and 12 weeks, as well as 6 and 12 months.	No significant differences in clinical parameters. Significantly more complications in the operative treatment group (p<0.05). DASH scores, 6 weeks group 1 vs 2; 18.8±17.9 vs 34.4±22.5 (p<0.001). Patient-Rated Wrist Evaluation (PRWE) scores at 6 weeks; group 1 vs 2; 36.4±28.7 vs 64.9±29.0 (p<0.001). DASH Scores at 12 weeks,	“Volar fixed-angle plate systems have made plate osteosynthesis popular for elderly individuals with osteoporotic bones. However, at twelve months after surgery, the active range of motion, the pain level, and the PRWE and the DASH scores were not different between the operative and	Data suggest at 12 months, ROM, pain level and PRWE and DASH scores equivalent. Patients in surgical group reported better grip strength throughout trial.

								group 1 vs 2; 13.3±14.8 vs 23.2±19.3 (p=0.02). PRWE score at 12 weeks, group 1 vs 2; 33.7±32.0 vs 54.4±31.8 (p=0.01). Last follow up, dorsal tilt, radial inclination, radial shortening, and intra-articular step-off were significantly better, and loss of reduction was significantly lower in group 1 (p<0.05).	nonoperative treatment groups.”	
New Articles										
Navarro 2016 (score=7.0)	Open Reduction/ External Fixation/Volar Plate/K-Wire	RCT	Sponsored by Swedish Research Council, the regional Agreement on Medical Training and Clinical Research between the Stockholm County Council and Karo-linska Institutet (ALF), and the King Gustav and Queen Victoria Free Mason Foundation. No COI.	N=140 patients with a dorsally displaced distal radius fracture	Mean age: 63 years; 11 males, 128 females	Volar Locking Plate (n=70) vs External Fixation with K-Wires (n=70)	Follow up at 3 and 12 months	Lower quality of life measured by EQ-5F was lower in external fixation group (p<0.02) at 2 and 6 weeks. Grip strength was improved more in volar plate group at 3 months (p=0.007) and 1 year (p=0.072). Range of motion was only better for radial deviation in volar plate group at 1 year (p=0.021).	“Volar plating and external fixation with optional addition of K-wires are 2 equally suitable treatment options for dorsally displaced distal radius fractures in a population aged 50–74 years after low-energy trauma. Volar plating and external fixation yielded similar clinical results 3 months and 1 year after treatment.”	Minimal differences between groups at 3 months and 1 year only enrolled older patients, may not be generalized to younger groups.

Costa 2014 (score=5.5)	K-Wire/Volar Locking Plate	RCT	Sponsored by Health Technology Assessment scheme of the NIHR. No COI.	N=461 adults with dorsally displaced fracture of the distal radius	Mean age: 56.1 years;	Locking Plate Fixation (n=231) vs K-Wire (n=208)	Follow up at 3, 6, and 12 months	Adjusted treatment effect for PRWE score was -1.3 (95% CI -4.5-1.8) in favor of the plate group (p=0.40). No other significant differences between groups were observed.	“Volar plating and external fixation with optional addition of K-wires are 2 equally suitable treatment options for dorsally displaced distal radius fractures in a population aged 50–74 years after low-energy trauma. Volar plating and external fixation yielded similar clinical results 3 months and 1 year after treatment.”	Methodological details sparse, no outcome differences between groups.
Landgren 2017 (score=5.5)	Volar Locking Plate/Fragment Fixation	RCT	Sponsored by Swedish Research Council, Greta and Johan Kock, Alfred Osterlund, Maggie Stevens, Thure Carlsson foundations, and the Medical Faculty of Lund. No COI.	N=50 patients with primarily nonreducible or secondarily redisplaced distal radius fractures	Mean age: 56 years; 11 males, 31 females	Volar Locking Plate: (n=25) vs Fragment Specific Fixation: (n=25)	Follow up at 2 and 6 weeks, 3 and 12 months	Achieving normal grip strength was shown in 90% of the volar locking plate group and 87% in the fragment specific group (p=0.62). Absolute grip strength was 25 kg for volar locking plate and 29 kg in the fragment specific group (p=0.55). Medium QuickDash score was similar in both groups.	“In treatment of primarily nonreducible or secondarily redisplaced distal radius fractures, volar locking plates and fragment-specific fixation both achieve good and similar patient-reported outcomes, although more complications were recorded in the fragment-specific group.”	No differences between groups except for radiographic outcomes. Higher complication rate in fragment specific fixation treatment group.

Gratl 2016 (score=5.5)	Intramedullary nailing/Palmar locking plate	RCT	No mention of sponsorship. No COI.	N=28 patients with intraarticular distal radius fractures	Mean age: 64.3 years; 4 males, 24 females	Volar Locking Plate Fixation: (n=14) vs Intramedullary Nailing (n=14)	Follow up at 8 weeks and 2 years	Both groups showed 82% achievement of improved wrist motion and grip strength. Patients in nailing group regained more extension than the plate group (98% of unaffected side vs 94% on affected side).	“The present study suggests that intramedullary nail fixation is a reasonable alternative to volar plate fixation for the treatment of intra-articular distal radius fractures and both techniques can yield reliably good results.”	Small sample size, matched on sex and age. Differences in radiographic measures at 2 years were the only statistically significant differences.
Bartl 2014 (score=5.5)	Cast Immobilization	RCT	No mention of sponsorship. Author Stengel received compensation from Biomet, Stryker, and the AO Foundation, the German Trauma Society (Deutsche Gesellschaft für Unfallchirurgie e.V., DGU), and the German Social Accident Insurance (Deutsche Gesetzliche Unfallversicherung, DGU).	N = 185 with AO type C distal radial fractures	Age and sex information only available for 174 participants . Mean age: 74.84 years; 21 males, 153 females	Open reduction and volar locking plate fixation (ORIF) – treated primarily or after soft-tissue conditional with open reduction and volar locking plate fixation (via volar Henry approach), prescribed physiotherapy according to standards of individual center 2 weeks after surgery (n=94) vs.	Follow-up at 3 and 12 months.	Short Form-36 health questionnaire (SF-36 PCS) at 3 months – ORIF: 44.5±8.4, Cast: 42.0±10.6 (Mean difference = 2.5, p=0.096). SF-36 PCS at 12 months – ORIF: 48.6±10.4, Cast: 45.3±11.3 (3.3, p=0.058)	“The findings with respect to mobility, functionality, and quality of life at 12 months provide marginal and inconsistent evidence for the superiority of volar angle-stable plate osteosynthesis over closed reduction and casting in the treatment of intra-articular distal radius fractures. Primary nonsurgical management is also effective in	Study was stopped early because of low enrollment and recruitment. Data suggest open reduction and plate fixation superior to closed reduction and casting in patients older than 65 years wrist complex distal radial fracture for the outcomes of range of motion and radiographic differences.

						Closed reduction and closed forearm cast for 6 weeks (n=91)			suitable patients.”	
Christersson 2016 (score=5.5)	Cast Immobilization	RCT	No sponsorship or COI.	N = 109 with moderately displaced distal radius fractures	Mean age: 65.8; 11 males, 98 females	All patients underwent closed reduction procedure. Immediate removal of plaster cast (active group) (n=54) vs. Continued plaster cast fixation for an additional 3 weeks (control group) (n=55)	Follow-up at 10 days, 1 month, and 12 months	Active group displaced more in dorsal angulation (4.5°, p<0.001), radial angulation (2.0°, p<0.001), and axial compression (0.5 mm, p=0.01) compared to control from 10 days to 1 month. Active group displaced more only in radial angulation (3.2°, p=0.002) compared to control at 12 months	“Early mobilisation 10 days after reduction of moderately displaced distal radius fractures resulted in both an increased number of treatment failures and increased displacement in radial angulation and axial compression as compared with the control group. Mobilisation 10 days after reduction cannot be recommended for the routine treatment of reduced distal radius fractures.”	The 10 day cast group had significantly more displacement than 1 month cast group.
Williksen 2013 (score=5.0)	Cast Immobilization	RCT	No mention of sponsorship. No COI.	N = 114 patients with unstable	Age and sex information	External fixation (EF) (Hoffman II)	Follow-up at 2, 6, 16,	QuickDASH scores for EF and VLP groups,	“Although we did not find a significant	Only 1 statistically significant

				distal radius fractures	only available for 111 participants . Mean age: 54 years; 22 males, 89 females	external fixator or Synthes used) with adjuvant pins introduce in second metacarpal and in the radius, pins removed 6 weeks after surgery (n=60) vs. Volar locking plate (VLP), performed through flexor carpi radialis approach, three plates used (n=54)	26, and 52 weeks	respectively, at 16 weeks: 3, 6 (mean difference = -3, p=0.21). At 26 weeks: 4, 4, (0.4, p=0.85). At 52 weeks: 1, 3 (-2, p=0.21)	difference between the groups for the QuickDASH score, we believe that our results support the use of VLPs for the treatment of unstable distal radius fractures. A serious concern is that some patients will have to have their plates removed; therefore, improving the surgical technique is important.”	difference suggesting no clinical difference between two groups.
Drobetz 2016 (score=5.0)	Cast Immobilization	RCT	No COI. No mention of sponsorship.	N = 56 patients with displaced radius fracture	Age and sex information only available for 50 participants . Mean age: 51.83 years; 28 males, 22 females	Volar locking plate (VLDRP) – volar Henry approach, Synthes plates used (n=29) vs. Another treatment modality (control) – case immobilization with or without wires	Follow-up at 2, 6, and 12 weeks	Comparison at 3 months for VLDRP and control groups, respectively: DASH score – 40, 50 (p=0.063), PRWE score – 21, 47 (p=0.007), Grip strength (% of grip strength of uninjured limb) – 64, 42 (p=0.012)	“The present study suggests that volar locking plates produced significantly better functional and clinical outcomes at 3 mo compared with other treatment modalities. Anatomical reduction was	Non-intervention comparison was an ill-defined broad combination of treatments.

						or external fixator (n=27)			significantly more likely to be preserved in the plating group.”	
Park 2017 (score=5.0)	Cast Immobilization	RCT	No COI or sponsorship.	N = 69 with unilateral distal radius fracture	Mean age: 66.77 years; 6 males, 63 females	All wrists positioned in slight flexion and ulnar deviation as to not immobilize metacarpophalangeal joint. Randomized to either short arm plaster (n=36) vs. long arm plaster (n=33). 6 to 7 weeks post-injury the plaster was removed, followed by the wearing of removable short arm splint for 2 additional weeks	Follow-up at 1, 3, 5, 12, and 24 weeks	Differences at 3 months between short and long arm cast, respectively: Visual analog scale (VAS) – 3.7, 3.1 (p=0.05), DASH – 55.6, 52.9 (p=0.50), Volar tilt – -0.2, 3.9 (p=0.01), Radial inclination – 13.4, 15.4 (p=0.21), Radial length (mm) – 5.0, 6.2 (p=0.13). Differences at 6 months between short and long arm cast, respectively: VAS – 2.5, 2.1 (p=0.12), DASH – 30.0, 26.8 (p=0.37), Volar tilt – -3.6, 2.3 (p<0.001), Radial inclination – 10.1, 12.4 (p=0.17), Radial length (mm) – 3.1, 4.5 (p=0.10).	“Our findings suggest that a short arm cast is as effective as a long arm cast for stable distal radius fractures in the elderly. Furthermore, it is more comfortable and introduces less restriction on daily activities.”	Study assessed for differences not equality so conclusions are not justified. Patients enrolled 1 week after injury and initial treatment volar tilt significantly different as is impact on activities.

Yamazaki 2015 (score=5.0)	Fluoroscopic/Arthroscopic Reduction	RCT	No mention of sponsorship. No COI.	N=74 patients with unilateral unstable intraarticular fracture of the distal radius	Mean age: 64 years; 16 males, 54 females	Fluoroscopic Reduction: (n=37) vs Arthroscopic Reduction (n=37)	Follow up at 6 and 48 weeks	No significant differences were observed between groups at any time. Mean gap and step in fluoroscopic and arthroscopic groups were similar 0.9±0.7 mm, 0.7±0.7 mm, 0.6±0.6 mm, and 0.4±0.5 mm, respectively (p=0.18 and p=0.35).	“Arthroscopic reduction conferred no advantage over conventional fluoroscopic guidance in achieving anatomical reduction of intra-articular distal radial fractures when using a volar locking plate.”	No statistical differences between groups, although there were some statistical trends were seen.
Shukla 2014 (score=4.5)	Cast Immobilization	RCT	No COI. No mention of sponsorship.	N = 110 with Cooney’s type IV distal radius fracture (diagnosed via Cooney’s classification system), without other skeletal injury	Mean age: 39.12 years; 49 males, 61 females	External fixation – Schanz pins in second metacarpal and in radius proximal to the fracture, a below-elbow plaster of Paris slab applied in all patients for 1 week, external fixator was removed after 8 week (n=62) vs. Volar locking plates – near flexor carpi radialis (FCR) tendon, casts applied did not allow free	Follow-up at 6 and 12 month	Comparison of final Green and O’Brien scores between external fixation and volar locking plates, respectively: At 6 months – 75.54, 80.33 (p=0.12), At 12 months – 87.36, 81.55 (p=0.01)	“External fixation showed superiority over volar locked plating after 1 year of surgery.”	Methodological details sparse. Differences in treatment response between patients younger than 50 years and those 50 years and above, particularly for external fixation.

						mobilization (n=48)				
Martinez-Mendez 2017 (score=4.5)	Casting/Volar Plating	RCT	No sponsorship or COI.	N =97 patients displaced complex intra-articular distal radius fractures	Mean age: 68.5 years; 21 males, 76 females	Casting: received plaster immobilization for 2 weeks, then a forearm cast for 4 more weeks (n=47) vs Volar plating: received open reduction and volar locking plate fixation (n=50)	Follow up at 2, 6 weeks, 6, 12, and 24 months	Functional and quality of life scores were better in the plating group compared to casting group (p=0.02, p=0.04, respectively). PRWE showed a treatment effect for casting of OR=1.2 (95% CI 1.0=1.72, p=0.04). Casting group showed 26% unacceptable loss of reduction.	“We conclude that the conservative treatment in patients over 60 years old had a high incidence of redisplacement. The functional outcomes and quality of life were better and clinically relevant after volar plating fixation compared with conservative treatment. The restoration of the articular surface and recovery of radial inclination and ulnar variance were important factors influencing the outcomes.”	While there is relatively little baseline data for these participants, who were mostly elderly, Data suggest surgical plating is superior to casting for intraarticular distal radius fractures. Study included range of severities from C1-C3 with roughly equal severities between treatment groups.
Sharma 2013 (score=4.0)	Cast Immobilization	RCT	No COI. No mention of sponsorship.	N = 64 with unilateral fractures of distal radius (AO type B or C)	Mean age: 50.25 years; 26 males, 38 females	Nonoperative group – closed manipulation under C-arm guidance, above-elbow plaster of Paris (POP) cast for 4 weeks (n=32) vs. Volar plating – open reduction and internal	Follow-up at 6 weeks, 3, 6, 12, 18, and 24 months	Range of movement and functional scores significantly better in volar plating group (p<0.001) except for ulnar variance and radial and ulnar deviation. Range of motion scores at 24 months for	“In cases of AO type B or C fractures of the distal radius, volar locked plating provides anatomical stable fixation and early mobilization with better clinoradiological outcome as	Non-operative treatment was above elbow casting for 4 weeks. No baseline outcomes reported. Surgical treatment had better outcomes for most measures of

						fixation with titanium volar locking plates (Synthes) via extended flexor carpi radialis approach, plaster splint applied for 1 week, upper extremities (n=32)		nonoperative and volar plating groups, respectively: Palmar flexion – 65.91, 83.86 (p<0.001), Dorsal flexion – 69.04, 84.33 (p<0.001), Radial deviation – 62.87, 79.14 (p<0.001), Ulnar deviation – 65.91, 79.62 (p<0.001), Pronation – 32.04, 34.19 (p=0.088), Supination – 41.96, 43.43 (p=0.932), Grip strength – 72.17, 89.05 (p<0.001)	compared to conservative treatment.”	range of motion and strength as compared to cast.
Gamba 2017 (score=4.0)	Cast Immobilization	RCT	No COI or sponsorship.	N = 72 with distal radius fracture	Mean age: 77.1 years; 3 males, 69 females	All patients underwent reduction procedures with mechanical traction via finger traps and manipulation after blocking with bupivacaine. Patients randomized to a below-elbow cast (n=40) vs. above-elbow	Follow-up at 1, 3, and 6 weeks	Loss of reduction parameters for the below-elbow cast group and the above-elbow cast group, respectively: volar tilt loss 10.8, 10.6 (p=0.89), radial tilt loss 4.6, 5.6 (p=0.08), ulnar variance loss 1.4, 0.7 (p=0.19)	“The above-elbow cast is not better than the below-elbow cast in terms of loss reduction. However, the below-elbow cast more efficiently controls radial tilt reduction.”	Methodological details sparse. No meaningful differences between groups except for radial tilt.

						cast (n=32). Casts were removed after 6 weeks				
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Evidence for the Use of X-rays for Diagnosis of Wrist Ganglia

There is one low-quality study included in Appendix 2.(1426) (Sakamoto 13)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ganglion, Cyst, Cysts, Xray, X-ray, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 371 articles in PubMed, 298 in Scopus, 2 in CINAHL, 0 Cochrane Library, and 3240 from Google Scholar. We considered for inclusion 1 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 3911 articles considered for inclusion, 1 met the inclusion criteria.

Evidence for the Use of MRI for Evaluation of Wrist Pain with Suspected Occult Dorsal or Volar Wrist Ganglia

There are 4 moderate-quality studies incorporated into this analysis.(1427-1430) (Anderson 06; Goldsmith 08; Vo 95; Cardinal 94)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: MRI, Magnetic resonance imaging, Ganglion Cyst, Wrist, hand, Ganglion, ganglia, dorsal, volar, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 19 articles in PubMed, 2037 in Scopus, 1 in CINAHL, 8 Cochrane Library, and 40 from Google Scholar. We considered for inclusion 0 from PubMed, 3 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 4 articles considered for inclusion 4 diagnostic studies met the inclusion criteria.

Author/Year Study Type	Score	Number	Area of Body	Diagnoses	Type of MRI used	Type of CT used	T1 weighted images	T2 weighted images	X-ray	Myelography	More than one rater	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Anderson 2006 Retrospective	6.0	34 patients 23 women 11 men Mean age = 29.5	Wrist	Dorsal occult ganglion cyst	1.5-T superconducting magnet	-	+	+	+	-	+	+	-	-	35 abnormalities were diagnosed with MRI: 25 ganglia, 16 dorsal occult ganglia and 6 synovitis. Surgery confirmed MRI diagnosis with an overall agreement of 71% (95% CI, 0.38-0.76) Sensitivity to ganglia was 89% (95% CI 56%-99%) to dorsal occult ganglia cysts was 94% (95% CI 70%-100%)	“MRI is accurate in preoperatively distinguishing between ganglion and synovitis in the setting of chronic dorsal wrist pain”	Data suggest MRI is useful preoperatively in distinguishing between synovitis and occult ganglia particularly in cases of chronic wrist pain and edema.

Goldsmith 2008 Retrospective	5.5	20 patients 20 wrists 11 women 9 men Mean age = 36	Wrist	Occult dorsal wrist ganglion cyst	Siemens' 1.5 T imager	-	+	+	+	-	-	+	-	-	MRI found 16 of 20 wrists had an occult ganglion. Surgery was performed on all 20 patients, identifying 18 occult ganglions. 16 of the 20 wrists had histological features of a ganglion cyst. The 4 negative MRI were positive and 3 of the 18 positive in surgery were negative. MRI at the time of surgery provided a sensitivity of 83%, a specificity of 50% and a PPV of 94%. However, when evaluated with histological findings, the sensitivity was 80%, specificity was 20%, the PPV was 75% and the accuracy was 65%.	"MRI scans provide relatively good reliability in establishing the diagnosis of an occult dorsal wrist ganglion"	Data suggest MRI is a good technique for visualizing occult dorsal wrist ganglia.
Vo 1995 Retrospective	4.0	14 patients with chronic dorsal pain No mention of age or gender	Wrist	Chronic Dorsal Wrist pain of unknown etiology	1.5-Tesla General Electric Signa	-	+	+	-	-	-	+	+	-	10 of 14 were positive for occult dorsal wrist ganglion on the MRI. 7 of the 10 MRI positive patients underwent surgery after nonoperative treatment failed and was confirmed as positive though histological examination. One of the positive patient developed a palpable ganglion. The two other positives were not confirmed. The PPV is 100%	"The use of a properly formatted high-resolution MRI in this patient population was diagnostic for occult dorsal wrist ganglion."	Small sample. Data suggest in the presence of a negative clinical workup, MRI is useful in detecting occult dorsal wrist ganglia.

Cardinal 1994 Prospecti ve	4.0	14 wrists in 13 patients Mean age = 30 9 women 4 men	Wrist	Occult dorsal carpal ganglion	1.5-T Imager, Signa Advanta ge	-	+	+	-	-	-	+	-	-	US identified 11 dorsal carpal ganglion cyst while MRI identified 9. One patient that was positive on US denied a MRI. The other US positive had an inconclusive diagnosis of a ganglion. Five of the cases were confirmed by surgery. One ganglion was missed by both imaging techniques.	“MR imaging and US are equally effective in the detection of occult dorsal carpal ganglia.”	Small sample. Data suggest comparable efficacy between MRI and US for detecting occult dorsal carpal ganglia.
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Evidence for the Use of Ultrasound for Evaluation of Chronic Wrist Pain with Suspected Occult Dorsal or Volar Wrist Ganglia

There is 1 moderate-quality study incorporated into this analysis.(1431) (Osterwalder 97)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: ultrasonography, ultrasound, sonography, ganglion cysts, ganglion, ganglia, dorsal, volar, hand, wrist, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 43 articles in PubMed, 94 in Scopus, 0 in CINAHL, 7 in Cochrane Library, and 2,190 from Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion 1 diagnostic study met the inclusion criteria.

Author/Year Study Type	Score	Number	Area of Bdoy	Diagnoses	Type of Ultrasound	CT used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Osterwalder 1997 Diagnostic	6.0	N = 168; mean age = 27 (52 male, 116 female)	Wrist	suspected occult wrist ganglion who complained of wrist pain and palpation findings were inconclusive	For first three years - Aloka model SSD-6202S, for last two years - Hitachi model EUB-55S, both models used 7.5-MHz linear transducer and spacer	-	+	-	-	-	+	-	-	Out of the 168 patients examined by ultrasound 68 were diagnosed with a cyst and 85 were diagnosed with absence of a cyst. In 15 patients the diagnosis was not clear enough to get a definitive answer. Ultrasound sensitivity, specificity, accuracy, positive predictive value and negative predictive values plus the 95% confidence intervals were the following: 88% (73-96%), 85% (64-95%), 87% (76-94%), 90% (75-97%), 83% (62-94%)	<p>“It was concluded that ultrasound of the wrist can be used as a first-line imaging procedure in clinically inconclusive situations and that ultrasound evidence of an occult dorsal ganglion is a reliable indicator for surgery.”</p> <p>“Only Cardinal et al. 8 specifically discussed MRI and ultrasound diagnoses of occult wrist ganglions. They reported that ultrasound allowed correct diagnosis in 5 positive ganglions and 1 false negative (2-mm) ganglion that MRI had indicated to be 4 positive, 1 false positive, and 1 false negative cases. It is therefore still uncertain whether the reliability of MRI for the diagnosis of occult wrist ganglions can approach that of ultrasound.”</p>	Data suggest US of wrist is useful for imaging inconclusive persistence wrist pain patients who are suspected of having an occult ganglion.

Evidence for Non-Operative Management for Acute Asymptomatic Wrist and Hand Ganglia

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: non operative management, no treatment, ganglion cyst, wrist, hand, ganglion, ganglia, dorsal, volar; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 56 articles in PubMed, 30 in Scopus, 0 in CINAHL, 3 in Cochrane Library, 12596 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, Scopus, CINAHL, Cochrane Library, Google Scholar, and 0 articles from other sources. Zero articles met the inclusion criteria.

Evidence for Aspiration for Acute Cosmetic and Ganglia Related Pain

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: aspiration; ganglion cyst, wrist, hand, ganglion, ganglia, dorsal, volar; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 11 articles in PubMed, 29 in Scopus, 0 in CINAHL, 5 in Cochrane Library, 8,180 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 1 from Cochrane Library, 0 Google Scholar, and 1 from other sources. Of the 3 articles considered for inclusion, 2 randomized trial and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: aspiration, ganglion cysts, ganglion or ganglia, dorsal or volar, hand, wrist, hand, wrist; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 5 articles. Zero articles met the inclusion criteria.*

Evidence for Aspiration with Steroids

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ganglion Cyst (wrist ganglia, dorsal or volar wrist ganglia), Aspiration with steroids; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 4 articles in PubMed, 15 in Scopus, zero in CINAHL, zero in Cochrane Library, 498 in Google Scholar, and zero from other sources. We considered for inclusion 3 from PubMed, zero from Scopus, zero from CINAHL, zero from Cochrane Library, zero from Google Scholar, and zero from other sources. Of the 3 articles considered for inclusion, 3 randomized trials and zero systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: aspiration, steroid, steroids, ganglion cysts, ganglion or ganglia, dorsal or volar, hand, wrist, hand, wrist; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 2 articles. Zero articles met the inclusion criteria.*

Evidence for Aspiration and Multiple Wall Punctures of Cyst Wall

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Aspiration and multiple punctures of cyst wall, Ganglion Cyst (wrist ganglia, dorsal or volar wrist ganglia); controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed zero articles in PubMed, 2 in Scopus, zero in CINAHL, zero in Cochrane Library, 155 in Google Scholar, and zero from other sources. Zero articles met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: aspiration, puncture, punctures, multiple punctures of the cyst wall, ganglion cysts, ganglion or ganglia, dorsal or volar, hand, wrist, hand, wrist.; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.*

Evidence for use of Splinting after Aspiration for Treatment of Dorsal or Volar Wrist Ganglia

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: aspiration, splint, splints, splinting, ganglion cyst, wrist, hand, ganglion, ganglia, dorsal, volar; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 2 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 1,294 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for Installation of Hyaluronidase into Cystic Structure

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: aspiration, hyaluronoglucosaminidase, hyaluronidase, Ganglion Cyst, Wrist, hand, Ganglion, ganglia, dorsal, volar; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 2 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 376 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: Aspiration, hyaluronidase, hyaluronidase instillation, ganglion cysts, ganglion or ganglia, dorsal or volar, hand, wrist, hand, wrist; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.*

Evidence for Use of Aspiration and Sclerosing Agents

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: aspiration and sclerosing agents, phenol and hypertonic saline, ganglion cyst, wrist, hand, ganglion, ganglia, dorsal, volar; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, Scopus, CINAHL, Cochrane Library, 346 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, Scopus, CINAHL, Cochrane Library, Google Scholar, and 0 articles from other sources. Zero articles met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: aspiration, sclerosing, sclerosing agents, ganglion cysts, ganglion or ganglia, dorsal or volar, hand, wrist, hand, wrist; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.*

Evidence for Surgical Excision of Upper Extremity Ganglia

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Surgical Excision, Ganglion Cysts, Ganglion, Ganglia, Dorsal, Volar, Hand, Wrist; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 11 in Scopus, 1 in CINAHL, 5 in Cochrane Library, 20 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 1 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 2 randomized trials and 0 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: Surgical excision, ganglion cysts, ganglion or ganglia, dorsal or volar, hand, wrist, hand, wrist; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 10 articles. Of the 10 articles we considered for inclusion 0. Zero articles met the inclusion criteria.*

Evidence for Arthroscopic versus Open Excision for Ganglia

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Arthroscopy, Arthroscopic, Open Excision, Surgery, Ganglion Cysts, Ganglion, Ganglia, Dorsal, Volar, Hand, Wrist; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 2 in Scopus, 1 in CINAHL, 1 in Cochrane Library, 20 in Google Scholar, and 2 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 2 from other sources. Of the 2 articles considered for inclusion, 0 randomized trials and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: arthroscopic vs. open excision, ganglion cysts, ganglion or ganglia, dorsal or volar, hand, wrist, hand, wrist; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 3 articles. Of the 3 articles we considered for inclusion 1. Of the 1 considered for inclusion, 0 are randomized controlled trials and 1 systematic reviews.*

Evidence for 7 moderate-quality RCTs incorporated into this analysis.(115, 1433, 1434, 1437, 1443-1446) (; Jagers Op Akkerhuis 02) There are 2 low-quality RCTs in Appendix 2.(1440, 1447) (Balazs 15, Varley 97)

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Aspirations and Multiple Puncture group										
Stephen 1999 (score=4.0)	Aspirations and Multiple Punctures	RCT	No mention of sponsorship or COI.	N = 119 with ganglia	No mention of age. Male to female ratio 1:3.1.	Simple aspiration (n = 65) Vs Aspiration and multiple wall punctures (n = 54)	Follow-up for 1 year.	“16 of 51 ganglia (31%) treated by aspiration alone resolved and did not recur in contrast to 9 of 41 ganglia (22%) in the multiple puncture group.”	“The study has demonstrated that multiple puncture of the ganglion wall does not improve the results of simple ganglion aspiration.”	Lack of study details. No randomization or allocation details. Drop-out 23% at 1-year follow-up.
Aspiration and Steroid Alone (prior use of Hyaluronidase)										
Paul 1997 (score=4.0)	Aspiration and Steroid Alone (prior use of Hyaluronidase)	RCT	No mention of sponsorship or COI.	N = 70 with ganglia of the wrist or hand.	Mean age given. 29 males, 41 females.	Group 1, local anesthetic of 0.5% lignocaine plus 0.5 mls of ganglion contents were aspirated v via a 16 gauge needle (n= 35) Vs Group 2, treated by conventional technique of aspiration under local anesthetic and immediate injection of 40 mg of Depomedrone (n= 35).	Follow up at 2 years	Patients reporting excellent results significantly higher in hyaluronidase group (49% vs. 20%, p = 0.0051). However, good and excellent ratings combined showed trend for hyaluronidase (89% vs. 57%) but not significant, (p = 0.072).	“The cure rate with the combined use of hyaluronidase and methylprednisolone was 89% compared to 57% when treated by aspiration and instillation of methylprednisolone alone.”	Lack of study details. 100% follow-up achieved at 2 years. Treatment may be beneficial for viscous cystic fluid that is too viscous for aspiration.
Aspiration and Surgical Excision and Steroid Injection										

Limpaphayom 2004 (score=6.5)	Aspiration and Surgical Excision and Steroid Injection	RCT	No mention of sponsorship or COI.	N = 28 pts with first time dorsal carpal ganglion	Mean age: 26.6 years; 4 males, 24 females	Surgery, 5 cc of 1% Xylocaine (n = 11) vs Aspiration, steroids, and immobilization (n = 13).	Follow up at 6 months	At 6 month follow-up, the success rate was 81.8% by surgical excision and 38.5% by aspiration,(p = 0.047).	“Result of treatment can be varied but by this RCT, surgery was shown to obtain a superior result in terms of success rate than aspiration, methylprednisolone acetate injection plus wrist immobilization.”	Single trial of aspiration. Lack of blinding. Only included dorsal wrist ganglia.
Latif 2014 (score=4.0)	Aspiration and Surgical Excision and Steroid Injection	RCT	No mention of sponsorship or COI.	N = 173 with ganglia within wrist, ankle and knee.	Mean age 26 years; 36 males and 147 females	Group 1 who opted for aspiration and injection treatment (n = 143) Vs Group 2 who opted for surgical treatment (n = 44).	Follow-up baseline and 6 months.	Group 1 vs group 2 success at third week of injection: 82 (57%) vs 41 (93%). Success rate at 6 months (116 (81%) vs 0 (0%). Failure rate within group 1 vs group 2: 27 (19%) vs 3 (7%) (p <0.028).	“In symptomatic ganglia, surgical excision is a better treatment option as the failure rate is less compared to triamcinolone acetate injection after aspiration..”	Data suggest surgical excision best treatment for symptomatic ganglia vs. injection-aspiration. At 6 months, injection-aspiration success rate 81.0% vs. surgical excision 93.0%. Failure rates significant at 19.0% for injection-aspiration group and 7.0% for surgical excision group.
Jagers Op Akkerhuis 2002 (score=4.5)	Aspiration and Surgical Excision and Steroid Injection	RCT	No mention of sponsorship or COI.	N = 89 patients with untreated ganglia of wrist or foot.	Mean age: 39.5 years; 27 males, 62 females	Hyaluronidase + Aspiration (n = 43) Vs Surgical Excision (n = 46)	Follow-up 1 year.	Hyaluronidase treatment resulted in recurrence in 33 of the 43 patients (77%). Recurrences after surgery were found in 11 of the 46 (24%) patients: six within 3 months	“Surgical excision is preferable to aspiration after hyaluronidase, assuming that the aim of treatment is resolution of the ganglion. However	Data suggest HA groups had a recurrence rate at 1 year of 77% vs. the surgery group 24% (p<0.01) when treating ganglia showing lack of efficacy.

								and five between 3 months and 1 year.	hyaluronidase and aspiration has a 23% success rate and can be used for those patients who prefer not to undergo surgery.”	
Arthroscopic Resection vs Open Excision Technique										
Rocchi 2008 (score= 4.0)	Arthroscopic Resection vs Open Excision Technique	RCT	No mention of sponsorship. No COI.	N = 51 with dorsal wrist ganglions	Mean age: 29.8 years; 17 males, 24 females.	Arthroscopic resection (n = 41) vs Open excision of volar ganglion cyst (n = 10).	Follow-up for 47.8 months.	Comparisons by radiocarpal ganglia (RCG) and midcarpal ganglia (MCG) locations. For open resection of RCG, mean functional recovery time 13 days with mean time lost from work 21 days, 15/20 reporting good results at 24 months and 3 bad results. Arthroscopic RCG 18/20 good results with 9 days recovery time and 9 days lost time. MCG subgroup, 5/5 good results with open excision with functional recovery time 10 days, lost time 17 days; 1/5 in arthroscopic group treated successfully.	“Comparing our two groups, we noted rather better results with arthroscopy in the treatment of radiocarpal ganglia, and better results for open operation in the treatment of midcarpal ganglia.”	No statistical analyses presented.
Kang 2008 (score= 4.0)	Arthroscopic Resection vs Open Excision Technique	RCT	No sponsorship. No mention of COI.	N = 72 with ganglion recurrence or wrist pain.	Mean age for the open group was 36 years and for the arthroscopi	Arthroscopic technique consisted of 2 stab incisions at the standard 3-4 and 4-5 portal sites (n = 41)	Follow-up of 12 months.	At 4-8 weeks, 1/41 in arthroscopic group vs. 0/31 in open excision group had recurrence (p = 0.381). 17% in arthroscopic group	“The results of our study suggest that the technique of arthroscopic surgery does not achieve superior	Lack of study details. High attrition rate at 12 month follow-up. No blinding.

					c group 34 years.	Vs Open excision of dorsal ganglion cyst (n= 31).		reported residual pain vs. 10% (p = 0.369). At 1 year, no significant difference in pain or recurrence.	rates of ganglion recurrence.”	
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Evidence for the Use of Medications for Upper Extremity Ganglia

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: anti-inflammatory agents, non-steroidal, NSAIDS, non-steroidal anti-inflammatory, ibuprofen, acetaminophen; ganglion cyst, wrist, hand, ganglion, ganglia, dorsal, volar; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 3 in Scopus, 0 in CINAHL, 8 in Cochrane Library, 7,710 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Exercise for Upper Extremity Ganglia

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, exercising, physical activity; ganglion cyst, wrist, hand, ganglion, ganglia, dorsal, volar; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 articles in PubMed, 5 in Scopus, 0 in CINAHL, 9 in Cochrane Library, 15,300 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for Special Studies for HAVS

A recent review of the literature concluded that there does not appear to be any single test with satisfactory diagnostic capability in diagnosing HAVS (white finger), but supports the use of cold provocation testing (CPT) as reasonable.(1460) However, a large scale review of cold provocation testing in over 40,000 UK miners being evaluated for compensation claims found only slight correlation of self-reported clinical severity and CPT results, concluding that CPT should not be used for evaluating the vascular component of HAVS.(1461) There remains no established standard for CPT methodology, which makes interpretation and comparisons difficult. While the test is relatively benign and inexpensive, the results are of unknown diagnostic utility.

There is little information available supporting the utility of thermographic imaging. Most of the reports are of small populations. The most recent study (21 patients) concluded that none of the available methods is sufficient for arterial constriction testing, but may be useful in follow-up testing of individuals.(1462) A similar story exists for finger systolic blood pressure monitoring as a diagnostic test. A recent prospective study measuring the changes in finger systolic blood pressure (FSBP) after segmental local cooling for vibration-induced white finger in vibration exposed vs. non-exposed populations showed a significant decrease in FSBP in the exposed group with reported HAVS vs. non-exposed as well as the exposed with no history of HAVS. The sensitivity and specificity of the FSBP test with a cut-off value of 75% of normal at 23 +/- 1 degrees C, were 65.2 and 87.5%, respectively, and at 21 +/- 1 degrees C, they were 73.9 and 82.5%, respectively.(1463) However, the study used self-report of HAVS and included retired (no longer exposed) persons in the exposed with HAVS group.

Testing for neurological deficits may be slightly more beneficial than vascular testing for confirming the severity of nerve damage associated with HAVS, although they are not definitive in objectively identifying HAVS. In a follow-up report of UK miners being evaluated for HAVS claims, 57,000 persons evaluated with vibrotactile threshold testing and thermal aesthesiometry showed some evidence that these tests are reliable indicators of underlying neurological damage.(1464)

Thus, there is insufficient evidence for making evidence based recommendations on the utility of each of the various tests currently available for the vascular and neurological components of HAVS. Administering a combination of these tests may improve the diagnostic utility when considered in context of the medical history and occupational exposures. Nerve conduction studies may also be indicated to rule out other associated or concomitant upper extremity disorders, although are not likely of useful benefit for diagnosis of HAVS. In addition to neurovascular physiologic testing, there are limited reports of serologic testing for HAVS.

Evidence for the Use of Diagnostic Testing

There are 3 moderate-quality studies incorporated into this analysis.(1458, 1465, 1466) (Coughlin 01a; Coughlin 01b; Poole 04) There are 4 low-quality studies in Appendix 2.(1467-1470) (Lindsell 99; Kurozawa 91; Bogadi-Sare 94; Lawson 97)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Hand-Arm Vibration Syndrome, Vibration white finger, dead finger, white fingers, hand-transmitted vibration, hand-arm vibration, traumatic vasospastic disease, Cold provocation, cold stress thermography, finger systolic blood pressure, vibrotactile threshold testing, thermal aesthesiometry, nerve conduction velocity, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 0 articles in PubMed, 2 in Scopus, 0 in CINAHL, 16 Cochrane Library, and 120 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 4 from Google Scholar, and 5 from other sources. Of the 9 articles considered for inclusion 7 diagnostic studies met the inclusion criteria.

Author/Year Study Type	Score	N	Area of Body	Diagnoses	Type of Thermography	CT used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Coughlin 2001 Same as OCC MED Case Control	5. 5	31 subjects in two groups. Group A: 10 healthy volunteers. 5 men, 5 women. Median age of 35. Group B: 21 patients. 20 men, 1 woman. Median age of 45	Hand	HAVS with RP	Cold Provocation	-	-	-	-	-	-	-	-	After cold provocation, the finger temperature and time for the finger temperature to return to pre-cooling levels were able to distinguish the HAVS group and the normal group. The sensitivity of CPT was low after cooling, but reach up to 95% 3 min after rewarming. The accuracy of the test was also the greatest towards the last stages of rewarming. The specificity and PPV were high during precooling stages and remained relatively high during the rewarming stages. NPV was low during the precooling stage and became high (>90) during the rewarming stages.	“CPT has a good sensitivity, specificity, positive predictive value and negative predictive value; it strongly supports the clinical diagnosis of digital vasospasm.”	Data suggest CPT test has good sensitivity and specificity and supports a diagnosis of digital vasospasm.

Author/Year	Score	Study Design	Population/ Case Definition	Investigative Test	Gold Standard/ Comparative Test	Results	Conclusion	Comments
Poole 2004	6. 0	Case Control	N = 46 24 Males with HAVS VS 22 Males without HAVS (Control) Mean age = 46	Measuring FSBP after cold provocation at 30, 15 and 10°C	FST measurement following immersion of hands in 15°C water for 5 min	FSBP on the middle finger yielded a sensitivity of 60%, specificity of 84.1%, PPV of 71.5%, and a NPV of 75.9%. Compared to FSBP, FST had results of 68%, 71%, 61%, and 77%, respectively.	“Based on our data, the FSBP may also have limited use in confirming a positive diagnosis of vibration-induced vascular problems.”	Data suggest FSBP is of limited value as a diagnostic test for HAVS although it may have value in ruling out and/or confirm the vascular component of HAVS.
Coughlin 2001 OCC MED	5. 5	Case Control	N = 50 particip ants 20 with HAVS VS 15 Sedenta ry worker VS 15 manual workers	Two-Point discrimination	Depth sense perception	When testing using DSP, there was no significant difference in the right hand of all three groups. The left hand was significantly poorer in the HAVS group than the two others. DSP has a sensitivity of 41, specificity of 94, PPV of 82 and NPV of 70. When testing with TPD, both hands were significantly poorer in the HAVS group than the two other groups. TPD has a sensitivity of 46, specificity of 94, PPV of 84, and NPV of 72.	“The increased sensitivity of the TPD disc would suggest that it should be used in preference to the DSP disc for the assessment of sensorineural dysfunction in patients with HAVS.”	Data suggests the 2 point disc provides increased sensitivity for the assessment of HAVS vs. the depth sense disc.

			No mention of mean age.					
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Evidence for the Use of Serologic Testing or Connective Tissue Disorders Testing

There is 1 moderate-quality study incorporated into this analysis. (1471) (Kanazuka 96) There is 1 low quality study in Appendix 2. (1472) (Kennedy 99)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Hand-Arm Vibration Syndrome, Vibration white finger, dead finger, white fingers, hand-transmitted vibration, hand-arm vibration, traumatic vasospastic disease, Cold provocation, cold stress thermography, finger systolic blood pressure, vibrotactile threshold testing, thermal aesthesiometry, nerve conduction velocity, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 0 articles in PubMed, 0 in Scopus, 4 in CINAHL, 9 Cochrane Library, and 150 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 2 from other sources. Of the 3 articles considered for inclusion 3 diagnostic studies met the inclusion criteria.

Author/Year	Score	Study Design	Population/ Case Definition	Investigative Test	Gold Standard/ Comparative Test	Results	Conclusion	Comments
Kanazuka 1996 No mention of sponsorship or COI.	4.0	Case Control	N=175 Males 100 Patients with HAVS (Mean age = 63.0±6.3) Vs 25 Patients with collagen disease (Mean age	TM one-step sandwich enzyme immunoassay	Not mentioned	Patients with HAVS had a significantly higher level of plasma TM (3.32±1.11 ng/mL) than the normal control (2.49±1.05 ng/mL, p<0.0001). There was no significant difference between the HAVS group and the collagen disease group (3.65±2.02 ng/mL, p<0.01).	“[W]e suggest that endothelial injury is present in vibration syndrome, the degree of endothelial injury in vibration syndrome equals that in collagen disease, and the endothelial injury in chain-saw operators is greater than that in rock-drill operators.”	Data suggest endothelial injury exists in patients with VWF as well as collagen disease.

			= 43.5±16.8)					
			Vs 50 Healthy patients (Mean age = 56.8±7.8)					

Evidence for the Use of Calcium Channel Blockers for HAVS

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: calcium channel blockers, hand arm vibration syndrome, vibration white finger, dead finger, white fingers, hand-transmitted vibration, hand-arm vibration, traumatic vasospastic disease; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 19 articles in PubMed, 0 in Scopus, CINAHL, and Cochrane Library, 152 from Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, CINAHL, Cochrane Library, Google Scholar, and from other sources. Of the 1 articles considered for inclusion, 0 randomized trials and 1 systematic studies/background met the inclusion criteria.

Evidence for the Use of Exercise for HAVS

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, exercising, physical activity, Hand-Arm Vibration Syndrome, vibration white finger, dead finger, white fingers, hand-transmitted vibration, hand-arm vibration, traumatic vasospastic disease; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 2 in Scopus, 0 in CINAHL, 14 in Cochrane Library, 1,158 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of X-ray for Evaluation of Lacerations with Suspected Fracture or Foreign Body

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Laceration management, x-ray, xray, radiography, lacerations with suspected fracture, foreign bodies, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 24 articles in PubMed, 20 in Scopus, 0 in CINAHL, 0 in Cochrane Library, and 1880 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Ultrasound for Evaluation of Suspected Superficial Foreign Bodies

There are 4 quality studies incorporated into this analysis.(1476-1479) (Soubeyrand 08; Tahmasebi 14; Wu 12; Fornage 86)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ultrasound, Laceration Management, Suspected superficial foreign bodies, ultrasonography, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 122 articles in PubMed, 62 in Scopus, 0 in CINAHL, 0 in Cochrane Library, and 8,560 from Google Scholar. We considered for inclusion 0 from PubMed, 2 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 5 articles considered for inclusion 4 diagnostic studies met the inclusion criteria.

Author/Year Study Type	Score	N	Area of Body	Diagnoses	Type of Ultrasound	CT used	MRI Used	More than one rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
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<p>Soubeyrand 2008 Diagnostic</p> <p>No mention of sponsorship or COI.</p>	<p>7.5</p>	<p>N=30 injuries in 26 patients (19 males, 7 females) Mean age: 34 years</p>	<p>Hand and Wrist</p>	<p>Laceration Management/Lesion</p>	<p>Doppler Ultrasound</p>	<p>-</p>	<p>-</p>	<p>+</p>	<p>-</p>	<p>-</p>	<p>+</p>	<p>+</p>	<p>72 hours</p>	<p>There were 20 injuries of the finger and 10 of the palm The right side was involved in 17 of 30 injuries (57%) and the dominant hand was involved in 11 of 30 injuries (37%). Injury at home occurred in 18 cases and at work in 10 cases. Two patients were injured on the street. Penetrating object was glass in 17 injuries, knife in 7 injuries, metallic object in 2, human teeth in 2, machinery in 1, and a stone in 1. A complete US examination was performed in all 30 cases, despite moderate pain in two cases. Of 98 examined tendons, 81 appeared intact and 17 were damaged. Of 81 examined nerves, 63 appeared intact and 18 were damaged. Of 75 examined arteries, 61 appeared intact and 14 were damaged. The lesion path was visualized in 22 of the 30 injuries. In five injuries, the path did not extend beyond the fascial layer (superficial injury), and in two injuries, the path ended in the muscle. Foreign bodies were visualized in five injuries.</p>	<p>“In conclusion, US proved highly effective in detecting tendon and arterial lesions. The results were less reliable regarding nerve damage. US may be effective in identifying hand lesions that require surgical repair and in selecting patients who can be treated without surgical exploration, provided they undergo a second physical examination 72 hours after the injury. Further studies in larger numbers of patients are needed to evaluate this possibility.”</p>	<p>Data suggest US is effective in the detection of volar injuries without tendon or arterial lesions but not as good for detection of nerve lesions.</p>
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<p>Tahmasebi 2014 Diagnostic Sponsored by Nil and no COI.</p>	<p>5.5</p>	<p>N=51 patients (41 males, 10 females) Mean age: 24.95±13.4 years</p>	<p>HWF</p>	<p>Laceration Management</p>	<p>USG</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>+</p>	<p>-</p>	<p>-</p>	<p>Predominant chief complaints of the patients were: foreign body sensation in 24, discharging wound in 15, and pain in 12 cases. Ten cases had a history of surgical exploration without the use of USG examination, which had no foreign body detected. On USG scan, 100% of the foreign bodies were echogenic. USG revealed a foreign body in 50 patients. All patients underwent surgical exploration or USG-guided removal. Forty-six patients had a foreign body removed. One patient had a negative USG exam and surgical exploring revealed a 7-mm thorn. USG was falsely positive in three cases with failed surgical manipulation due to the presence of air bubbles and scar tissue, as well in as one case with calcified granuloma. Foreign bodies were thorn, wood, glass, and plastic. The sites of the foreign bodies were foot, hand, leg, arm, forearm, ankle, wrist, knee, and thigh. Sizes of foreign body varied from 4-51 mm and in 50% of cases, the size of the foreign body was greater than 13 mm.</p>	<p>“Real-time high-frequency USG is a highly sensitive and accurate tool for detecting and removing the radiolucent foreign bodies, which are difficult to be visualized by routine radiography.”</p>	<p>Data suggest US can detect radiolucent-soft-tissue foreign bodies that radiographs can not.</p>
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Wu 2012 Diagnostic	4.5	N=34 patients	H W F	Laceration Managem ent	Bedsid e Tendo n Ultras onogra phy	-	+	-	-	-	-	+	-	<p>“Thirty-four patients were enrolled in this study. There were 6 finger injuries, 11 hand injuries, 6 forearm injuries, 6 arm injuries, and 5 lower extremity injuries. Based on MRI or direct wound exploration, 4 patients had partial tendon injuries, 9 patients had complete tendon injury, and 21 patients had no evidence of tendon injury noted. Bedside ultrasound was able to accurately diagnose the extent of tendon injury in 33 of the 34 total cases. In comparison, physical examination accurately diagnosed 29 of the 34 total cases. On average, time to diagnosis and disposition based on bedside ultrasound findings was 46.3 minutes. In contrast, overall time to wound exploration, MRI, or consultation was 138.6 minutes.</p>	<p>“Bedside ultrasound is more sensitive and specific than physical examination alone for detecting tendon lacerations and takes less time to perform than traditional wound exploration techniques or MRI. Data obtained from bedside ultrasonography can be used to improve diagnostic accuracy and enhance and expedite patient care.”</p>	<p>No mention of gender or mean age. Data suggest bedside US increases the sensitivity/specificity in detection of tendon injuries when compared to physical exam alone.</p>
Fornage 1986 Diagnostic No mention of sponsorship or COI.	4.0	N=10 patients suspected of having a foreign body in either hand or foot.	Hand and Foot	Laceration Managem ent	High- resolut ion linear array real- time scanne r sonogr aphy	-	-	-	-	-	+	-	-	<p>“Eight foreign bodies were found at surgery; glass in 4 cases, metal in 3 cases, and vegetable material in 1 case. All foreign bodies were visualized as hyperechoic on sonograms. An acoustic shadow was present in 2 cases only (glass fragments). A hyperechoic comet-tail artifact secondary to reverberations inside the dense echogenic foreign body was visualized in 3 cases. In 7 cases a surrounding hypoechoic mass ranged from 1.2-3 cm in diameter correlated well with inflammatory changes found at surgery. Seven of the eight foreign bodies were glass or metallic fragments and were radiopaque with sizes of 0.1-1 cm. In 1 case a vegetable fragment responsible for a cyst could not be seen on the radiograph, but was demonstrated on sonograms.</p>	<p>“Evaluation of foreign bodies should begin with radiographs. If these are negative or inconclusive, sonography may be helpful in detecting nonopaque foreign bodies or foreign bodies in areas that are not easily evaluated by radiographic projections. When a foreign body is visualized, sonography allows its 3D localization.</p>	<p>No mention of gender or mean age. Data suggest after initial radiographic evaluation for foreign bodies are negative, sonography may be useful in locating foreign bodies.</p>

Evidence for the Use of CT for Evaluation of Suspected Superficial Foreign Bodies

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Laceration, Foreign, CT, CAT, Computerized Tomography, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 60 articles in PubMed, 12 in Scopus, 0 in CINAHL, 63 Cochrane Library, and 4680 from Google Scholar. Zero articles met the inclusion criteria.

Evidence for Wound Preparation

There is 1 high-(1486) and 3 moderate-quality(1485, 1489, 1490) RCTs incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: wound preparation, wound cleansing, irrigation, debridement, wound healing, laceration, wound, cuts, management, repair, care, upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 4 articles in PubMed, 0 in Scopus, 15 in CINAHL, 5 in Cochrane Library, 8321 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 5 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Wound Irrigation Tap Water vs Normal/Sterile Saline						
Bansal 2002 RCT Sponsored by funds from Sarah M. and Charles E. Seay Distinguished Chair in Pediatric Medicine, University of Texas. No mention of COI.	9.0	N = 46 (17 female and 28 male) with simple lacerations. Age range 2-15.	Wound irrigation by high pressure (25-40 PSI) syringe using tap water (N = 21) vs Normal sterile saline (N = 24). Follow-up for 48 hours.	Post irrigation culture positive in 11/21 (52%) for tap water, 7/24 for sterile saline (29%) p = 0.20. No difference in infection rates at 48 hours.	“Our study suggests that tap water may serve as a cost-saving alternative to normal saline for irrigating simple lacerations before repair.”	Hand lacerations were excluded. Pediatric population.
Moscato 2007 RCT Sponsored in part by a grant from the Federal	7.5	N = 715 with acute simple lacerations require ing sutures or staples. Age and gender not specified.	Tap water irrigation at sink (N = 300) vs High pressure sterile saline (N = 334). Follow-up for 48 hours.	11/374 in saline group developed infection (3.3%) vs. 12/339 (4.0%) with no significant difference between the groups.	“Compared with sterile saline, tap water for wound irrigation is more cost-effective and appears to be equally safe and efficacious.”	Sixty percent of enrolled lacerations were of upper extremity. Baseline comparability of common variables not presented. Author estimates total US savings \$65.6 million by using tap water irrigation vs. current practice.

Highway Administration and he Calspan University at Buffalo Research Center. No mention of COI.						
Wound irrigation: Syringe Irrigation vs Pressurized Canister						
Chisholm 1992 RCT Sponsored in part by a grant from Dey Laboratories, Inc.	5.0	N = 542 (male to female ratio 1.8:1 and 2.7:1 in Canister group) with lacerations requiring closure. Mean age for Syringe and Canister groups; 24.9 and 23.8 years.	220mL canister of sterile NS with 0.006% benzalkonium chloride (N = unknown) vs NS irrigation using 30-mL syringe, 20-gauge IV catheter tip 1 in. above skin edge, depress syringe plunger with maximal force (N = unknown). Follow-up	Face and hands most frequently lacerated. Mean irrigation time for pressurized canister group (281) 3.9 vs. 7.3 minutes for syringe irrigation group (254) (p <0.0001). Wound complications occurred in 8/221 (3.6%) in syringe irrigation group and 12/ 245 (5.0%) in pressurized canister group, (p = 0.50).	“There was no significant difference in infection rates between the two groups. The pressurized canister group’s wounds were cleansed in almost half the time of those in the syringe group.”	Lack of control for dressing type, use of topical antibiotics. Final wound observations made by multiple observers including patient self-report office based practitioners, and ED practitioners.
Sterile vs Nonsterile Gloves for Uncomplicated Lacerations						

<p>Perelman 2004 RCT Sponsored by research grants from Canadian Association of Emergency Physicians and Bales Research Foundation of North York General Hospital. No COI.</p>	<p>7.5</p>	<p>N = 816 (221 female and 595 male) any type of uncomplicated soft tissue lacerations. Age for Standard and Clean nonsterile groups: 30.2± 18.2 and 30.5±19.1.</p>	<p>Standard intervention, sterile (N = 408) vs Clean non-sterile gloves for uncomplicated lacerations in immunocompetent patients (N = 408). Follow-up for 1 year.</p>	<p>Infection rates: sterile gloves (n = 24) 6.1% (95% CI 3.8-8.4%) vs. clean gloves (n = 17) 4.4% (2.4-6.4%) (NS). No difference in infection rates (relative risk 1.37; 95% CI 0.75 to 2.52; p = 0.295).</p>	<p>“[S]tudy provides evidence that clean, nonsterile, boxed gloves can be safely used for repairing uncomplicated traumatic lacerations without increasing the risk of wound infections.”</p>	<p>All wounds injected with pressure. Unclear if blinding possible for proportion of follow-ups completed at study sight vs. those going elsewhere. Laceration sites: extremities in 61.8% of patients, head or neck in 36.6%, and trunk or buttocks in 1.6%.</p>
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Evidence for Wound Anesthesia

There are 5 high-(1491, 1496, 1497, 1499, 1500) and 5 moderate-quality (1492-1495, 1498) RCTs incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: anesthesia, wound healing, laceration, wound, cuts, management, repair, care, upper extremity, local infiltration plus topical anesthetic; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 76 articles in PubMed, 39 in Scopus, 3 in CINAHL, 3 in Cochrane Library, 4524 in Google Scholar, and 5 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 5 Google Scholar, and 5 from other sources. Of the 10 articles considered for inclusion, 10 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Digital vs. Local Infiltration						
Chale 2006 RCT No mention of sponsorship or COI.	9.0	N = 55 (16 female and 39 male) with traumatic lacerations of 1 finger. Age 40.1 (19.3) digital group; 36.3 (14.0) topical group.	Digital block 1 to 2 mL of lidocaine 1% was injected on both sides of the finger (N = 28) vs Local anesthesia 1 to 2 mL of lidocaine 1% was injected (N = 27). Both had topical anesthetics as co-intervention. 15 minute topical application	Wound outcomes; digital vs. local anesthesia: Time until onset of anesthesia in minutes: 7.7 vs. 1.9 p = 0.001. Mean pain of needle insertion in mm: 29.4 vs. 28.1 p = 0.87. Mean pain of anesthetic infiltration in mm 24.9 vs. 22.6, (p = 0.72).	“Digital and local anesthesia of finger lacerations with prior application of LET to all wounds results in similar pain of needle insertion, anesthetic infiltration, and pain of suturing.”	Application of LET to all wounds makes comparison of digital to local needle injection pain difficult in the absence of LET, which is most cases in the U.S.
Robson 1990 RCT No mention of sponsorship or COI.	5.0	N = 60 (gender not specified) with lacerations of the digits. Age over 16 years.	Digital block 1 ml of anesthetic was applied (N = 28) vs Local anesthesia 2% plain lignocaine (N = 32). Follow-up unclear.	Assessment by patient and operator for pain related to application of anesthesia and suturing significantly better for digital block compared with local infiltration, (p < 0.01).	“[D]igital block should be considered as the method of choice in all cases of digital lacerations requiring local anesthesia for their repair.”	No baseline comparison data was presented.
Injectable Agents						
Ernst 1996 RCT No mention of sponsorship or COI.	10.0	N = 200 (50 female and 130 male) with simple lacerations not involving vascular compromise infection. 18 years of age.	Group A, buffered 1% lidocaine (N = 45) vs Group B, buffered 1% lidocaine with epinephrine (N = 46) vs Group C, 1% lidocaine with epinephrine (N = 47) vs Group D, 0.5% diphenhydramine for suturing of minor lacerations (N = 42).	“Buffered lidocaine (A) and buffered lidocaine with epinephrine (B) were significantly less painful to inject than was diphenhydramine with epinephrine (D) (p < 0.01 for both the physicians and the patients). Lidocaine with epinephrine (C) was not statistically different from A, B, or D (p < 0.05). For suturing (anesthesia	“Although we found buffered lidocaine solutions less painful to inject in this four-agent comparison study, we were unable to detect a statistically significant difference.”	Author confirms findings of related study on diphenhydramine causing more pain on injections with solutions at room temperature in this study.

			Follow-up unclear.	effectiveness), the patients and the physicians found that lidocaine with epinephrine with or without buffering (B or C) worked better than A or D, (p < 0.01).”		
Topical Agents						
Ernst 1995 RCT Sponsored by grant from Louisiana State University Emergency Medicine Residency Grant Fund. No mention of COI.	9.5	N = 95 (23 female and 76 male) with linear lacerations of face or scalp. Mean age LAT/TAC group: 33±11 / 34±13.	LAT or lidocaine – adrenaline-tetracaine (N = 48) vs TAC or tetracaine – adrenaline – cocaine (N = 47). Follow-up for unclear.	LAT found to have fewer painful sutures than TAC (p = 0.036). For physician ratings, difference between LAT vs. TAC groups showing that LAT more effective than TAC during suturing, (p = 0.093). Patient ratings however showed no significant difference in pain scores.	“We found that patients had smaller percentages of sutures causing pain in the LAT group than in the TAC group.”	This study of topical anesthetics was in an adult population. Study limited to small lacerations (< 5 cm). Anesthetic solutions were refrigerated which may have affected results (painful injections).
Singer 2001 RCT No mention of sponsorship or COI.	9.5	N = 60 (14 female and 44 male) with pretreating lacerations prior to lidocaine injection. Mean age 8.5 years.	EMLA cream (N = 31) vs LET or cream for pretreating lacerations prior to lidocaine injection (N = 29). Anesthetic application times range from 15 to 135 minutes, not other follow up specified.	“51/54 wounds received supplemental injection of lidocaine and were similar in the both groups (92% for LET vs 97% for EMLA, p = 0.47). Wounds treated with LET were more frequently anesthetic to a stick with a 27-gauge needle than wounds treated with EMLA (73% vs 40%, respectively, p = 0.01)... no difference in the median pain of supplemental lidocaine injection between the two groups.”	“[P]retreatment of uncomplicated lacerations ... with LET or EMLA cream results in a similar reduction in the pain of subsequent injection of lidocaine.”	Lack of placebo group.
Schilling 1995 RCT	8.5	N = 171 (51 female and 100 male) with uncomplicated laceration on face or scalp.	Lidocaine, epinephrine, tetracaine (LET) solution (N = 57) vs Tetracaine, adrenaline, cocaine (TAC) solution (N = 58).	“In the TAC and LET groups combined, 116 of the 151 patients (76.8%) received adequate anesthesia before suturing. There was no difference between TAC	“LET is an effective alternative to TAC for topical anesthesia during suturing of uncomplicated lacerations on the face and scalp in children.”	Applicability uncertain as population was pediatric with scalp/ facial lacerations. May have had adult parents with needle phobia.

Sponsored by FA Bean Education and Research Fund, Minneapolis Children's Medical Center. No mention of COI.		Mean age TAC/LET group: 5.9 ±3.3/6.4±3.4	Serum lidocaine obtained 10, 20, and 40 minutes after LET and TAC application.	(79.5%) and LET (74.4%) (p = 0.46). There was no difference between TAC and LET in adequacy of anesthesia before suturing or duration of anesthesia during suturing of lesions located on the forehead/eyebrow or scalp area.”		
Pryor 1980 RCT No mention of sponsorship or COI.	7.5	N = 151 (gender not specified) with lacerations. Age range 1 to >17, mean age 9 years.	Topical TAC (N = unknown) vs topical lidocaine (N = unknown) vs placebo for lacerations <5cm (N = unknown). Wound complications assessed at 48 to 72 hours.	“These was no significant difference between patients anesthetized with TAC (18%) and lidocaine (23%) in their need for additional lidocaine following initial anesthetic application and/or during wound repair; 83% of the patients in the placebo group required supplemental lidocaine. Successful initial anesthesia did not differ significantly in any of the anesthetic groups. TAC produced initial anesthesia more often in extremity locations vs lidocaine or placebo.”	“These results suggest that TAC, when applied correctly, may be the preferred anesthetic for laceration repair in children.”	Blinding only in TAC vs placebo group. Remarkably, 17% of topical placebo group did not require anesthesia. Study was pediatric population.
Zempsky 1997 RCT Sponsored by by grant from the General Clinical Research Center, Children's Hospital of Pittsburgh. No	7.5	N = 32 (gender not specified) with lacerations. Ages 5 to 18 years.	EMLA without supplemental anesthesia (N = 16) vs TAC for suturing uncomplicated extremity wounds (N = 16). Mean time of anesthetic application in the EMLA-treated group was 55 minutes vs 29 minutes in TAC-treated group, (p < 0.01).	“85% of EMLA group had complete wound repair without supplemental anesthesia, compared with 7 of 16 patients (45%) in the TAC-treated group (p=0.03)... The mean time of anesthetic application in the EMLA-treated group was 55 minutes, compared with 29 minutes in the TAC-treated group (p<0.01). The EMLA- and TAC-treated groups were not significantly different	“Our data show that extremity wounds treated with EMLA for 60 minutes require supplemental anesthesia less often than those wounds treated with TAC for 30 minutes.”	No mention of control of other analgesics. May not be applicable to adults. Although inclusion criteria was up to 18 years old.

mention of COI.				with regard to the VAS scores.”		
Kuhn 1996 RCT Sponsored by grant from Development Fund of Society of Hospital Pharmacists of Australia. No mention of COI.	7.5	N = 181 (gender not specified) with lacerations. Age >12 years.	MAC (N = 95/114) vs TAC topical anesthesia for wound suturing (N = 37/66). Follow-up unclear.	“There was no significant difference in the overall efficacy of the two solutions... MAC was significantly more effective in anaesthetizing wounds of the head than of the extremities (p<0.001), while TAC did not differ significantly in effectiveness between the two sites...Patients’ preference for topical anesthesia in the future did not differ markedly between the two treatment groups: 70/86.”	“MAC can be substituted for the less readily available TAC whenever expedient.”	Purpose of study was to determine if acceptable alternative to tetracaine, which is not readily available in Australia. Allocation method and baseline comparability unclear.
Vinci 1996 RCT No mention of sponsorship or COI.	7.0	N = 156 with lacerations. Age range 3-18 years.	Group I, TAC 11.8% cocaine (N = 49) vs Group II, TAC 4% cocaine (N = 49) vs Group III, tetracaine plus cocaine 4% for lacerations anesthesia (N = 58). First assessment after 15 minutes and 15 after second application.	“Solutions containing 11.8% cocaine (TAC 1) and 4% cocaine with adrenaline (TAC 2) were significantly more likely (p < 0.001) to produce complete anesthesia then the solution with 4% cocaine without adrenaline...A second dose of TAC 3 was more often required to produce complete or partial anesthesia, (p< 0.003).	“The application of a TAC solution containing 4% cocaine is as effective as a TAC solution containing 11.8% cocaine; use of this 4% solution decreases the cost of the agent.”	No placebo group. Allocation unclear. Population 3-18 year olds.

Evidence for Wound Repair

There are 29 moderate-quality RCTs incorporated into this analysis.(151, 1501-1504, 1506, 1509, 1510, 1512-1515, 1517-1530, 1532-1534) There are 4 low-quality RCTs(1507, 1535-1537) in Appendix 2.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: wound repair, wound healing, laceration, wound, cuts, management, repair, care, upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 454 articles in PubMed, 95 in Scopus, 17 in CINAHL, 2 in Cochrane Library, 15062 in Google Scholar, and 0 from other sources. We considered for inclusion 20 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 9 Google Scholar, and 4 from other sources. Of the 34 articles considered for inclusion, 34 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Suturing vs. Healing by Secondary Intention						
Quinn 2002 RCT Sponsored by US National Institutes of Health. JQ was paid by Ethicon, for speaking and educational sympsioms.	7.5	N = 91(40 female and 51 male) with lacerations. Age in Suture and Conservative groups: 40 (16) and 38 (15).	Suturing method of securely closing wounds (N = 47) vs Conservative treatment of uncomplicated lacerations <2cm (N = 48). Follow-up at 8 and 10 days.	Mean scores for cosmetic appearance; suturing vs. conservative treatment: Doctor scores 83mm vs. 80mm; patient scores 83mm vs. 82mm. One sutured wound treated with antibiotics for infection. No infections in conservatively treated wounds.	“Similar cosmetic and functional outcomes result from either conservative treatment or suturing of small uncomplicated lacerations of the hand, but conservative treatment is faster and less painful.”	Results are specific to hand lacerations < 2 cm in linear length. The authors caution against generalization to cosmetically sensitive areas.
Suturing Techniques						
Singer 2005 RCT No mention of sponsorship. No COI.	7.0	N = 65 (9 female and 56 male) with lacerations; mean age 18.5±20.0.	Single-layer sutures (N = 32) vs Double-layer closure of facial lacerations (N = 33).	Mean number of deep sutures used in patients assigned to a 2-layer closure was 2.8 ± 1.4. Wound outcomes; Single vs. double-layer. No infections in either group.	“Single-layer closure of non- gaping, minor facial lacerations is faster than double- layer closure.”	Results may not be applicable to other body areas.
Alam 2006 RCT Sponsored by by research funds from Department of Dermatology, Northwestern University.	7.0	N = 36 (21 female and 15 male) with lacerations. Age 18-65 years.	Simple running polypropylene sutures 14 days (N = unknown) vs Subcuticular running polypropylene sutures 14 days (N = unknown) vs Subcuticular running polypropylene sutures not removed (N = unknown) vs Subcuticular polyglactin 910 sutures left in place (N = unknown). Follow-up at 3 and 9 months.	No difference in suture at either 3 months or 9 months. Greater scar width at 3 and 9 months, with back wounds being wider, (p < 0.001). No technique was superior.	“While scar width does not appear to vary significantly based on choice of epidermal closure, bilayered closures of the trunk and extremity have better overall appearance and less associated erythema at 3 and 9 months.”	Patient was both control and experimental arm with 2 lesions per person.

Jones 1993 RCT No mention of sponsorship or COI. No COI.	7.0	N = 30 (gender not specified) with lacerations. Age for traditional and shorthand group: 27.9 ± 6.3 and 25.3 ± 5.5.	Shorthand vertical mattress sutures (N = 15) vs Classic mattress sutures for lacerations ranging from 2 to 9cm (N = 15). Follow-up 7 to 10 days for wound assessment.	“Suture repair times were significantly shorter using the shorthand vertical mattress stitch compared with the traditional method (88.4 vs. 45.6 sec/suture; p <0.05). No incidents of significant scar widening, cross-hatching, or prolonged inflammation were noted with the shorthand vertical mattress technique.”	“The shorthand vertical mattress stitch is an efficient, alternative method for laceration repair that does not compromise wound eversion.”	Allocations unclear. No blinding.
Karounis 2004 RCT Sponsored by the Montreal Children’s Research Institute and the Canadian Association of Emergency Physicians. No mention of COI.	5.0	N = 95 (58 male and 37 female) with lacerations < 12 hours old requiring suture repair. Mean age for groups A and B: 8.1 and 9.5 years.	Group A, absorbable catgut sutures (N = 50) vs Group B, non-absorbable nylon sutures (N = 45). Follow-up at 4 months.	No differences were found in proportion of optimal WES (6/6) between Group A and NA (62% vs. 49%; relative risk = 0.73%; 95% CI = 0.45 to 1.17). No differences found between Group A and NA for rates of dehiscence (2% vs. 11%; p = 0.07).	“Long-term cosmetic outcomes in wounds repaired with simple plain gut sutures seem to be at least as good as in wounds repaired with non-absorbable nylon sutures.”	Randomization, allocation unclear. High drop-out rate.
Kundra 2010 RCT No mention of sponsorship or COI.	4.5	N = 100 (21 male and 49 female) elective day case hand and wrist surgery. Mean age Absorbable/ non-absorbable group: 54.0 / 57.3.	Absorbable 3/0 Vicryl rapide™ (N = 37) vs Non-absorbable (3/0 nylon) for the wound closure (N = 33). Follow-up 6 weeks post-surgery.	Mean VAS score for wound satisfaction were 82.5 for non-absorbable group vs 80.4 for the absorbable group. Mean DASH scores were 21.7 vs 21.1 absorbable group.	“Either suture material can be used confidently with respect to overall aesthetic appearance in such patients.”	Data suggest both suture types were comparable, but data based upon questionnaire responses.
Suture vs. Staples						
Orlinsky 1995 RCT	7.0	N = 141 with suturable linear lacerations of the extremities. Average age	Stapling (N = 78) vs Suturing for skin closure	“The average speed for stapling was 8.3 seconds per centimeter and for suturing was 63.2	“We conclude that, with respect to emergency department repair	Results are based on hourly wage rather than payment by procedure codes. No outcomes measures for cosmetic results or complications were presented.

No mention of sponsorship or COI.		was 28 years and 29 for suture group.	(N = 83). Follow-up until wound closure, average speed for stapling was 8.3 seconds per centimeter and suturing was 63.2 seconds.	seconds,(p = 0.0001) . Cost of labor was calculated to be 1.23 per minute... The relative labor cost of stapling versus suturing was 0.14 (76 cents v \$ 5.31, p = 0.001). The speed of repair increased with increasing length of lacerations.”	of linear nonfacial lacerations, stapling is a less expensive means of skin closure than suturing.”	
Tissue Adhesives vs. Suturing						
Singer 1998 RCT Sponsored in part by a grant from Closure Medical, Inc., Raleigh, NC. No mention of COI.	7.0	N = 124 (48 female and 76 male) with standard closure of traumatic lacerations. Range age 1-17 years.	Tissue adhesive Octylcyanoacrylate (N = 63) vs Standard wound closure techniques for lacerations (N = 61). Follow-up for 3 months.	Patients treated with octylcyanoacrylate less frequently received local anesthesia (21% vs. 89%, p < 0.001). Groups similar with respect to decontamination with normal saline (81% vs. 75%, p = 0.36), irrigation (50% vs. 65%, p = 0.13), and use of a scrub (48% vs 31%, p = 0.08).	“Wounds treated with Octylcyanoacrylate and standard wound closure techniques have similar appearances 3 months later.”	Comparison group included sutures and staples. Not clear how these were selected once randomized to control group.
Quinn 1993 RCT Sponsored by the Children's Hospital of Eastern Ontario Research Nstitute. No mention of COI.	6.5	N = 81 (34 male and 47 female) children with clean facial lacerations less than 4 cm in length and 0.5 cm in width. Age range, 0.7 to 16 years and 0.5 to 15 years.	Tissue adhesive Histoacryl Blue® (N = 37) vs Suturing with local anesthetic (N = 38). Follow-up for 5 days.	Cosmetic outcomes; Histoacryl vs. suture: Mean visual analog scale score (mm) 60.6 vs. 57.2 p = 0.45	“Histoacryl Blue® is a faster and less painful method of facial laceration repair that has cosmetic results similar to the use of sutures.”	Pediatric population (newborn to 18). Randomization and allocation not well defined.
Holger 2004 RCT	6.5	N = 150 (108 male and 42 female) with facial lacerations. Mean age for those completing follow-	OC or octylcyano-acrylate tissue adhesive (N = 49) vs NL or 6-0 monofilament suture	No clinically significant differences in cosmetic outcome among the three groups at 9-12 months.	“The use of either octylcyanoacrylate or rapid absorbing gut suture could be	All repairs made by physician assistants. High lost to follow-up rate at 9-12 months.

Sponsored by HealthPartners Research Foundation. No mention of COI.		up and did not: 70.2 and 28.6 (N = 84 and 66).	(N = 49) vs RG or Rapid 6-0 gut absorbable suture (N = 47). Follow-up at 9 and 12 months.		preferred in this setting (ED), eliminating the need for follow-up visits for suture removal.”	
Sinha 2001 RCT No sponsorship. No mention of COI.	6.5	N = 50 (9 male and 35 female) with variety of hand operations. Mean age for adhesive and suture groups: 49 (9) and 51 (17).	N-butyl 2-cyanoacrylate tissue adhesive (Indermil) (N = 20) vs Sutures (5-0 nylon) at 2 and 6 weeks (N = 24). Follow-up at 2 and 6 weeks.	No significant difference in cosmetic outcome assessment, but 5 minor wound dehiscences (3 in tissue adhesive group, 2 in suture group).	“Evaluation of patients in the two groups of our study showed similar wound outcomes.”	Post-operative hand surgery wounds. Study limited to 6 week follow-up. Small sample size limits study power.
Shamiyeh 2001 RCT No mention of sponsorship. No COI.	6.5	N = 79 (24 male and 55 female) requiring varicose vein surgery. Are range for group S / T/ and TA: 26 – 70 / 16 – 72 / and 20 – 73.	S group or Suture 5-0 monofilament (N = 26) vs Group T or adhesive tape (N = 28) vsTA or octylcyanoacrylate tissue adhesive (N = 25).	There were no differences between the groups for dehiscence or infections. The scars were judged slightly better for cosmetic result in the suturing group, but scores were not statistically significant.	“Comparing 5-0 monofilament sutures, tapes, and tissue adhesive for skin closure after phlebotomy, there was no difference in cosmesis, but closure with tape was by far the cheapest method.”	Cost argument is relative, as all treatment material costs were \$11 or less.

<p>Singer 2002</p> <p>RCT</p> <p>Sponsored by a research grant from Closure Medical Corporation, Raleigh, NC, which developed TraumaSeal. Two of the authors (AJS, JEH) are on the speaker's bureau of Ethicon Inc. No mention of other COI.</p>	<p>6.0</p>	<p>N = 924 wounds of traumatic lacerations, excisions of skin lesions or scar revisions, minimally invasive surgeries, and general surgical procerus. Mean age 31.9 and 30.7 for standard group.</p>	<p>OCA or octylcyanoacrylate tissue adhesive (N = 406) vs Standard wound closure methods, sutures, adhesive tapes, or staples (N = 408).</p> <p>Follow-up 5 to 10 days.</p>	<p>Wounds widely distributed over body. Many required subcutaneous sutures (55%). At 5-10 day follow-up, wound dehiscence and infection rates not significantly different between groups. At 3 months, no differences in wounds considered optimal (82% OCA vs. 83% other).</p>	<p>“Repair of traumatic lacerations and surgical incisions with OCA is faster than with standard wound closure techniques, and cosmetic outcome is similar at 3 months.”</p>	<p>Allocation unclear although baseline comparability was non-significant. Study included large number of wounds (surgical and traumatic) which may improve applicability.</p>
<p>Quinn 1997</p> <p>RCT</p> <p>Sponsored by Closure Medical Corp, Raleigh, NC. No mention of COI.</p>	<p>6.0</p>	<p>N = 136 (101 male and 35 female) with lacerations requiring suture. Mean age 35.3 ± 14.1 and 36.9 ± 17.2 for suture group.</p>	<p>Skin closure with octylcyanoacrylate adhesive (N = 68) vs Monofilament suture (N = 68).</p> <p>Follow-up for 3 months.</p>	<p>Octylcyanoacrylate vs. sutures: Mean VAS cosmesis scores, mm: 67 vs. 68 p = 0.65. Mean VAS pain scores, mm: 7.2 vs. 18.0 p <0.01; Infection, No.: 0 vs. 1; Dehiscence, No.: 3 vs. 1</p>	<p>“Octylcyanoacrylate tissue adhesive effectively closes selected lacerations. This relatively painless and fast method of wound repair can replace the need for suturing several million lacerations each year.”</p>	<p>High dropout rate at 3 month follow-up.</p>
<p>Quinn 1998</p> <p>RCT</p> <p>Sponsored by a research gift from</p>	<p>6.0</p>	<p>N = 136 (63 male and 13 female) with traumatic wounds. Mean age for OCT and Sutures groups: 37.4 ± 12.4 and 39.6 ± 18.3 years.</p>	<p>Octylcyano-acrylate tissue adhesive (N = 68) vs 5-0 or smaller monofilament suture (N = 68).</p> <p>Follow-up at 3 months and 1 year.</p>	<p>No differences found in demographic or clinical characteristics between groups. At 1 year, no difference found in optimal wound scores (73% vs. 68%, p = 0.60) or in visual analog scale cosmesis scores (69 vs.</p>	<p>“One year after wound repair, no difference is noted in the cosmetic outcomes of traumatic lacerations treated with octylcyanoacrylate</p>	<p>One year follow-up to 1997 study.</p>

Closure Medical Corp. No mention of COI.				69mm, p = 0.95) for octylcyanoacrylate.	tissue adhesive and sutures. The assessment of wounds 3 months after injury and wound repair provides a good measure of long-term cosmetic outcome.”	
Bruns 1996 RCT No mention of sponsorship or COI.	6.0	N = 61 (49 male and 12 female) with lacerations less than 12 hours old. Between 1 and 18 years of age.	Histoacryl Blue (HAB) tissue adhesive (N = 30) vs Suture (N = 31) Follow-up at 1 week and 2 months.	Two plastic surgeons blinded to treatment. One rated no difference between groups, other favored HAB for better scar appearance.	“The use of HAB is an acceptable alternative to conventional suturing.”	Pediatric population (<18 years old). Allocation not well defined.
Simon 1998 RCT No mention of sponsorship or COI.	6.0	N = 61 (49 male and 12 female) with lacerations. Median age for with follow-up and without: 4.0 and 3.0.	Histoacryl Blue (HAB) tissue adhesive (N = 30) vs Sutures in facial lacerations (N = 31). Follow-up at 2 months and 1 year.	Overall ratings of cosmetic outcomes were comparable or better in appearance for HAB group by blinded plastic surgeons. When reviewed by Langer line orientation, cosmetic appearance of sutured lacerations worse against Langer lines vs. sutured with Langer line orientation. No difference in Langer orientation with HAB group.	“The cosmetic appearance of facial lacerations repaired with HAB was comparable to conventional suturing, and appears to be less affected by the initial orientation of the wound with Langers lines than with conventional suturing.”	Second report of similar study group. Allocation unclear.
Toriumi 1998 RCT Sponsored partially by Closure Medical Corporation, Raleigh, N.C.	5.5	N = 111 (gender not specified) underwent surgical procedure for skin closure. Mean age was 41.2 years.	Octyl-2-cyanoacrylate (N = 57) vs 5-0 sutures (N = 54). Follow-up at 5, 7, and 90 days and 1 year.	Difference in time for skin closure between octyl-2-cyanoacrylate and sutures significant (p < 0.0001). No significant difference on modified Hollander scale at 90 days (p = 0.51). However, at 1 year, mean VAS scale for cosmetic outcome showed improved cosmetic results for incisions treated with	“The lower visual analog scale score represented a superior cosmetic outcome at 1 year with the octyl-2-cyanoacrylate as compared with sutures.”	Study population was post-operative plastic surgery for facial and neck lesions.

No mention of COI.				octyl-2-cyanoacrylate (p = 0.03).		
Simon 1997 RCT No mention of sponsorship or COI.	5.0	N = 61 (49 male and 12 female) with lacerations. Median age for with follow-up and without: 4.0 and 3.0.	Skin sutures (N = 30) vs Histoacryl blue (HAB) tissue adhesive (N = 31). Follow-up at 1 year.	Wounds evaluated at 2 months and 1 year. Wounds comparable in cosmetic appearance at 2 months by one rater and significantly better for HAB by second rater. At 1 year, wounds comparable by both raters.	“The use of HAB in an ideal alternative to conventional suturing for cutaneous closer of low-tension lacerations in children with a long term cosmetic outcome comparable to conventional suturing.”	Allocation, baseline comparability not described.
Handschel 2006 RCT No mention of sponsorship or COI.	5.0	N = 45 with an orbital floor fracture or facial wounds. The mean Age in the adhesive group was 47 years and 42 years in suture group.	Dermabond (octyl-2-cyanocrylate) (N = unknown) vs Ethilon 6-0 sutures (N = unknown). Follow-up at 3 months after surgery.	Patients rated skin adhesive higher on VAS, whereas surgeons rated sutured wounds as best cosmetically based on photographs. The scar wound depth was statically significantly greater in skin adhesive group than suture group.	“The adjustment of the edges of the wounds as measured by the depth of the scar is significantly worse with (Dermabond) than with thin sutures. The sutured wounds give better cosmetic results in younger patients in particular.”	Authors used standardized incision (periorbital) to control wound type. Lack of study details for randomization. Small sample size. Results may be more applicable to cosmetically sensitive areas (face).
Karcioglu 2002 RCT No mention of sponsorship or COI.	4.0	N = 92 (male to female ratio 1.26) with lacerations equal to or shorter than 5 cm. Mean age 34 ± 11.04.	Histoacryl Blue (HAB) tissue adhesive (N = 24) vs Suture repairs (N = 28). Follow-up at 10 days and 3 months.	“There were no statistically significant scores of cosmetic outcomes at the tenth day and third month. The ratio of patients who reported satisfaction from the method was significantly higher in the HAB group than the sutured group (p = 0.007). Costs of treatment were	“HAB is a cheaper method of laceration repair and results in greater satisfaction of both the patient and the physician. The cosmetic outcomes are the comparable.”	Lack of study details. No baseline data presented. High dropout at follow-up visits at 10 days and 3 months.

				significantly lower than sutures (p = 0.000).”		
Tissue Adhesive vs. Adhesive Strips, Staples						
Singer 1998 RCT Sponsored in part by a grant from Closure Medical, Inc., Raleigh, NC. The authors also acknowledge the ED academic associates, nurses, and physicians for assistance in data collection. No mention of other COI.	7.0	N = 124 (48 female and 76 male) with standard closure of traumatic lacerations; age 1-17 years.	Tissue adhesive (Octylcyano-acrylate) (N = 63) vs Standard wound closure techniques for lacerations (N = 61). Follow-up assessment at a median of 93.5 days.	Patients treated with octylcyanoacrylate less frequently received local anesthesia (21% vs. 89%, p <0.001). Groups similar with respect to decontamination with normal saline (81% vs. 75%, p = 0.36), irrigation (50% vs. 65%, p = 0.13), and use of a scrub (48% vs 31%, p = 0.08).	“Wounds treated with Octylcyanoacrylate and standard wound closure techniques have similar appearances 3 months later.”	Comparison group included sutures and staples. Not clear how these were selected once randomized to control group.
Bruns 1998 RCT Sponsored in part by a grant from Closure Medical Corporation. No COI.	6.0	N = 83 (55 male and 28 female) with lacerations. Mean and median age for 2-OCA and Sutures / Staples: 3.5 (2.0, 5.0) and 4.0 (3.0, 6.0)	2-OCA or 2-Octylcyano-acrylate (N = 42) vs staples, steri-strips or monofilament sutures (N = 41). Follow-up at 3 months.	Length of time for cutaneous closure was decreased (median, 2-OCA 2.9 minutes vs. suture/staple 5.8 minutes; p <0.001). Assessment of pain not significantly different between groups. 95% receiving 2-OCA would choose 2-OCA over standard wound closure at next visit for laceration repair. No significant differences in clinical characteristics between groups at 3 months.	“2-OCA is an acceptable alternative to conventional methods of wound repair with comparable cosmetic outcome.”	Similar study design as previous study by same author (Bruns 1996). Funded by manufacturer of ethilon and Dermabond.
Mattick 2002	5.5	N = 60 (28 male and 16 female) children with	2-Octylcyano-acrylate or tissue adhesive (N = 30)	Evaluation at 3 and 12 months. “Cosmetic	“In conclusion, both tissue	Small sample size with high percentage lost to follow-up.

<p>RCT</p> <p>No sponsorship. Ethicon supplied the Dermabond tissue adhesive and the camera. The Steristrips were from departmental stock.</p>		<p>suitable lacerations. Between 1-14 years of age.</p>	<p>vs Adhesive strips (N = 30).</p> <p>Follow-up at 3 and 12 months.</p>	<p>outcome for both treatments was high, with no significance when viewed from the critical eye of both the parent and the plastic surgeon.”</p>	<p>adhesives and adhesive strips are excellent "no needle" alternatives for the closure of suitable pediatric lacerations.”</p>	
<p>Zempsky 2001</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>5.5</p>	<p>N = 97 (60 male 37 female) and with simple facial lacerations in children. Mean age for Steri-step group and Dermabond: 5.2 (2.7) and 5.3 (4.1) years.</p>	<p>3M Steri-Strip Closure, 2-Octylcyano-acrylate (N = 48) vs Dermabond or Adhesive strips (N = 49).</p> <p>Follow-up at 2 months.</p>	<p>Wound dehiscence occurred in 1 steri-strips and 5 dermabond patients. No difference in total complication rates between groups (p = 0.11). Wound scores for rating surgeons not significantly different.</p>	<p>“Steri-strips and Dermabond provide similar cosmetic outcomes for closure of simple facial lacerations..”</p>	<p>Lack of study details. No allocation and minimal baseline compatibility data provided.</p>

<p>Singer Plast Reconstr Surg 2002</p> <p>RCT</p> <p>Sponsored by a research grant from Closure Medical Corporation, Raleigh, NC, which developed TraumaSeal. Two of the authors (AJS, JEH) are on the speaker's bureau of Ethicon Inc. No mention of COI.</p>	5.0	N = 924 and 814 patients (542 male and 382 female) wounds. Mean age 31.3 (21.1) years.	<p>Octylcyanoacrylate tissue adhesive (N = 455 wounds) vs Standard wound closure methods sutures, adhesive tapes, or staples (N = 469).</p> <p>Follow-up for 3 months.</p>	<p>Characteristics associated with suboptimal cosmetic appearance on multivariate analysis were presence of associated tissue trauma 3.9 (95 C.I. 1.4-10.7), use of electrocautery (OR 2.9, 95% CI 1.8-6.5), extremity location (OR 2.9, 95% CI 1.2-3.7), wound width (OR 1.08, 95% CI 1.01-1.14). Wound infection associated with tissue trauma (8.7% vs. 1.7, p = 0.04) and incomplete wound apposition (6.6 % vs. 0.5 %).</p>	<p>“Suboptimal wound appearance is increased with extremity wounds, wide wounds, incompletely apposed wounds, associated tissue trauma, use of electrocautery, and infection.”.</p>	<p>This is the second report of same population. Some methodology details lacking in this report.</p>
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Tissue Adhesive vs. Tissue Adhesive

<p>Osmond 1999</p> <p>RCT</p> <p>Sponsored by Closure Medical Corp., Raleigh, NC. No mention of COI.</p>	7.0	N = 94 (37 female and 57 male) with facial lacerations. Age at least 18 years.	<p>Octylcyano-acrylate (N = 47) vs butylcyano-acrylate for superficial linear facial lacerations (N = 47).</p> <p>Follow up at 3 months.</p>	<p>No difference between butylcyanoacrylate and octylcyanoacrylate in time of wound repair (4.2 vs. 4.0 min, p = 0.88), pain induced by the procedure (VAS score 24 vs. 15, p = 0.37), and ease of procedure as rated by study physician (12 vs. 15).</p>	<p>“Although octylcyanoacrylate may have some superior physical properties compared with butylcyanoacrylates , based on this trial we recommend that children with selected facial lacerations (superficial, linear, < 4cm) may have their lacerations closed by either method.”</p>	<p>Study population limited to pediatrics (<18 years old) with facial lacerations.</p>
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Flexor Tendon Laceration Repair with Device vs. Simple Tendon Repair						
Su 2005 RCT No mention of sponsorship or COI.	5.0	N = 67 (67 male and 20 female) with 85 flexor tendon injuries digits 2-5. Zone II laceration of flexor digitor-um profundus tendon with or without superficialis laceration. At least 18 years of age.	Teno Fix® repair (N = 29) vs Simple repair with cruciate suture (3-0/4-0 polypropylene) plus circumferential (6-0 monofilament nylon). Tendon had to be wide enough for use of the device. Rehabilitation with passive ROM first POD. Kleinert method for 1 st 3 weeks (N = 38). Active flexion protocol at 4 weeks. Follow-up at 12 weeks.	Excellent/good and fair/poor results in: Teno Fix vs. 67% and 33% vs. traditional suture 70% excellent/good and 30% fair/poor. Ruptures developed in 0% Teno Fix vs. 9/51 (18%) traditional suture (p = 0.01). No differences in pain, grip/pinch strength or DASH scores, (p > 0.05).	"Tendon repairs with the Teno Fix® have lower rupture rates and similar functional outcomes when compared with conventional repair, particularly in patients who are noncompliant with the rehabilitation protocol."	Some baseline differences may be due to 7 crossovers to control group for technical reasons. High dropouts in control group at 6 months. More smokers in control group combined with more ruptures in controls raise concern for potential confounding.
Other						
Sener 2015 RCT No mention of sponsorship or COI.	5.5	N = 54 (39 male and 15 female) with hand lacerations. Age range 18-65 years.	Local infiltration anesthesia or LIA; hydrochloride 2% and 27 gauge needles used (N = 23) vs Peripheral nerve block or PNB (N = 31). Follow-up not given.	Response to injection pain and suture pain, (p = 0.220 and p = 0.316). Patient satisfaction and need for additional local anesthetics, (p = 0.785 and p = 0.628). Difference statistically significant for time to loss of pinprick sensation in the local infiltration group 1.3 min vs 2.2 minutes in block group, (p < 0.001). Significant difference regarding pain response to suturing; 8.8 vs 14.50, (p = 0.045).	"In conclusion, LIA or PNB for hand laceration surgery is convenient and predictable."	Data suggest both groups with comparable efficacy except for time required to administer (nerve block 2.2 min and local anesthesia 1.3min)
Moazzam 2003 RCT No mention of sponsorship or COI.	5.0	N = 20 (17 male and 3 female) undergoing free radial forearm flap surgery. Average age 58 years (range 28–84).	Cross-suturing, using a 4/0 gauge suture of Polyglyconate (N = 10) vs Control, the graft was applied without cross-suturing of the wound (N = 10). Follow-up at 3 and 7 months.	Cross-suturing group had immediate reduction in size of 30-68%, the mean reduction of 53%. Reduction of area of the cross-sutured forearm scars made after 3-7 months from 40 to 77%, with a mean reduction of 65%. At 3-7 months after surgery in the control	"A cross-suturing technique is presented to reduce the deformity of the radial forearm flap donor defect."	Small sample size. Data suggest cross-suturing technique decreased size of forearm deformity when compared to controls (65% vs. 38%) as well as decreasing the area of the split skin donor site.

				cases had a reduction in scar area ranging from 17 to 68%, the mean of 38%.		
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Evidence for Follow-up Wound Care

There is 1 moderate-quality RCT incorporated into this analysis.(1542)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: follow-up wound care, semi occlusive dressing, routine wound check, wound healing, laceration, wound, cuts, management, repair, care, upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 67 articles in PubMed, 84 in Scopus, 176 in CINAHL, 10 in Cochrane Library, 25 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, CINAHL, Cochrane Library, Google Scholar, and 0 articles from other sources. Of the 1 article considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Wounds of Minor Skin Excision and Wound Management						
Heal 2006 RCT No mention of sponsorship or COI.	6.0	N = 857 (600 male and 257 female) with wounds or minor skin excision. Mean age 44 years.	Intervention group, or wound kept dry and covered 48 hours (N = 450) vs Control group, dressing removal and bathing within 12 hours of repair (N = 420). Follow-up within 12 and 24 hours.	Infection rates: dry group 8.9% vs. no dressing and wet 8.4%, intervention rate ratio not inferior to control p <0.05.	“Wounds can be uncovered and allowed to get wet in the first 48 hours after minor skin excision without increasing the incidence of infection.”	Wounds were post-surgical excision repairs, which may be different characteristically from traumatic laceration. No blinding.

Evidence for the Use of Antibiotic Prophylaxis

There is 1 high-quality RCT on topical antimicrobials(1549) and 3 moderate-quality RCTs on antibiotic prophylaxis that are incorporated into this analysis.(1544-1546)

Antibiotic Prophylaxis

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Antibiotic, Prophylaxis, Wound, Healing, Laceration, Cuts, Management, Repair, care, Upper, Extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 4 in Scopus, 8 in CINAHL, 8590 in Google Scholar, and 1 in Cochrane Library. We considered for inclusion 2 from PubMed, 0 from Scopus, 1 from CINAHL, 2 from Google Scholar, 1 from Cochrane Library and 0 from other sources. Of the 8608 articles considered for inclusion, 4 randomized trials and 6 systematic studies met the inclusion criteria.

Topical, Antimicrobials

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Topical, Antimicrobials, Wound, Healing, Laceration, Cuts, Management, Repair, care, Upper, Extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 58 articles in PubMed, 0 in Scopus, 8 in CINAHL, 5960 in Google

Scholar, and 1 in Cochrane Library. We considered for inclusion 2 from PubMed, 0 from Scopus, 3 from CINAHL, 5960 from Google Scholar, 3 from Cochrane Library and 0 from other sources. Of the 6026 articles considered for inclusion, 0 randomized trials and 1 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Dire 1995 RCT No mention of sponsorship or COI.	8.5	N = 426 (gender not specified) with hand lacerations. Age BAC/NEO/SIL/PTR group: 19.9 (15.1)/18.3 (13.7)/19.7 (14.1)/17.1 (13.1).	BAC or topical antimicrobials Neomycin (n = 109) vs. NEO group or bacitracin (n = 110) vs. SIL or silvadene group (n = 99) vs. PTR or petroleum ointment group (n = 108). Follow-up for 15 months.	Wounds were primarily head/neck followed by hand, lower extremity, and arm. Overall 42/426 infections (9.9%). Infection rates with 95% CI. Bacitracin 5.5% (2.0-11.6), Neomycin 4.5% (1.5-10.3). Silvadene 12.1% (6.4-20.2). Petrolatum 17.6% (10.9-26.1). Petrolatum was significantly higher (p = 0.0034) than others. No differences between other arms.	“The use of topical antibiotics resulted in significantly lower infection rates than did the use of a petrolatum control.”	Study unable to address question of anti-microbial vs. no topical preparation. Infection rates in antimicrobial arms similar to previous studies using same techniques without antimicrobial treatment. Possible conclusion is that use of ointments without antimicrobial therapy increase risk of infection.
Lindsey 1982 RCT No mention of sponsorship or COI.	6.0	N = 260 Gender and age were not disclosed.	0.9% NaCl vs. 5% sodium benzyl penicillin for lacerations Follow-up history not disclosed.	“The study was terminated ...after the inclusion of 260 lacerations, when the upper sloping boundary was crossed for late infections... [A]nalysis of the distribution of preferences in the data at the time of stopping the study indicated high levels of statistical significance in the early purulent infections as well.”	“It appears that two out of three or three out of four infections can be averted merely by flooding the wound with penicillin immediately before suture.”	Methodology details sparse. Analyses and results also sparse.
Roberts 1985 RCT No mention of sponsorship or COI.	4.5	N = 418 Povidone Iodine average age 33.0 with 74.3% male and No treatment average age 28.1 with 71.2% males.	Povidine-iodine powder aerosol treatment of wound vs. none prior to suture repair Follow-up history not disclosed.	“There was no significant difference in the infection and imperfect healing rates between the povidine iodine and control groups. Significant factors (P<0.01) in the infected wounds were the condition of the dressing and part of the injured hand (palmar injuries). Neither the patients age, the time from injury to suturing or the number of sutures made a significant difference to the incidence of perfect healing.”	“This trial does not show a significant difference in infection rate with povidine iodine therapy. The number of infected cases which were statistically analyzed was small.”	No blinding of observer. Lack of study details. High dropout rate.
Roberts 1977 RCT No mention of sponsorship or COI.	4.0	N = 368 patients with hand lacerations. Triplopen group mean age is 30.4, Flucloxacillin group mean age is 29.8, and No antibiotics group mean age is 33.8. No gender disclosed.	Trilopen IM vs. Flucloxacillin PO vs. Control (no antibiotics) Follow-up 7 days after suturing.	“Chi-square analysis showed no significant difference in infection rate between the three groups (P > 0.3), but the Trilopen-treated group healed better (P < 0.05) than either of the other groups. Severe contamination of the original wound and a change of dressing carried out at home were also found to be significant compared to controls.”	“Overall infection rate was 9.8 %, lower than other published work. Our results show that a course of flucloxacillin gave no improvement in wound healing over a policy of using no antibiotics. The other surprising fact...58% of patients said they had experienced no pain at all when the anesthetic had worn off.”	Lack of study details. No allocation or baseline compatibility data provided.

Evidence for the Use of NSAIDs/Acetaminophen for Upper Extremity Post-Laceration Repair

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDs, Wound Healing, Laceration, Lacerations, Wound, Cuts, Management, Repair, care, upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 10 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 2900 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of NSAIDs/Acetaminophen for Exercise for Laceration Management

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, exercising, physical activity, wound healing, laceration, wound, cuts, management, repair, care, upper extremity, hand, arm, forearm; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 72 articles in PubMed, 39 in Scopus, 17 in CINAHL, 195 in Cochrane Library, 72,700 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for the Use of Bite Wound Cultures and Sensitivity of Animal and Human Bites

There is 1 high-(163) and 2 moderate-quality(162, 1550) RCTs incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: wound culture, human, animal, dog, cat, bite, bites, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 1 articles in PubMed, 12 in Scopus, 0 in CINAHL, 17 in Cochrane Library, and 29,100 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 3 from other sources. Of the 3 articles considered for inclusion 3 diagnostic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Skurka 1986 RCT No mention of sponsorship. All three authors worked in the Division of Infectious Diseases at the hospital where study was held.	8.5	N = 39 (gender not specified) with obviously infected wounds, allergy to penicillin, antibiotics administered within 3 days prior to bite. Age 1-16.	Penicillin V-K (100,000 U/Kg/day q6hours x 2 days (n = 19) vs. Placebo (n = 20).	Overall infection rate 7.7%. Infection rate of antibiotic group = 5% vs. placebo = 10.5%, (p = NS).	“Prophylactic penicillin failed to prevent infection in dog bite wounds. Cultures showed various organisms but were of no predictive value for development of infection. It seems failure is better correlated to the quality of the local wound care than to prophylactic antibiotic.”	Small sample size. No control for co-interventions. Culture samples of infected wounds not resistant to penicillin. Sample size for wounds sutured too small for comparison (N = 2), although neither became infected.

<p>Brakenbury 1989</p> <p>RCT</p> <p>Beecham Research Laboratories sponsored the research and helped with the analysis.</p>	5.0	N = 122 (42 female, 80 male). Mean ages of antibiotic and placebo groups for general bites is 30 and 34. Mean ages for same groups for hand bites are 30 and 37.	Amoxicillin/clavulanate for 5 days vs. placebo in full thickness animal bite wounds.	Non-significant trend toward faster healing with amoxicillin/clavulanate. No difference in age subgroups in rate healing. In adults, 33% of wounds in antibiotic treatment group became infected vs. 60% receiving placebo (p = 0.009). In children, difference non significant (24% antibiotic vs. 20% placebo). Wound infection significantly reduced by antibiotics in wounds older than 9 hours, but not in fresher wounds.	Amoxicillin/clavulanate significantly reduced the wound infection rate in patients with bites where the skin is broken and where the patient presented 9 to 24 hours after injury.	Study included a mixture of dog, human, and cat bites, although a majority was dog bites. Study included primarily bites to the hand.
<p>Boenning 1983</p> <p>RCT</p> <p>Douglas A. Boenning is the Microbiology Laboratory director for The Children's Hospital of Philadelphia. Coauthor Gary R. Fleisher is the assistant director of The Children's Hospital of Philadelphia Emergency Department. No mention of sponsorship.</p>	4.0	N = 55 (gender not specified) with mean age for penicillin group and control group being 10.5 and 9.5 respectively.	Penicillin V 250mg PO QID for 5 days vs. no antibiotics	Overall infection rate 3.6%, with no significant difference between control and penicillin groups. No difference in types of organisms isolated prior to treatment.	Penicillin prophylaxis of superficial non-facial dog bites in children appears no better than local wound care alone when lesions are cleansed soon after occurring. Initial cultures of dog bite wounds have no value in predicting subsequent wound infection.	Quasi-randomization by odd-even day of admission. No blinding, non-placebo control group.

Evidence for the Treatment of Dog Bites

There is 1 high-(163) and 5 moderate-quality(162, 1550, 1551, 1553, 1554) (Rosen 85) RCTs incorporated into this analysis. There is 1 low-quality RCT in Appendix 2.(1552)

Blood Borne Pathogen Protocol

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Blood borne pathogen protocol, Human bites, animal, dog, cat, bites, bite, Torso, Upper Extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 618 in Google Scholar, and 7 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 7 from other sources. Seven articles met the inclusion criteria.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Prophylactic Antibiotics/ Cat bites, lacerations, upper extremity, bites, hand, arm, forearm;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 article in PubMed, 6 in Scopus, 2 in CINAHL, 9 in Cochrane Library, and 1542 in Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 in Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 0 randomized trials and 1 systematic study met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: prophylactic antibiotics, dog bites, torso, upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 2 articles. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Skurka 1986 (score= 8.5)	Prophylactic Antibiotics for Dog Bite Wounds	RCT	No mention of sponsorship or COI.	N = 39 with obviously infected wounds, allergy to penicillin, antibiotics administered within 3 days prior to bite.	No mention of mean age or sex. Ages of participants were 1-16 years.	Penicillin V -K (100,000 U/Kg a day 6 hours for 2 days (n = 19) vs. Placebo (n = 20).	Follow up within 48 to 72 hours.	Overall infection rate 7.7%. Infection rate of antibiotic group = 5% vs. placebo = 10.5%, (p = NS).	“Prophylactic penicillin failed to prevent infection in dog bite wounds.”	Small sample size. No control for co-interventions. Culture samples of infected wounds were not resistant to penicillin. Sample size for wounds sutured too small for comparison (n = 2), although neither became infected.
Brakenbury 1989 (score= 5.0)	Prophylactic Antibiotics for Dog Bite Wounds	RCT	No mention of sponsorship or COI.	N = 125 with dog, human and cat bites.	Mean age for adults: 33.5 years, and 9 for kids; 42 females, 80 males for adults & 20 females, 43 males for kids	Augmentin (n=88) for 5 days vs. Placebo (n=97) in full thickness animal bite wounds.	Follow up on day 3 and on day 7 if wound was not healed.	Non-significant trend toward faster healing with amoxicillin/clavulanate. No difference in age subgroups in healing rates. In adults, 33% of wounds in antibiotic treatment became infected vs. 60% receiving placebo (p = 0.009). In children, difference non-significant (24%	“Amoxicillin/clavulanate significantly reduced the wound infection rate in patients with bites where the skin is broken and where the patient presented 9-24 hours after injury.”	Study included a mixture of dog, human, and cat bites, although a majority was dog bites. Study included primarily bites to the hand.

								antibiotic vs. 20% placebo). Wound infection significantly reduced by antibiotics in wounds older than 9 hours, but not in fresher wounds.		
Jones 1985 (score= 4.5)	Prophylactic Antibiotics for Dog Bite Wounds	RCT	No mention of sponsorship or COI.	N = 113 patients for dog bite wounds.	Mean age and gender not specified.	5 day course of Co-trimoxazole 960 mg twice daily (n=58 wounds) vs. placebo (n=55 wounds)	Follow up at 1 week.	Incidence of wound infection 13.8% in placebo vs. 5.5% in antibiotic group (p = 0.135). Hand wounds, infection rate 16.7% in placebo vs. 0% antibiotic (p = 0.0595).	“In conclusion, we feel that the routine treatment of dog bite wounds with antibiotics is not justified, but that hand wounds should be considered for such treatment.”	Thirty-five subjects who failed to return for follow-up were classified as non-infected. Study had low power (required 370 patients in each group for sufficient power).
Rosen 1985 (score=4.5)	Prophylactic Antibiotics for Dog Bite Wounds	RCT	No mention of sponsorship or COI.	N = 33 (66 wounds with dog-bite wounds who were admitted within 8 hours of the incident.	Mean age 27.8 years for antibiotics group and 31.8 years for placebo group; 73 females, 77 males	Prophylactic antibiotics (either cloxacillin, dicloxacillin or erythromycin) group receiving 250mg 4x times daily for 5 days (n = 35 wounds) vs. Placebo control group (n = 31 wounds). Both groups	Follow-up at 2 or 3 days.	Overall infection rate was 7.6% with 2/35 infections in antibiotics group, 3/31 in placebo group (p = NS). All infected wounds were of the hand/wrist vs. elsewhere p <0.01).	“Antibiotic administration does not reduce the likelihood of subsequent infection in the management of recent dog-bite wounds, or the incidence of infection when only hand wounds were considered.”	Authors found higher risk for infection in hand/wrist wounds than other body parts. No information provided on compliance or other co-interventions.

						received standardized wound cleaning based on protocol.				
Boenning 1983 (score=4.0)	Prophylactic Antibiotics for Dog Bite Wounds		No mention of sponsorship or COI.	N = 55 children with non-facial dog bites	Mean age for penicillin group: 10.5 years; control group: 9.5 years. gender: not specified	Penicillin V 250mg PO QID for 5 days (n=25) vs. no antibiotics only local wound care (n=30)	Follow up at 2-5 days	Overall infection rate 3.6%, with no significant difference between control and penicillin groups. There was no difference in types of organisms isolated prior to treatment.	Penicillin prophylaxis of superficial non-facial dog bites in children appears to be no better than local wound care alone when lesions are cleansed soon after they occur. Initial cultures of dog bite wounds have no value in predicting subsequent wound infection.	Quasi-randomization by odd-even day of admission. No blinding, non-placebo control group.
Dire 1992 (score=4.0)	Prophylactic Antibiotics for Dog Bite Wounds	RCT	No mention of sponsorship. COI: Authors Dire and Hogan were part of the Emergency Medicine Residence Program for the Darnall Army Community Hospital where the study was held.	N = 185 patients presenting with non-infected dog bite wounds to the emergency department.	Mean age 9.0 years for antibiotic group and 9.2 years for placebo group; 110 males, 75 females.	Oral antibiotics (cephalexin, dicloxacillin or erythromycin) (n= 89) vs. no antibiotic treatment. (n=96)	Follow up at 3-7 days.	One wound (1.1%) in antibiotic group and 5 (5.1%) in control group became infected (p = 0.212). No partial-thickness wounds became infected. No difference in wound infection rates for sutured wounds in the two groups (p = 0.562).	“Our results do not show a significant difference in wound infection rates among all low-risk dog bite wounds with or without oral antibiotic use. Routine prophylactic antibiotics would not seem cost-effective in the	Sparse study details. No blinding or placebo. Wounds were irrigated with povidone-iodine.

									low-risk dog bite population.”	
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Evidence for the Treatment of Human Bites

There is 1 moderate-quality RCT incorporated into this analysis.(164)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Prophylactic Antibiotics / Human bites, torso, Upper extremity, lacerations, antibiotics, Animal bites ;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 8 in Scopus, 1 in CINAHL, 5 in Cochrane Library, and 3161 in Google Scholar. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 1 from other sources. Of the 5 articles considered for inclusion, 1 randomized trial and 3 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: prophylactic antibiotics, human bites, torso, upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Zubowicz 1991 (score= 5.0)	Prophylactic Antibiotics for Uncomplicated Human Bite Wounds	RCT	No mention of COI or sponsorship.	N = 48 patients presenting with human bites of the hand.	Mean age: 26 years; 23 males, 25 females.	Ceclor 250mg po tid vs Kefzol 1gm IV q8 and penicillin G 1.2 million U IV q 6 h vs. placebo	Followed daily for clinical signs of infection.	Infection rate in placebo group was 47% (7/15) with no infections in oral or IV antibiotics groups (p <0.05).	“In uncomplicated human hand bite, wound toilet coupled with daily dressing changes and an oral prophylactic broad-spectrum antibiotic is satisfactory treatment in compliant patient.”	Adult population. Sparse study details including lack of randomization and allocation methods. Patients admitted to hospital for control of co-interventions and compliance.

Evidence for the Use of Prophylactic Antibiotics for Cat Bite Wounds

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Prophylactic Antibiotics/ Cat bites, lacerations, upper extremity, bites, hand, arm, forearm; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 article in PubMed, 6 in Scopus, 2 in CINAHL, 9 in Cochrane Library, and 1542 in Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 in Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 0 randomized trials and 1 systematic study met the inclusion criteria

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: prophylactic antibiotics, cat, bites, bite, torso, upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 1 articles. Zero articles met the inclusion criteria.*

Evidence for the Treatment of Bite Laceration Repair

There is 1 moderate-quality RCT incorporated into this analysis.(1551) There is 1 low-quality RCT in Appendix 2.(1557)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Suture, Bites, Human, Animal, Dog, Cat, Bite, Torso, Upper Extremity, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 2 in Scopus, 3 in CINAHL, 5 in Cochrane Library, and 50 in Google Scholar. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 1 from Cochrane Library, 2 from Google Scholar, and 2 from other sources. Of the 6 articles considered for inclusion, 4 randomized trials and 2 systematic studies met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Dire 1992 RCT Authors Dire and Hogan were part of the Emergency Medicine Residence Program for the Darnall Army Community Hospital where the study was held. No mention of sponsorship.	4.0	N = 185 (75 female/110 male). Mean age 9.0 for antibiotic group and 9.2 for placebo group.	Oral antibiotics (cephalexin, dicloxacillin or erythromycin) vs. no antibiotic treatment	One wound (1.1%) in antibiotic group and 5 (5.1%) in control group became infected (p = 0.212). No partial thickness wounds became infected. No difference in infection rate for sutured wounds in groups (p = 0.562).	“Our results do not show a significant difference in wound infection rates among all low-risk dog bite wounds with or without oral antibiotic use. Routine prophylactic antibiotics would not seem cost-effective in the low-risk dog bite population.”	Sparse study details. No blinding or placebo. Wounds irrigated with povidone-iodine.

Evidence for the Use of X-rays for Hand/Finger Osteoarthritis

There are no quality studies incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: X-ray, radiography, x-rays, hand and finger osteoarthritis, joint disease, osteoarthritis, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 0 articles in PubMed, 36 in Scopus, 0 in CINAHL, 1 in Cochrane Library, and 378 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Evidence for Splinting and Exercise for Hand Osteoarthritis

There are 10 moderate-quality RCTs and randomized crossover trials incorporated into this analysis.(1558, 1566-1574) (Bani 13; Becker 13; Carreira 10; Villafane 13) There are 4 low-quality RCTs and 1 low-quality controlled clinical trial(1559, 1561, 1575-1577) (Boustedt 09; Adams 14; Weiss 00) in Appendix 2.

Rest:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Rest, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 26 articles in PubMed, 20 in Scopus, 169 in CINAHL, 1 in Cochrane Library, 100 in Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Ice:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ice, Cryotherapy, Cold Therapy, Ice Pack, Self-Applied Ice, Cold Pack, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 12 articles in PubMed, 22 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 47,970 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 0 randomized trials and 1 systematic studies met the inclusion criteria.

Splinting:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: splints, splint, splinting; hand, fingers, thumb, metacarpus, osteoarthritis, osteoarthritis, degenerative arthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 63 articles in PubMed, 73 in Scopus, 18 in CINAHL, 57 in Cochrane Library, 15,710 in Google Scholar, and 0 from other sources. We considered for inclusion 8 from PubMed, 2 from Scopus, 1 from CINAHL, 2 from Cochrane Library, 4 from Google Scholar, and 0 from other sources. Of the 17 articles considered for inclusion, 10 randomized trials and 10 systematic studies met the inclusion criteria.

Exercise:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Exercise, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic,	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments

<p>systematic review, retrospective, and prospective studies. We found and reviewed 10 articles in PubMed, 182 in Scopus, 5 in CINAHL, 184 in Cochrane Library, 150 in Google Scholar, and 2 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 2 Google Scholar, and 2 from other sources. Of the 5 articles considered for inclusion, 4 randomized trials and 1 systematic studies met the inclusion criteria. Author/Year</p> <p>Study Type</p> <p>Conflict of Interest (COI)</p>						
Splint vs. No Splint						
<p>Rannou 2009</p> <p>RCT</p> <p>No conflict of interest disclosed. Funded by the Programme Hospitalier de Recherche Clinique National.</p>	7.0	<p>N = 112 (56 females/56 males) base of thumb OA (trapeziometacarpal)</p> <p>Age = Mean of 63 for custom-made group, Mean of 63.5 for control group</p>	<p>Custom-made splint vs. no splint. Nocturnal use only prescribed for 12 months.</p>	<p>Pain VAS (baseline/change at 1 mo/change at 12 months): splint (45.5±19.9/-10.1±3.0/-22.2±3.2) vs. control (47.7±19.8/-10.7±3.3/-7.9±3.5), p = 0.89 at 1 month and p = 0.002 at 12 months. Similar results for Cochin Hand Function Scale, patient-perceived disability. Pinch strength at 12 months splint: -5.4±7.1 vs. -14.4±7.7 (p = 0.38).</p>	<p>“For patients with base-of-thumb osteoarthritis, wearing a splint had no effect on pain at 1 month but improved pain and disability at 12 months..”</p>	<p>Subjects had severe disease. Baseline duration of disease worse in controls. More co-interventions in controls may have lessened differences. Post-traumatic disease excluded. No differences at 1 month vs. positive differences at 3 months difficult to resolve, particularly with nocturnal splint use.</p>
<p>Bani 2013</p> <p>RCT crossover</p> <p>No COI. Financial support provided by the University of Social Welfare and Rehabilitation Science.</p>	5.0	<p>N = 35 (25 female/10 male) with grade 1 or 2 thumb carpometacarpal joint osteoarthritis, clinical and radiological diagnosis, pain in the base of the thumb</p> <p>Age = Mean average of 53.42 for prefabricated group, 54.91 for</p>	<p>Prefabricated thumb splints (N=12)</p> <p>vs</p> <p>Custom made thumb splint (N=12)</p> <p>vs</p> <p>Control group (N=11)</p> <p>Follow up</p>	<p>The control group reported no significant differences in pain, function, or grip and pinch strength at week 4. At week 6 pinch strength significantly improved (p=0.000). At week 10 pinch strength (p=0.000) and pain (p=0.05) were the only parameters to improve.</p> <p>At week four both splints produced significant differences in pain</p>	<p>“Both splints increased pain, pinch strength and function compared to baseline and control group. We found no evidence that splints improved grip strength as compared to control group. There were no significant differences in function and pinch in comparing the splints. Pain was the</p>	<p>Data suggest comparable efficacy with respect to functional outcomes but custom made splints were reported to be more comfortable. Small sample size. Crossover design.</p>

	<p>custom made group, and 58.64 for control group</p>	<p>Weeks 4, 6, and 10</p>	<p>(p=0.000 for prefabricated, p=0.000 for custom) and pinch strength (p=0.000, p=0.001). Functionality scores were significant for prefabricated splints (p=0.018) but not for custom splints (p=0.232). All were compared to the control group.</p> <p>At week 6 pain was significantly different for the custom splint (p=0.049). Grip strength was not improved. Pinch strength was improved in both prefabricated (p=0.000) and custom (p=0.000) groups. Functionality also improved in custom group (p=0.026).</p> <p>At week 10 both splints reduced pain (p=0.000 for prefabricated, p=0.000 for custom). Pinch strength and functionality were significant (p=0.000) for both).</p> <p>There were no significant differences between the two types of splints for functionality (p=0.136), grip strength (p=0.528), or pinch strength (p=0.651). At week 10 pain levels significantly differed (p=0.024).</p>	<p>only significant difference. The custom made splint demonstrated better results in pain reduction. It appears that these splints are helpful in the short-term in early CMC OA, particularly for pain.”</p>	
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<p>Becker 2013</p> <p>RCT</p> <p>No COI or sponsorship.</p>	<p>4.5</p>	<p>N = 62 (48 female/14 male) with diagnosis of trapeziometacarpal arthrosis</p> <p>Age = mean of 63</p>	<p>Pre-fabricated neoprene Comfort Cool_Thumb CMC Restriction Splint (N=32)</p> <p>vs</p> <p>Customized 3.2 mm thick thermoplast hand-based thumb spica splint (N=30)</p> <p>Follow up 9 weeks (average)</p>	<p>Comfort was the only statistically significant variable between the two splints (p=0.048) with participants preferring the neoprene splint. There were no detectable differences between the splints for areas of functionality, pain, pinch strength, satisfaction, and grip strength.</p>	<p>“When compared to custom-made thermoplast splints, pre-fabricated neoprene hand-based thumb spica splints are, on average, more comfortable, less expensive, and as effective in treating trapeziometacarpal arthrosis.”</p>	<p>High dropout rate for final analysis. Data suggest comparable efficacy but neoprene splints tend to be reported as being more comfortable.</p>
<p>Carreira 2010</p> <p>RCT</p> <p>No mention of COI. Study was supported by the Fundacao de Amparo a Pesquisa do Estado de Sao Paulo.</p>	<p>5.0</p>	<p>N = 40 (38 female/2 male) with osteoarthritis in trapeziometacarpal joint in dominant hand, clinical and radiological diagnosis, pain in base of thumb of dominant hand of between 3 and 7 on visual analog scale for pain (0 – 10 cm)</p> <p>Age =</p>	<p>Splint group, thermoplastic splint, used splint from day 1 for daily activities (N = 20)</p> <p>vs</p> <p>Control group, thermoplastic splint, used only during evaluations and between days 90 and 180</p> <p>Follow up Day 45, 90, and 180</p>	<p>Between day 0 and day 90 there was a statistically difference in pain level between the groups (p=0.003). This was also observed at day 45 (p=0.013) and day 90 (p=0.002). In the splint group the pain was significantly reduced when comparing levels from day 0 to 45 (p < 0.001) and 0 and 90 (p < 0.001).</p> <p>No significant difference between the groups in scores of the first (p=0.524) and second (p=0.893) question of the DASH scores. Scores differed significantly for question three (p=0.382). No significant difference was observed between groups for dexterity, grip</p>	<p>“Splint use during activities of daily living for patients with trapeziometacarpal osteoarthritis reduces pain, but does not alter function, grip strength, pinch strength or dexterity.”</p>	<p>Data suggest that functional splints used for OA of the trapeziometacarpal joint “may” reduce pain but do not alter function (grip strength, pinch strength or dexterity).</p>

				strength, and pinch strength. Comparing score differences from day 0 and day 180 the only significant difference was for pain without a splint (p=0.009).		
Splint vs. Another Splint						
Weiss 2004 Randomized Crossover Trial No mention of COI. Funded by grant from the AAHS.	4.0	N = 25 (21 females/4 males); all with first CMC joint OA No mention of ages.	Prefabricated neoprene splint vs. custom thermoplastic short opponens splint for 1 week each	Pain at rest baseline 5.42 (SEM 0.48). Pain after CMT: 3.59 (0.44) vs. PFN: 2.29 (0.33), p <0.05. Pain with pinching favored PFN splint (p <0.05). "Long-term" patient preference 72% PFN vs. 24% CMT.	"[S]ubjects with stage I and II first CMCJ-OA will have pain relief with thumb splinting. In addition, the PFN splint will provide greater relief when compared with the CMT splint."	Suggests prefabricated neoprene splint over MCP and MCM superior to custom made orthosis for very short term treatment of 1 week.
Buurke 1999 Randomized Crossover Trial No mention of COI or sponsorship.	4.0	N = 10 (10 females/0 males) with OA of 1st CMC joint Age = Mean of 67.2	3 thenar eminence orthoses [supple elastic (Uriel 25), elastic with semi-rigid thumb busk (Gibortho ref. 6302) vs. semi-rigid polyethylene (Sporlastic 07051)]; 4 weeks each splint	Wearing comfort: Uriel 62.5 vs. Sporlastic 28.6 vs. Gibortho 23.3 (p <0.05). Order of preference Uriel then Gibortho/Sporlastic. Pain ratings: Uriel 47±34 vs. Sporlastic 55±37 vs. Gibortho 48±31. No preference for pain ratings.	"Eight out of 10 patients prefer the permanent use of a TE orthosis. Six patients chose the supple elastic orthosis and two chose the semi-rigid orthosis."	Small sample size. Half were splinting at the start of study. Crossover trial and 4 weeks duration are relative strengths.
Exercise vs. Sham						
Stamm 2002 RCT Sponsored by an unrestricted grant from Merck, Sharp, and Dohme. No mention of COI.	4.5	N = 40 with hand osteoarthritis Mean Age of 60.5 years 35 Females, 5 Males	Control (N = 20) Vs Joint protection and exercise (JPE) group (N = 20)	At baseline, grip strength was slightly, but not significantly, higher in the control group (0.43 ± 0.21 in JPE group and 5.4 ± 0.16 in the control group in the right hand and he left hand yielded 0.44 ± 0.19 and 0.53 ± 0.19, respectively. After 3 months, grip strength	"Joint protection and hand home exercises, easily administered and readily acceptable interventions, were found to increase grip strength and global hand function."	Program involves minimal 1 visit. Baseline controls' grip stronger than exercise group may bias in favor of exercises. Improvements in strength not related to exercise time

			No mention of Follow up	significantly improved in the JPE for both hands (P <0.0001 for the right hand and P = 0.0005 for the left hand, when compared to baseline). There was no significant improvement for the control group (P = 0.2335 for the right hand and P = 0.1612 for the left hand).		raises some questions.
Rogers 2009 Randomized Clinical Trial Sponsored by the Hygenic Corporation. No COI.	4.0	N = 46 subjects at least 50 years or older with radiographic OA. Mean age of 75 years old. 40 Females, 6 Males	Exercise Group – 16 weeks of daily hand exercise intervention. Vs Sham Group – 16 weeks with OTC nonmedicated hand moisturizing lotion. No mention of group distribution. Time of follow up not mentioned.	Changes in AUSCAN sub-scales did not differ between the two treatment groups. Grip and pinch measures improved after exercise but not sham.	“The results of this investigation found that while a home-based daily 16-week regimen of hand strength and range of motion exercises modestly improved grip and pinch strength, this benefit was not sufficient to see an improvement in self-reported hand physical function or pain”	No placebo control. Exercise regimen emphasized range-of-motion, which may have biased towards null.
Villafine 2013 RCT No sponsorship or COI.	7.0	N = 60 diagnosed with CMC joint OA Mean Age of 82 years 51 Females, 9 Males	Control (N = 30) – Placebo group, received detuned ultrasound therapy. vs Experimental (N = 30) – Received multimodal treatment protocol	The experimental group (3.7, CI 95% 2.4, 3.8) had a significant greater reduction in pain than the control group (0.3, CI 95% 0). An ANOVA revealed no significant differences in pressure pain threshold between both groups (F=0.44, P=.72). There was no significant difference between the two groups in regards to grip strength (F=1.2, P = .31) and tip	“This study provides evidence that a multimodal intervention consisting of joint mobilization, neural mobilization, and exercise is beneficial to reduce pain in patients with CMC joint OA.”	Data suggest combination therapy (ie. Joint mobilization, neural mobilization and exercise) is better than sham for pain treatment in patients with CMC joint OA.

			for CMC joint OA- related pain. Follow-up 1 and 2 months after intervention.	pinch strength (F = 0.4, P = .75)		
Exercise and Splint vs. Other Exercise and Splint						
Wajon 2005 RCT No mention of COI or sponsorship.	4.0	N = 40 (31 females/9 males) All with Stage I-III trapezio-metacarpal OA Age = 59.7 for thumb strap group, 61.2 for short opponens splint	Thumb strap splint plus abduction exercises vs. short opponens splint plus pinch exercises. Splints custom thermoplast. Exercises (5-10 reps, 3 sessions a day) added after 2 weeks of splinting. Total 6 weeks treatment.	VAS pain scores (weeks 0/2/6): thumb strap plus abduction exercises (3.0±1.9/2.1±1.8/1.3±2.2) vs. opponens splint plus pinch exercises (2.9±2.2/1.8±1.8/0.9±1.2).	“While both groups improved, neither regimen is superior to the other in patients with trapeziometacarpal osteoarthritis.”	Data suggest comparable efficacy. Splint worn full time, which may reduce ability to work or perform other activities.

Evidence for the Use of NSAIDs and Acetaminophen for Hand Osteoarthritis

There is 1 high-quality crossover trial(1614) and 6 moderate-quality RCTs(1582, 1615-1619) (Gabay 11) incorporated into this analysis. There is 1 low-quality RCT in Appendix 2.(1583)

Acetaminophen:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis, NSAIDS, Acetaminophen; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 42 articles in PubMed, 58 in Scopus, 11 in CINAHL, 3 in Cochrane Library, 24081 in Google Scholar, and 0 from other sources. We considered for inclusion 4 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 4 from other sources. Of the 8 articles considered for inclusion, 7 randomized trials and 0 systematic studies met the inclusion criteria.

Gastrointestinal tolerability:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis NSAIDS, gastrointestinal tolerability; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 articles in PubMed, 8 in Scopus, 1 in CINAHL, 13 in Cochrane Library, 5496 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

Cardiovascular tolerability:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, NSAIDS, cardiovascular tolerability; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 article in PubMed, 6 in Scopus, 3 in CINAHL, 10 in Cochrane Library, 5425 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Acetaminophen, Aspirin, cardiovascular tolerability:

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, Acetaminophen, Aspirin, cardiovascular tolerability; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 6 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 5199 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Pope 2004 RCT Sponsored by by Physicians Services Incorporated Foundation, Toronto, Ontario. No mention of COI.	8.5	N = 51 (gender not specified) with hip, knee or hand OA. Mean age 54 ± 2.4 years in N of 1 group, and 59 ± 2.3 years in conventional therapy	N of 1 group or of diclofenac 50mg plus misoprostol 200µg (n = 24) vs. Conventional therapy or placebo for 2 week durations for 6 months (n = 27).	In one group 11 patients preferred diclofenac, none preferred placebo, and 11 had no preference. NSAID appeared to be effective in 81% of patients.	“N of 1 trials were time-consuming in these patients and are more expensive, but with slightly better outcomes. In addition, NSAID seem to be effective in a majority of subjects with OA who have been uncertain of their benefit.”	Subjects at enrollment “uncertain the nonsteroidal anti-inflammatory drugs were helpful.” Results suggest NSAIDs are efficacious for majority of patients who were uncertain if they were effective.
Barthel 2010 RCT Sponsored by Novartis Consumer Health, Inc. and Endo Pharmaceuticals Inc. COI: MBC is fulltime employee of Endo Pharmaceuticals Inc. MSG is full-time employee of Novartis Consumer Health, Inc. RDA has received research grants from Novartis Consumer Health, Inc. and Ferring Pharmaceuticals, Inc. and consulting fees from Novartis Consumer Health,	7.5	N = 783 (80.2% female and 19.8% male) with radiographically confirmed hand osteoarthritis. Mean age was 63.9 years.	Diclofenac Group- Diclofenac sodium 1% gel (4 g total, 2 g to each hand) (n = 400) vs. Placebo Group- Vehicle consisted of isopropyl alcohol, propylene glycol, cocoyl caprylocaprates, mineral oil, ammonia solution, perfume cream 45/3, carbomer homopolymer type C, polyoxyl 20 cetostearyl ether, and purified water (n = 383). Follow-up for 8 weeks.	There was no significant difference between groups for VAS pain intensity at 8 weeks, (p > 0.05). There were also no significant differences between groups for changes in AUSCAN scores, (p > 0.05) and global rating of disease, (p > 0.05).	“Pain relief correlated with improvements in physical function, stiffness, and global rating of disease in patients with hand OA, irrespective of treatment.”	Combined analyses of 2 prospective RCTs suggesting that pain from hand OA is directly related to function, stiffness, disease status, and improvements in any of above is not dependent upon active vs. placebo treatment. Anticipation of pain is what limits function.

Inc., Ferring Pharmaceuticals, Inc., and Rottapharm and has participated in speakers' bureaus for Ferring Pharmaceuticals, Inc. and Forest Laboratories, Inc.						
Grifka 2004 RCT Sponsored by grant from Novartis Pharma AG, Basel, Switzerland. No mention of COI.	7.5	N = 594 (490 female and 401 male) with symptomatic osteoarthritis. Mean age 61.9 years.	200 mg Group- Lumiracoxib 200mg od (n = 205) vs. 400mg Group-Lumiracoxib 400mg od (n = 193) vs. Placebo (n = 196). Follow-up at 4 weeks.	At week 2, 200mg had pain intensity decrease of 21.3 points, 400mg group had decrease of 21.1 and placebo was 12.5. Both Lumiracoxib groups showed significant difference for pain intensity vs. placebo (p <0.001). But differences not significant between lumiracoxib groups. At week 4, respective decreases 28, 30 and 19.3. Global assessment of disease activity also decreased at week 4; 16.3, 20.9 and 9.4 in 200, 400 and placebo groups.	"Lumiracoxib 200 and 400 mg od were effective and well tolerated treatments for OA of the hand. Lumiracoxib significantly improved overall OA pain intensity in the target hand versus placebo, with a tolerability profile similar to placebo."	Data suggest both lumiracoxib 200mg and 400mg superior to placebo for treating hand OA pain at 4 weeks and overall tolerability comparable between all 3 groups.
Widrig 2007 RCT No mention of sponsorship or COI.	7.5	N = 204 (147 female and 57 male) with hand osteoarthritis. Mean age was 64 years.	Ibuprofen Group- 4cm strip of gel, applied 4x a day for 3 weeks. (n = 99) vs. Arnica gel 4cm strip of gel applied 4x a day for 3 weeks (n = 105). Follow-up for 3 weeks.	Pain intensity and hand function very similar in both groups, (p >0.05). No significant differences between groups for secondary outcomes of number of painful joints, intensity and duration of morning stiffness, (p >0.05).	"Our results show that short-term use, up to three weeks, of arnica gel improves pain and function in hand OA, indistinguishably from ibuprofen gel."	A non-inferiority study. Data suggest comparable efficacy between NSAID and arnica for topical treatment of hand OA.
Smith 2010 RCT Sponsored by past Peacock Trust. No COI.	7.0	N = 40 (35 female/5 male) with osteoarthritis in first carpometacarpa 1 joint. Mean age 66.9 years.	Treatment group up to 20ml 0.5% sodium salicylate injected on any 1 occasion, given all in 1 large patch or divided between 2-4 smaller patches (n = 20) vs. Control Group: blunt 23-gauge probe pressed on skin over each patch as if patch injected (n = 20). Assessments at weeks 3, 7, and 13 years.	Patients assessed for pain, tenderness and disability using the VAS scale. The difference was 1.9 cm between the groups for VAS pain at the final follow-up in favor of the active group, (p = 0.007). The difference for VAS tenderness score was also	"The data show that subcutaneous sodium salicylate injections are an effective symptomatic treatment for OA of the thumb."	Small sample size. Data suggest injection of subcutaneous sodium salicylate effective in thumb OA vs. sham.

				significant in favor of the active group, 1.4 cm, (p = 0.02).		
Gabay 2011 RCT Supported by the Institut Biochimique SA (IBSA), PambioNoranco, Switzerland. Cem Gabay, MD, Carole Medinger-Sadowski, MD, Danielle Gascon, RN, Frank Kolo, MD, Axel Finckh, MD: University Hospitals of Geneva and University of Geneva School of Medicine, Geneva, Switzerland. Dr. Gabay has received consulting fees, speaking fees, and/or honoraria from IBSA, Roche, MSD, Pfizer, and Bristol-Myers Squibb (less than \$10,000 each)	7.5	N=162 patients (42 males, 120 females) with hand OA. Mean age 63.9±8.5 years for CS group and 63.0±7.2 years for placebo group.	CS group: (n=80) 800 mg tablet of chondroitin sulfate with glass of water taken for 6 consecutive months. Vs. Placebo Group: Placebo same size tablet as CS group. (n=82)	Improvement in patient hand pain was significantly better for the CS group than the placebo group (p=0.016). The decrease in FIHOA score showed a similar pattern (p=0.008). Presence of erosive OA was significantly associated with higher FIHOA score (p=0.005), but not with global pain intensity (p=.75). Hand function improved significantly more in the CS groups than in the placebo group (p=0.008). There was a statistically significant difference between groups in favor of CS for duration of morning stiffness and for investigator’s global impression of treatment efficacy. No statistical significance for grip strength, acetaminophen consumption, and safety end points.	“This study demonstrates that CS improves hand pain and function in patients with symptomatic OA of the hand and shows a good safety profile.”	Data suggest CS efficacy vs. placebo in hand OA patients with improved function and reduced pain.
Gastrointestinal Complications						
Lisse 2003 RCT Sponsored by Merck & Co., Inc. No COI.	7.0	N = 5,557 (3948 female/1609 male) with knee, hip, hand or spine OA. Mean age 63 years.	Rofecoxib 25mg a day (n = 2785) vs. Naproxen 500mg twice daily for 3 months. Double dummy (n = 2772).	Discontinuation due to adverse GI events lower in rofecoxib group (5.9% vs. 8.1%), RR = 0.74 (95% CI 0.60-0.92, p = 0.005). Similar findings in low-dose ASA takers. Less use of GI meds in rofecoxib group (9.1% vs. 11.2%, p = 0.014). Two perforations, ulcers or bleeding episodes	“[R]ofecoxib, 25 mg once daily, was as efficacious as naproxen, 500 mg twice daily, in controlling symptoms over a 3-month period and was associated with significantly better GI tolerability.”	Very large sample size; no placebo. Participants allowed to take H-2 blockers. Results suggest equivalent efficacy for pain, but higher adverse GI symptoms and bleeds for naproxen vs. rofecoxib.

				in rofecoxib vs. 9 in naproxen (RR = 0.22, p = 0.038).		
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Evidence for the Use of Topical NSAIDs for Hand Osteoarthritis

There are 4 moderate-quality RCTs or crossover trials (1616, 1620, 1621, 1623) (Rothacker 94; Altman 09; Barthel 10) incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Topical NSAIDs, Topical non steroidal anti-inflammatory drug, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 32 in Scopus, 9 in CINAHL, 67 in Cochrane Library, 150 in Google Scholar, and 2 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 3 Google Scholar, and 2 from other sources. Of the 6 articles considered for inclusion, 4 randomized trials and 2 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Topical NSAIDs vs. Placebo						
Rothacker 1994 RCT Crossover Trial Sponsored in part by Thompson Medical Company, West Palm Beach, Florida. No mention of COI.	7.5	N = 50 (41 female/8 male) with hand OA. Mean age 66 years.	Trolamine salicylate 10% cream single application (n = 24) vs. Placebo single application (n = 25).	Changes in right hand pain severity (0/45/120 minutes): Trolamine salicylate (-0.2/-1.3/-1.4) vs. placebo (-0.2/-0.9/-1.1), p = 0.60, p = 0.08, p = 0.32. Mean change in pain relief scores at 45 minutes p = 0.047, with other times not significant.	“Trolamine salicylate has been shown to be both safe and effective in this single-application study of patients suffering from morning pain and stiffness associated with osteoarthritis in the hands.”	Ultra-short term study, single application. Suggests weak efficacy that is not long lasting.
Rothacker 1998 RCT	6.5	N = 86 with hand OA.	Trolamine salicylate 10% cream vs. placebo. Single applications of each.	Sum of pain intensity differences scores: Trolamine salicylate -3.44 vs. -2.45, p = 0.072. Combined hands analysis p = 0.049.	“10% trolamine salicylate cream was shown to be safe and effective for the temporary relief of minor pain and stiffness associated with osteoarthritis in the hands.”	Data suggest efficacy over very short-term from single application.
Altman 2009 RCT No mention of sponsorship and COI.	7.5	N = 385 diagnosed with OA in their primary hand. Mean age of 64.1 years old. 296 Females, 89 Males	Diclofenac Sodium Gel Group (N = 198) – Patients were given a topical 1% diclofenac sodium gel. vs Vehicle Group (N = 187) – Patients were given a placebo gel.	At week 8, the diclofenac sodium gel group stayed significantly superior to the vehicle group on the AUSCAN stiffness and functional indices (P<0.048 and P<0.017, respectively). Diclofenac sodium gel decreased pain intensity by 42.3%, total AUSCAN score by 35% and global rating of disease by 36.1%.	“Topical diclofenac sodium gel was generally well tolerated and effective in primary hand OA.”	Data suggest topical diclofenac gel was superior to placebo suggesting efficacy.

			Follow up 1, 2, 4, 6, 8 weeks after gel given.			
Barthel 2010 Prospective Sponsored by Novartis Consumer Health, Inc. and Endo Pharmaceuticals Inc. No COI.	7.5	N = 783 diagnosed with primary hand OA by American College of Rheumatology criteria Mean age of 63.9 years old 628 Females, 155 Males	Diclofenac Sodium Gel Group (N = 400) – Received 4g of 1% diclofenac sodium gel. Vs Vehicle Group (N = 383) – Received 4g of vehicle gel. Follow up 1, 2, 4, 6, 8 weeks after gel given.	Patients with at least 70% improvement from baseline score in VAS pain intensity had large mean improvements in AUSCAN pain, function, stiffness, and global rating of disease. Those that worsened also experienced a decrease in AUSCAN pain, function, stiffness, and global rating of disease. Change in VAS is correlated with AUSCAN pain, function, stiffness, and global rating of disease (P<0.001).	“Diclofenac sodium 1% gel is indicated for relief of OA pain in joints amenable to topical treatment, such as the hands and knees.”	Data suggest pain relief correlates with improved hand function in OA patients irrespective of treatment.

Evidence for the Use of Complementary and Alternative Therapies for Hand Osteoarthritis

There is 1 high-(1629)(Reeves 00) are 4 moderate-quality RCTs and crossover trials incorporated into this analysis.(1624, 1625, 1628, 1630) (Shin 13) There are 4 low-quality RCTs(1626, 1627, 1631, 1632) in Appendix 2.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Complementary therapy, alternative therapy, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 55 in Scopus, 6 in CINAHL, 70 in Cochrane Library, 150 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 1 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 7 from other sources. Of the 9 articles considered for inclusion, 9 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Capsaicin vs. Placebo						
McCarthy 1992 RCT	5.0	N = 21 OA (14) and RA (7)	Capsaicin 0.075% vs. placebo QID for 4 weeks	VAS pain scores were (baseline vs. weeks 1/2/4): Capsaicin -10% vs. placebo -11%/- 35% vs. -10%/ -55% vs. -18% (p <0.02) (graphic interpretations).	“[T]opical capsaicin is a safe and potentially useful drug for the treatment of painful OA of the hands.”	Blinding questionable. Suggests capsaicin reduces pain.
Schnitzer 1994 RCT	4.0	N = 59 Hand OA	Study began with all on capsaicin 0.025% vs. placebo and all QID dosing for 3 weeks, then BID for 6 weeks.	Capsaicin superior to placebo at Weeks 1 and 3 for pain responses (p = 0.046 and p = 0.018). Articular tenderness also favored capsaicin at all times except 6 weeks.	“[I]t may be prudent to taper the regimen gradually to avoid the decrease in pain relief seen with an abrupt decrease in dosage.”	Data suggest capsaicin effective, however study both decreased treatment frequency and randomized to placebo vs. treatment, thus somewhat limiting conclusions.
Stinging Nettle vs. Non-Stinging Nettle						
Randall 2000 Crossover Trial No mention of sponsorship or COI.	7.0	N = 27 (23 female/4 male) with OA base of thumb or index finger. 2RA, 1 AS. Age range 45-82 years.	Stinging <i>Urtica dioica</i> (n = 13) vs. non-stinging nettle leaf <i>Lamium</i> album (n = 14).	VAS pain scores (baseline/post): stinging nettle (38.3/23.67) vs. non-stinging nettle (36.59/37.04), p = 0.026. Daily NSAID use: nettle (1.04/0.70) vs. non-stinging nettle (0.93/0.93), p >0.05. Health assessment scores improved more with stinging nettle (p = 0.003).	“After one week’s treatment with nettle sting, score reductions on both visual analogue scale (pain) and health assessment questionnaire (disability) were significantly greater than with placebo.”	Success of blinding questionable. Patients applied the plant leaf themselves.
Dextrose vs. Placebo						
Reeves 2000 Prospective RCT No mention of sponsorship or COI.	8.0	N = 27 patients with osteoarthritis in the hands. Mean age of 64.2 years old. 16 Females, 11 Males	Dextrose Group (N = 13) – Received 0.5 mL of 10% dextrose or 0.075% xylocaine in bacteriostatic water. vs Control Group (N = 14) – Received 0.075% xylocaine in bacteriostatic water. Follow up 6 months and 12 months after first injection.	Flexion range improved significantly (P = 0.003) in dextrose treated joints compared to placebo-treated joints. After 6 months, the control group received dextrose injections and improved pain reduction from 18% to 54% in the average joints and 9.7% to 38% in total joint collection.	“Dextrose prolotherapy was clinically effective and safe in the treatment of pain with joint movement and range limitation in osteoarthritic joints.”	Data suggest at 12 months, ROM, pain level and PRWE and DASH scores equivalent. Patients in surgical group reported better grip strength throughout trial.
Diacerein vs. placebo						
Shin 2013 RCT	7.0	N = 86 patients fulfilled the American College Board of Rheumatology	Diacerein Group (N=42) – Received Diacerein 50 mg BID or 12 weeks vs	There are no significant difference in change in AUSCAN pain score at 4 weeks (Diacerein vs placebo, P = 0.507). Diacerein was significantly improved (P = 0.004) for the physician global	“The results of this trial indicate that the safety profile of diacerein 50 mg BID is acceptable, although the regimen may be unsuccessful in controlling the symptoms of hand OA.”	Data suggest comparable efficacy between groups.

Sponsored by Myungmoon Pharmaceutical Co, Ltd. COI, Dr. Shin is a consultant to Pfizer Inc.	criteria for hand OA. Mean age of 57.8 years old. 83 Females, 3 Males	Placebo Group (N=44) – Received placebo BID for 12 weeks Follow up 4 and 12 weeks after initial enrollment.	assessment. Adverse events occurred 38 (90%) times in the diacerein group and 29 (67%) in the placebo group.		
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Evidence for the Use of Low-Level Laser Therapy for Hand Osteoarthritis

There is 1 high-quality RCT incorporated in this analysis.(1636)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Low Level Light Therapy, LLLT, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 9 articles in PubMed, 18 in Scopus, 1 in CINAHL, 0 in Cochrane Library, 150 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
LLLT vs. Sham						
Brosseau 2005 RCT Sponsored by Ontario Arthritis Society, Ontario Ministry of Health and Long-Term Care, University Research Chair, and inistry of Human Resources. No menstion of COI.	9.0	N = 88 patients diagnosed with OA. Mean age of 65.7 years old. 69 Females, 19 Males	Low Level Laser Therapy Group (N = 42) – Received inactive LLLT vs Sham Low Level Laser Therapy Group (N = 46) – Received Gallium Aluminum Arsenide LLLT Follow-up 6 and 18 weeks after last treatment of LLLT.	There was no significant difference in VAS sores and morning stiffness. Grip strength significantly improved for participants in the active LLLT group (P = 0.041) and a significant reduction in finger distance between thumb and the base of the fifth metacarpal (P = 0.011). No significant differences were found in other outcomes.	“LLLT is no better than placebo at reducing pain, morning stiffness, or improving functional status for OA-hand patients.”	Suggests LLLT not effective.

Evidence for the Use of Intraarticular Injections for Hand Osteoarthritis

There is 1 high-(1646) and 5 moderate-quality RCTs(1643, 1647-1650) (Spolidoro Paschoal Nde 15; Stahl 05) incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Intraarticular Injections, glucocorticosteroid, hyaluronate injection; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 22 articles in PubMed, 9 in Scopus, 3 in CINAHL, 0 in Cochrane Library, 9928 in Google Scholar, and 0 from other sources. We considered for inclusion 7 from PubMed, 1 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Of the 9 articles considered for inclusion, 6 randomized trials and 1 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: intraarticular injections, glucocorticosteroid, hyaluronate injection, hand, fingers, thumb, metacarpus, osteoarthritis, and osteoarthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 6 articles. Of the 6 articles we considered for inclusion 3. Of the 3 considered for inclusion, 1 are randomized controlled trials and 2 systematic reviews.

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Glucocorticosteroid vs. Placebo Injections										
Meenagh 2004 (score=8.5)	Intraarticular Glucocorticosteroid or Hyaluronate Injections	RCT	No mention of sponsorship or COI.	N = 40 pts with CMC joint OA.	Age range 41-71 years; 4 males, 36 females.	Triamcinolone hexacetonide 0.25mL, 5mg (n = 20) vs. sterile saline, fluoroscopically guided injections (n = 20).	Follow up at 4, 12, and 24 weeks	VAS pain changes (4/12/24 weeks): placebo (18.5/23.3/14.0) vs. steroid (10.5/3.5/0.0), NS. Patient and physician global assessments improved in both groups at 4-12 weeks.	“No clinical benefit was gained from intra-articular steroid injection to the CMCJ in moderate to severe osteoarthritis compared with placebo injection.”	VAS pain ratings suggest trend towards modest pain reductions especially at 4 weeks, but none at 24 weeks. Suggests steroid injection relatively ineffective.
Different Types of Glucocorticosteroid Injections (No Placebo)										
Monfort 2015 (score=5.5)	Intraarticular Glucocorticosteroid or Hyaluronate Injections	RCT	No COI. No mention of sponsorship.	N = 88 with osteoarthritis in the thumb (via Kellgren-Lawrence grade II-III criteria)	Mean age: 62.8 years; 11 males, 77 females	Three injections (one at week 2, 3, and 4) of 0.5 cm ³ (5 mg) of hyaluronic acid (n=48) vs. Three injections (one at week 2, 3, and 4) of 0.5 cm ³ of betamethasone disodium	Follow-up at 7, 13, 30, 90, and 180 days	Functional Index for Hand Osteoarthritis score (FIHOA) score changes from baseline at day 7, 14, 30, 90, and 180 days, respectively: hyaluronic acid group – 0, -2, -3, -4 (p=0.071), -3, betamethasone	“Both hyaluronic acid and betamethasone were effective and well-tolerated for the management of rhizarthrosis. Hyaluronic acid was more effective over time and more efficiently	Data showed no statistically significant differences between treatment groups. However there was a trend toward better VAS and

						phosphate 1.5 mg and betamethasone acetate 1.5 mg (n=40)		group -- -1, -1, -3, -1 (p=0.071), -1. No significant difference between groups	improved functionality and pain in patients with more severe symptoms.”	functional outcomes for hyaluronic acid over corticoid treatment.
Jalava 1983 (score=5.0)	Intraarticular Glucocorticoid or Hyaluronate Injections	Crossover trials	No mention of sponsorships.	N = 24; 120 injected DIP, PIP joints, yet study describes RA patients	Mean age 48.6 years; 12 males, 12 females.	Triamcinolone hexacetonide (n= 59 joints) vs. methyl-prednisolone 0.2-0.3mL/joint (n= 61 joints)	Follow-Up at baseline, week 1, 4, 12, and 24.	Effect at 6 months: TH: 21.0% Unchanged; 3.5% Worse, p<005. MP: 32.0 % unchanged; 10.0 % worse	“All injections produced clinically significant effects. There were no significant differences between the two treatment groups at the start of the treatment, but after 6 months the results in the TH group were significantly better. However, there were also more joints with skin and soft tissue atrophy in this group than in the MP group.”	Crossover trial. States RA patients, but DIP/PIP joint injections. Multiple injections in multiple digits of same patient. No placebo group, thus conclusion on benefit for all not clearly supportable. Data suggest triamcinolone may be superior.
Glucocorticosteroid vs. Viscosupplementation Injections										
Fuchs 2006 (score=6.0)	Intraarticular Glucocorticoid or Hyaluronate Injections	RCT	Sponsored by TRB Chemedica AG, Richard-Reitzner-Allee. No COI.	N = 56 thumb CMC joint OA	Median Age, Group 1: 59.5 Group 2: 61.0; 11 males, 45 females	Three intraarticular injections of: Group 1 - Sodium hyaluronic acid (SH) 10mg (n=28) vs. Group 2 - triamcinolone acetate TA 10mg injections. (n=28) Imaging not used	Follow Up at baseline, 3, 14, and 26 weeks.	VAS pain assessment (visits 1/3/5/6/7): SH (65.5/54.0/34.0/35.0 /30.0) vs. TA (63.5/46.0/20.0/22.0 /45.5).	“A single course of three SH injections is effective in relieving pain and improving joint function in patients with OA of the CMC joint of the thumb. Although in comparison with triamcinolone its effects are achieved more slowly, the results indicate a superior long-lasting effect	No placebo group. Data suggest effect of steroid largely gone at 6 months, but not for viscosupplementation .

									of hyaluronan at 6 months after end of treatment period.”	
Viscosupplementation vs. Glucocorticosteroid vs. Placebo										
Heyworth 2008 (score=7.5)	Intraarticular Glucocorticosteroid or Hyaluronate Injections	RCT	Sponsored by a grant from Wyeth-Ayerst Pharmaceuticals and Genzyme Corporation. No mention of COI.	N = 60 with basal joint OA	Mean age 63 ± 1 years; 2 males, 52 females.	(2) 1-mL injections of hylan G-F 20 1 week apart (n = 20) vs. Steroid 1mL betamethasone (n = 22) vs. 2 placebo saline injections (n = 18). All received 2 injections, 1 week apart.	Follow up at 2, 4, 12, and 26 weeks	Data graphically presented; suggest grip strengths worse for saline than other 2 groups. However, not statistically significant between groups. Within groups, steroid superior at Weeks 2 and 4 to baseline and Hylan better at Weeks 2, 4, 12, 26 compared with baseline. No between-group VAS differences, but lower VAS pain compared with baseline for controls and steroid at Weeks 2 and 4, however for hylan, reductions were at Weeks 2, 12, 26 compared with baseline.	“There were no statistically significant differences among hylan, steroid, and placebo injections for most of the outcome measures at any of the follow-up time points. However, based on the durable relief of pain, improved grip strength, and the long-term improvement in symptoms compared with preinjection values, hylan injections should be considered in the management of basal joint arthritis of the thumb.”	Trend towards Hylan relief lasting longer than glucocorticosteroid injection. States no baseline difference but stats for age are dissimilar. Dropout rate unclear.
Single vs. Multiple Viscosupplementation Injections										
Roux 2007 (score=4.0)	Intraarticular Glucocorticosteroid or Hyaluronate Injections	RCT	No mention of sponsorship or COI.	N = 42	Mean Age 64.8 ± 8.0 years; 4 males, 38 females.	1ml sodium hyaluronidate (Sinovial) 1 injection (n=14) vs. 2 injections (n=14) vs. 3	Follow-Up at baseline, 1 month, and 3 months.	1 injection VAS (1 month, 3 months): 58.4±16.2, 43.1±22.8; 2 injections: 54.6±18.9,	“No significant differences were found between each group over the study period for pain relief and	No placebo. Unequal treatment control biases towards more treatment. Trend

						weekly injections using image intensifier (n=14)		39.5±28.6; 3 injections: 60.1±17.0, 29.8±21.9	function. But the intra groups analysis results show that intra-articular sodium hyaluronidate injections into the carpometacarpal joint of the thumb in osteoarthritis can be efficacious on pain and functionality.”	towards lower grade disease across the categories (x-ray grades 3.1/2.7/2.4) may bias towards more injections suggests randomization failure and may be fatal flaw.
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Evidence for the Use of Injections for Hand Osteoarthritis

There are 2 high-(1629, 1641) quality and 5 moderate-quality RCTs and crossover trials incorporated into this analysis.(1638-1640, 1642, 1651) (Jahangiri 14) There is 1 low-quality RCT in Appendix 2.(1643)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Prolotherapy Injections OR Proliferative Therapy AND Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 2 in Scopus, 1 in CINAHL, 2 in Cochrane Library, 997 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 1 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 1 Google Scholar, and 4 from other sources. Of the 8 articles considered for inclusion, 8 randomized trials and 2 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: prolotherapy injection, hand, fingers, thumb, metacarpus, osteoarthritis, osteoarthritis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Prolotherapy Injections										
Reeves 2000 (score=8.0)	Prolotherapy Injections	RCT	No mention of sponsorship or COI.	N = 27 with 150 joints DIP, PIP and thumb CMC joint OA.	Mean age: 64.19 years; 11 males, 16 females.	0.5ML of 10% dextrose plus 0.075% xylocaine (n=13) vs. 0.075% xylocaine injections into medial and lateral aspects of each joint (n=14). Injections at 0, 2, 4 months	Follow up at 6 months.	VAS after 3 injections improved 37% in active treatment vs. 18% controls (NS). Pain with rest and grip non-significant trend towards dextrose. Pain with movement improved with dextrose (59 to 67 vs. 57 to 48 in controls) (p = 0.027)	“Dextrose prolotherapy was clinically effective and safe in the treatment of pain with joint movement and range limitation in osteoarthritic finger joints.”	Small sample sizes and high dropout rates.
Jahangiri 2014 (score=7.0)	Prolotherapy Injections	RCT	No sponsorship or COI.	N = 60 patients with osteoarthritis in the first carpometacarpal joint (CMC)	Mean Age: 63.6 ± 9.7 years; 16 males, 44 females.	Local corticosteroid (LC) group, had placebo injections of 1 ml 0.9 % saline were administered (for masking) followed by a single dose of 40 mg methylprednisolone acetate (0.5 ml) mixed with 0.5 ml of 2 % lidocaine in the 3rd month (n=30) Vs. Group 2: Dextrose Prolotherapy (DX) group, had 0.5 ml of 20 % DX mixed with	Follow-Up at baseline 1, 2, and 6 months.	LC - DX difference, Hand Assessment Questionnaire Disability Index (HAQ-DI) scores (Mean Difference (95% CI)), two months: 1.0 (0.2-1.9) (p=0.01). 6 months: 1.0 (0.2 – 1.8) (p=0.01). Pain, Visual Analogue Scale (VAS), 2 months: 1.0 (0.1-2.0) (p=0.01). 6 months: 1.1 (0.2-2.0) (p=0.02). Pinching, 1 month: 2.9 (0.9-4.9) (p=0.005). Both groups improved significantly within themselves and was significant in all	“Both LC and DX can relieve pain and suppress Inflammatory processes. Furthermore, DX has been suggested To strengthen soft tissue too. There are some reports Indicating improvement in ligament laxity after DX prolotherapy.”	Data suggest steroid is better at 1 month but at 2 months, both groups had comparable results but at 6 months there was a better outcome in the DX group. After 6 months, both groups showed improved function but DX group had an overall better function score.

						0.5 ml of 2 % lidocaine was injected (n=30)		three categories listed above.		
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Evidence for the Use of Surgery for Hand Osteoarthritis

There are 5 moderate-quality RCTs incorporated into this analysis.(1654, 1669, 1670, 1675, 1677)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Reconstructive surgery , Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, trapeziometacarpal arthrosis, trapeziectomy with ligament reconstruction and tendon interposition, thumb CMC joint osteoarthritis, fusion, hand osteoarthrosis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 136 articles in PubMed, 22 in Scopus, 6 in CINAHL, 1 in Cochrane Library, 20105 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 3 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 1 from other sources. Of the 5 articles considered for inclusion, 5 randomized trials and 2 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: reconstructive surgery, trapeziometacarpal arthrosis, trapeziectomy, ligament reconstruction, tendon interposition, thumb CMC joint osteoarthritis, fusion, hand, fingers, thumb, metacarpus, osteoarthritis, osteoarthrosis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 38 articles. Of the 38 articles we considered for inclusion 2. Of the 2 considered for inclusion, 2 are randomized controlled trials and 0 systematic reviews.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Trapeziectomy vs. Trapeziectomy plus Palmaris Longus Tendon Interposition										
Vermeulen 2014 (score=8.5)	Reconstructive Surgery	RCT	No COI. No mention of sponsorship.	N = 79 patients with symptomatic osteoarthritis who failed to improve after nonsurgical treatment and had stage 4 osteoarthritis of the thumb base	Mean age: 64.1 years; 0 males, 79 females	Burton-Pellegrini technique (BP) – incision along radial border of first metacarpal, then removed trapezium, tendon graft of ~10 cm removed, tendon graft passed through bone, sutured into a ball and secured in trapezial space as a spacer (n=40) vs. Weilby technique – trapezium removed as in BP technique, tendon graft was made into a figure-of-8 fashion around the APL tendon and the rest of the FCR tendon (n=39)	Follow-up at 3 and 12 months	Within-group comparisons preoperative scores and 3 and 12 month scores – improvement in both groups for Patient-Rated Wrist/Hand Evaluation (PRWHE) pain scores (p < 0.001), PRWHE activities scores (p < 0.001), PRWHE total score (p < 0.001), improvement in Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire (p < 0.003). Between-group comparisons of preoperative and 3 month scores showed larger improvement in BP group for PRWHE pain and total scores (p = 0.02, p = 0.03). Between-group comparisons from preoperative to 12 months showed no significant difference in improvement between groups (p > 0.001)	“After the bone tunnel technique, patients have better function and less pain 3 months after surgery than do those in the non—bone tunnel group, which indicates faster recovery. However, 12 months after surgery, the functional outcome was similar. Because of faster recovery, we prefer the bone tunnel technique in the treatment of stage IV osteoarthritis.”	Groups at 12 months had no difference between treatments although recovery may be slightly faster in the Burton-Pellegrini treatment compared with the weilby treatment.

Prosser 2014 (score=6.5)	Reconstructive Surgery	RCT	No mention of COI or sponsorship.	N = 56 with osteoarthritis of TMC joint underwent TMC arthroplasty allocated to either rigid orthotic or Semi-rigid orthotic groups.	Mean age: 66.9±8.5 years; 11 males, 45 females.	Allocated to rigid orthosis (n = 28) vs. Allocated to semi-rigid orthosis (n = 28). Following surgery, a dorsal plaster backslab was applied to Immobilize the wrist and thumb of all participants. Immediately following surgery the surgeon advised the patient to move the fingers (composite extension and flexion) and thumb interphalangeal joint (extension and flexion) within the confines of the backslab.	Follow-up after 6weeks, 3 months and 1 year.	Both groups performed equally well. There was no significant between-group difference for PRWHE scores (0.47, CI -11.5 to 12.4), including subscales for pain and function, or for any of the secondary outcomes at one year follow-up	“The rigid orthosis and semi-rigid orthosis (allowing more wrist and thumb motion) used from 2 to 6 weeks following TMC arthroplasty performed equally well in this study. There was no significant difference between the two groups at one year for the primary outcome of PRWHE scores or for any secondary outcome. Clinically, either orthosis could be recommended. Patient comfort, cost and availability may determine choice between orthoses in clinical practice.”	Data suggest comparable efficacy between rigid vs semi-rigid orthotics post TMC arthroplasty.
Davis 2004 (score=6.5)	Reconstructive Surgery	RCT	No COI. No mention of sponsorship.	N = 162 patients with painful trapeziometacarpal osteoarthritis; 183 thumbs; 183 surgeries	Mean age: 59 years; 0 males, 162 females.	Simple trapeziectomy (n= 62) vs. trapeziectomy with Palmaris longus interposition (n= 59) vs. trapeziectomy with ligament reconstruction and tendon interposition using 50% of	Follow up at 3 and 12 months	82% good pain relief and 68% regained sufficient strength for normal activities of daily living at 1-year follow-up. No differences in pain levels at 3 months (p = 0.58) or 1 year (p = 0.4). Pain levels at 3 months (No pain or restriction): T = 12,	“The outcomes of these 3 variations of trapeziectomy were very similar at 1-year follow-up evaluation. In the short term at least there appears to be no benefit to tendon interposition or ligament reconstruction.”	Includes patients in other report below; 21 bilateral cases – did not always crossover. Results suggest no differences in outcomes.

						flexor carpi radialis tendon. (n=62) All thumbs splinted for 6 weeks.		T+PL = 9, T+LRTI = 10. Discomfort with use but no restriction: T = 24, T+PL = 20, T+LRTI = 19.		
Davis 2009 (score= 6.5)	Reconstructive Surgery	RCT	No mention of COI or sponsorship.	N = 113 patients; 20 bilateral	Mean age: 60.5 years; 5 males, 103 females.	Trapeziectomy with Flexor carpi radialis ligament reconstruction, tendon interposition and Kirschner wire insertion followed by splintage for 6 weeks (n= 67) vs. excision of trapezium with no Kirschner wire and immobilization of thumb in soft bandage for 3 weeks (n=61).	Follow up at 3 and 12 months	At 1 year, 81% of trapeziectomy had no pain or only discomfort after use with no activity restrictions vs. 67% of trapeziectomy with LRTI (p = 0.1). DASH scores [baseline (95% CI)/3 months/1 year]: Trapeziectomy [65(58-72)/52(44-59)/34 (26-42)] vs. Trapeziectomy and LRTI [65(59-72)/42 (35-50)/37(28-45)]. Key pinch: trapeziectomy (4.1/3.5/4.4) vs. trapeziectomy plus LRTI (4.0/3.7/4.7).	“[T]his study found that the results of simple excision of the trapezium, as described by Gervis (1949), are similar to those produced by excision of the trapezium with ligament reconstruction and tendon interposition using the technique described by Burton and Pellegrini (1986)...[A]nd, until further larger studies are performed, the value of such additions to trapeziectomy remain unproven.”	Suggests no short or intermediate term (1 year) benefits demonstrable of more extensive procedures and trend of benefit for trapeziectomy alone
Hansen 2013 (score=5.0)	Reconstructive Surgery	RCT	No COI. No mention of sponsorship.	N = 32 hands of 28 patients with Eaton-Glickel stage 2 or 3 TM joint osteoarthritis	Mean age: 56 years; 5 males, 23 females	All patients received an uncemented Elektra grit-blasted titanium hydroxyapatite-coated metacarpal stem in combination with a chrome-cobalt	Follow-up at 3, 6, 12, and 24 months	At 24 months the 2-year total translation (TT) similar between C (0.24 mm) and UC (0.19 mm, p = 0.2). Grip strength, pain and the Disabilities of the Arm, Shoulder, and Hand (DASH)	“Early implant fixation and clinical outcome were equally good with both cup designs. This is the first clinical RSA study on trapezium cups, and the method appears to be clinically useful	Outcome assess using stereoradiograph which have some differential error. Sparse baseline data for a small study size. However, data suggest

						neck/head. Randomized to receive a cemented DLC all-polyethylene cup (c) (n=16) vs. uncemented Elektra chrome-cobalt grit-blasted hydroxyapatite-coated screw up (UC) (n=16)		scores similar between treatments	for detection of loose implants.”	there may not be a difference between the cemented polyethylene cups and the uncemented metal cup for total transaction assessed with stereoradiograph .
Davis 1997 (score= 4.5)	Reconstructive Surgery	RCT	Sponsored by Wishbone Trust. No mention of COI.	N = 76 patients	Mean age: 58.2 years; 0 males, 76 females.	Trapeziectomy (n=30) vs. trapeziectomy with soft tissue interposition (n=23) vs. trapeziectomy with ligament re-construction and tendon interposition (n=23)	Follow up at 3 and 12 months.	RSD complications: T = 0, T+STI = 0, T+LRTI = 2. Thumb key pinch strengths (baseline/3 months/1 year): T (3.7/3.4/4.8) vs. T+STI (4.0/3.1/4.6) vs. T+LRTI (3.4/3.1/4.4). Hand grip strengths [mean (range in kg)]: T [14.8 (4-46)/14.7(2-40)/19.2) vs. T+STI [12.4 (4-25)/10.8 (2-27)/16.9) vs. T+LRTI [11.3 (1-22)/14.0 (2-25)/19.1).	“In the short term at least, tendon interposition and ligament reconstruction do not improve the results of trapeziectomy.”	Some baseline differences. Results suggests trapeziectomy equivalent to combined ligament reconstruction procedure or soft tissue interposition.
Kriegs-Au 2004 (score=4.0)	Reconstructive Surgery	RCT	No COI and no sponsorship.	N = 43 patients; 52 thumbs	Mean age: 58.7 years; 6 males, 25 females.	Trapezium excision with ligament reconstruction (n=15) vs. trapezium excision with tendon interposition (n=16)	Mean follow up period of 48.2 months	Long-term outcome (Buck-Gramcko Score): 51.3 vs. 44.6 points. Strength measures Group I (ligament reconstruction) vs. (pre-op and final follow-up) vs. Group II (ligament reconstruction and tendon	“Tendon interposition does not affect the outcome after the ligament reconstruction for the treatment of osteoarthritis of the thumb carpometacarpal joint. Furthermore, proximal migration	High dropout rate. Original demographic data not reported. Data suggest tendon interposition not superior to ligament reconstruction.

								interposition): Mean tip-pinch strength (bar[Pa]): 0.21, 0.32; 0.23, 0.25; Mean grip strength bar [Pa]): 0.52, 0.46; 0.52, 0.44; Mean palmar abduction (degree): 10.7, 3.6:2.4; 11.9, 4.1:2.9.	of the thumb metacarpal does not appear to influence the functional outcome.”	
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Evidence for the Use of Post-operative Soft Bandages and Splints

There are 7 moderate-quality RCTs(1568, 1681-1686) incorporated into this analysis. There are 4 low-quality RCTs in Appendix 2.(963, 1679, 1680, 1687)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Soft bandage, splint, splinting, immobilization, Postoperative Period, post-operative, rehabilitation, upper, extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 120 articles in PubMed, 12 in Scopus, 35 in CINAHL, 1 in Cochrane Library and 18800 in Google Scholar. We considered for inclusion 7 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library 0 from Google Scholar, and 1 from other sources. Of the 18968 articles considered for inclusion, 11 randomized trials and 1 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Immobilization vs. Early Mobilization						
Crowley 2013 RCT No sponsorship or COI.	4.0	N = 12 with ulnar collateral ligament (UCL) injuries of the thumb who underwent UCL repair with Mitek bone anchor. Median age 42 years.	SR: standard rehabilitation for 4 weeks of immobilization in POP thumb spica then 2 weeks of flexion, extension, opposition, abduction, and adduction of thumb and ultrasound, scar massage, light function for ADLs, and splint at night and out of home; therapy continued for 2-4 more weeks (N = 6) vs.	There were no significant differences between groups.	“Our results suggest that there may be a benefit in early active mobilization over standard rehabilitation but that a larger randomized control trial is needed to assess this more accurately.”	Pilot study of 12 patients. Data suggest early active mobilization lead to earlier restoration of hand function as well as an earlier return to work but no difference between groups in final ROM. A larger study would support preliminary findings.

			(EAM) early controlled active mobilization 3-5 days postop; given custom-made thermoplastic splint; first 4 weeks exercises emphasized flexion, extension, opposition, abduction and adduction of thumb ; next 2 weeks same as SR group (N = 6). Study duration, 8-12 weeks or until participants could resume full ADLs.			
Germann 2001 RCT No mention of sponsorship or COI.	4.0	N = 20 with extensor indicis proprius transfer for extensor pollicis longer (EPL) tendon rupture. Mean age dynamic motion 52 years, immobilization 42 years.	Dynamic motion protocol (DG group): 2 days after surgery wore forearm splint with limited but progressive increase in active flexion of interphalangeal (IP) joint plus passive extension through wire-rubber band system for 3 weeks (N = 10) vs. immobilization protocol (IG group): forearm cast with 20° wrist extension and thumb in full extension and abduction for 3 weeks (N = 10). Follow-up at 3, 4, 6, and 8 weeks after surgery	Active ROM of IP joint after 4 weeks: DG 74° vs. IG 50° (p<0.05). Grip strength (DG vs. IG): 3 weeks 49% vs. 27% (p<0.05); 4 weeks 45% vs. 60% (p<0.05); 6 weeks 44% vs. 65% (p<0.05). Pinch grip (DG vs. IG): 3 weeks 36% vs. 20% (p<0.05).	“The dynamic protocol can therefore be considered as an important factor for a considerable reduction of overall treatment cost. Although all parameters plateaued after 6 and 8 weeks, the early dynamic motion protocol is the superior concept and has become standard procedure for these patients.”	Small sample. Data suggest early dynamic motion group had better ROM of the interphalangeal joint grip and pinch strength at 3 weeks compared to immobilization group. Hand function was comparable between groups at 6 and 8 weeks but the shortened total rehab time in dynamic motion group appears cost effective as there was approximately 10 days of treatment and time off work saved.
Splint vs. Splint						
Sillem 2011 RCT/Crossover Sponsored by British Columbia Medical Services Vancouver Foundation	6.0	N = 59 with carpometacarpal (CMC) OA of the thumb. Mean age 64 years.	Comfort Cool™ prefabricated neoprene splint (n = 59) vs. Hybrid custom-made splint (N = 59). Participants wore splint when symptomatic, during heavier manual tasks, and at night. Two 4 week treatment periods were separated by a 1 week washout period. Total duration of study was 9 weeks. Follow-up at 4, 5, and 9 weeks and 3 months.	Mean±SD mean difference Australian Canadian Hand Osteoarthritis Hand Index (AUSCAN): 3.7±1.13 in favor of Hybrid splint (p=0.02).	“The Hybrid and Comfort Cool™ splints had an equivalent therapeutic effect on hand function, grip strength, and lateral pinch strength.”	Crossover equivalence trial. Data showed comparable results for hand function, grip strength and lateral pinch strength but the Hybrid splint was better at decreasing pain compared to Comfort Cool™.

Splint vs. Control

<p>Rannou 2009</p> <p>RCT</p> <p>Sponsored by the Programme Hospitalier de Recherche Clinique National. No COI.</p>	<p>7.5</p>	<p>N = 112 (101 female/11 male) with base-of-thumb osteoarthritis. Mean age splint group 63.0±7.9 years, control 63.5±7.6 years.</p>	<p>Intervention group: custom-made neoprene splint (n = 57) vs. Control group: usual care (n = 55). Follow-up: 1, 6, and 12 months.</p>	<p>Intervention group had reduction in VAS pain score/ reduction in disability by Cochin Hand Function Scale score/patient-perceived disability at 12 months: -22.2 vs. -7.9, -14.3 [CI: -23.4 to -5.2]; p = 0.002/ -1.9 vs. 4.3; -6.3 [CI: -10.9 to -1.7]; p = 0.008/ -11.6 vs. 1.5; -13.1 [CI: -21.8 to -4.4]; (p = 0.003). Intervention group experienced statistically significant improvements (61% vs. 38%, >10-mm [p = 0.014]; 56% vs.31% >15-mm [p = 0.007]; and 54% vs. 25% >20-mm [p = 0.002]).</p>	<p>“For patients with base-of-thumb osteoarthritis, wearing a splint had no effect on pain at 1 month but improved pain and disability at 12 months.”</p>	<p>Data suggest wearing a splint for base of thumb OA had no effect on pain reduction at one month but at 12 months there was pain and function improvement.</p>
<p>Hermann 2014</p> <p>RCT</p> <p>Sponsored by Norwegian Occupational Therapy Association, Norwegian Rheumatism Association, and the Norwegian Women’s Public Health Association. No COI.</p>	<p>7.5</p>	<p>N = 59 (58 female/1 male) with hand osteoarthritis (HOA). Mean age 70.5±6.7 years.</p>	<p>Orthosis group: soft thumb base orthosis and hand exercises focused on increasing joint mobility, grip strength, and stability of CMC joint 2 sessions per day (n = 30) vs. Control group: hand exercises only (n = 29). Study duration 2 months. Follow-up at 2 months.</p>	<p>There were no significant differences between groups.</p>	<p>“[A] soft orthosis seems to have an immediate pain-relieving effect when worn, but no general effect in terms of reduced pain, or improved hand strength or activity performance in participants with CMC-OA when not worn.”</p>	<p>Data suggest a soft orthosis has immediate pain relieving benefits when worn but no benefit in terms of pain reduction, improved hand strength or activity when not worn.</p>
<p>Jerosch-Herold 2011</p> <p>RCT</p> <p>Sponsored by Action Medical Research Charity and National Institute for Health</p>	<p>5.5</p>	<p>N = 154 undergoing fasciectomy of dermofasciectomy for Dupuytren’s disease. Mean age hand therapy only 67.5±9.2 years, splint 67.2±10.0 years.</p>	<p>Hand therapy only (n = 77) vs. hand therapy with night splinting worn for 6 months (n = 77). Follow-up for 12 months after surgery.</p>	<p>There were no significant differences between groups.</p>	<p>“Contrary to the widespread belief in the value of postop night splinting for up to 6 months after fasciectomy or dermofasciectomy we found no evidence of its short or long-term effect.”</p>	<p>Data suggest comparable results from self-reported outcomes.</p>

Research (NIHR). No COI.						
Cook 1995 RCT No mention of sponsorship of COI.	4.0	N = 50 patients having undergone CTR. Patient's age and gender are not disclosed.	Volar splint vs. soft bulky dressing removed 1st post-op day. 1 month follow-up.	Excellent results (14 days/1 month): unsplinted 9/25 (36%)/12/25 (48%) vs. splinted 1/25 (4%)/2/25 (8%). More rapid RTW in unsplinted (15 days vs. 24 days, p = 0.01). Return to full work in 17v27days, p = 0.005.	“We conclude that splinting the wrist following open release of the flexor retinaculum is largely detrimental, although it may have a role in preventing the rare but significant complications of bowstringing of the tendons or entrapment of the median nerve in scar tissue. We recommend a home physiotherapy programme in which the wrist and fingers are exercised separately to avoid simultaneous finger and wrist flexion, which is the position most prone to cause bowstringing.”	Sparse details. Full open incision suggests splints not appropriate post-operatively.

Evidence for the Use of NSAIDs Post-operatively

There are 1 high-(639) and 9 moderate-quality(972, 1688-1695) RCTs incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDs, Anti-Inflammatory Agents, Non-Steroidal, acetaminophen, Agents, Non-Steroidal, Postoperative, Period, post-operative, rehabilitation, upper, extremity;controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 40 articles in PubMed, 0 in Scopus, 0 in CINAHL, 0 in Cochrane Library and 13502 in Google Scholar. We considered for inclusion 10 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 13542 articles considered for inclusion, 10 randomized trials and 0 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Husby 2001 RCT No mention of sponsorship or COI.	8.0	N = 42 (9 female/33 male) due to be operated on for DC or CTS. Mean age 61 years.	Post-op naproxen (500mg BID) vs. Paracetamol (1000mg QID) vs. Placebo for 3 days immediate post- op CT release surgery. Second trial 35 with Dupuytren's contracture.	Post-op CTS swelling as percentage of pre-op volume 3.5±3.3 vs. 4.6±3.2 vs. 3.8±2.6. For Dupuytren's contracture releases 5.6±3.8 vs. 6.9±3.7 vs. 8.2±5.1. Additional analgesics used 0, 2, and 8 in naproxen, paracetamol and placebo groups.	"Naproxen might have a clinical relevant effect on swelling when used on minor surgery in the hand, unlike paracetamol. Naproxen might be a useful analgesic during the immediate postoperative phase."	Results suggest a beneficial effect that the studies were not powered to detect.
Sen 2006 RCT No mention of sponsorship or COI.	7.5	N = 45 (24 female/21 male) ASA I-II undergoing hand or forearm surgery. Mean age control 45 years, L-IVRA 42 years, L-IV 39 years.	Control group: IV saline 0.9% 2 ml + intravenous regional anesthesia (IVRA) with lidocaine 0.5% and saline (n = 15) vs. L-IVRA group: IV saline + IVRA lidocaine 0.5% with lornoxicam 8mg (n = 15) vs. L-IV group: intravenous lornoxicam 8mg + IVRA lidocaine 0.5% and saline (n = 15). Follow-up for 24 hours post-op.	Mean±SD intraoperative fentanyl (control vs. L-IVRA vs. L-IV): amount (µg) 23.3±25.8 vs. 3.3±12.9 vs. 19.4±18.6 (p = 0.014); requirement time (min): 15.8±6 vs. 28±9 vs. 13.6±8 (p = 0.042). Mean VAS (control vs. L-IVRA vs. L-IV): tourniquet release 3.33 vs. 1.73 vs. 3.13 (p = 0.003); tourniquet release after 2 hour 2.6 vs. 2.0 vs. 2.93 (p = 0.031). Mean±SD time to first postoperative analgesic request, minutes (control vs. L-IVRA vs. L-IV): 28±20 vs. 229±85 vs. 95±24 (p = 0.0038). Mean±SD diclofenac mg (control vs. L- IVRA vs. L-IV): 85±26 vs. 15±31 vs. 67±36 (p <0.001). Mean±SD paracetamol consumption mg (control vs. L-IVRA vs. L-IV): 1400±207 vs. 200±253 vs. 1100±320 (p <0.0001).	"[A]ddition of lornoxicam to lidocaine in IVRA shortens sensory and motor block onset times, prolongs sensory and motor block recovery times, and improves tourniquet pain while it prolongs first analgesic requirement time, and decreases total amount of analgesic."	Pilot study. Data suggest adding lornoxicam to lidocaine for intravenous regional anesthesia shortens the onset of sensory and motor block, decreases tourniquet pain and improves post-op analgesia. However, data suggest recovery times were prolonged in lornoxicam plus lidocaine group.
Ashworth 2002 RCT No mention of sponsorship or COI.	7.0	N = 47 (20 female/29 male) scheduled for inpatient elective hand surgery. Mean age systemic presurgery 57 years, regional presurgery 54.7 years, systemic postsurgery 53.4 years.	Systemic presurgery group: ketorolac 20mg intravenously in non- operative arm before surgery (n = 15) vs. regional presurgery group: ketorolac 20mg intravenously to operative arm after tourniquet inflation (n = 15) vs. systemic postsurgery group: ketorolac 20mg intravenously in non- operative arm after	VAS score 24 hours after surgery: 12.2 mm higher in systemic postsurgery group vs. systemic presurgery group (p=0.037).	"[T]here seems no benefit to be gained by giving ketorolac as intravenous regional anaesthesia compared with the usual method of giving it intravenously into the general circulation before the operation."	Data suggest no benefit in the administration of ketorolac post surgery.

			surgery (n = 15). Follow-up 1, 2, 4, 6, and 24 hours after surgery.			
Rivera 2008 RCT Sponsored by Bureau of Medicine and Surgery at the Navy Department in Washington, DC, Clinical Investigation Program. No mention of COI.	7.0	N = 60 (20 female/35 male) undergoing hand surgery. Mean age ketorolac 39.5±13.6 years, placebo 37.58±12.2 years.	Bier block of 50mL of 0.5% lidocaine + 20mg ketorolac (n = 30) vs. Bier block of 50mL of 0.5% lidocaine + normal saline (n = 30). Follow-up 48 hours after discharge.	VAS post anesthesia care unit (PACU) ketorolac vs. control: 30 min 0.48 vs. 2.20 (p<0.05); 45 min 0.38 vs. 2.23 (p<0.05); 60 min 0.45 vs. 2.50 (p<0.05). Median time (minutes) to second request of postop analgesic (ketorolac vs. placebo): 1102 vs. 505 (p=0.048).	“Based on the results of this study we recommend that 20 mg ketorolac be considered in intravenous regional anesthesia.”	Blinding is poorly described. Compared to placebo data suggests addition of ketorolac (20 mg) to lidocaine for controlling postoperative pain after non-traumatic hand and wrist surgery may be beneficial for reducing subsequent pain medication requests.
Sai 2001 RCT No mention of sponsorship or COI.	6.5	N = 120 (gender not specified) undergoing hand surgery with brachial plexus block. Mean age 43 years.	Ampiroxicam 27mg orally vs. alegioxa 100mg, orally vs. placebo 3 hours before surgery. Follow-up when each patient requested an analgesic suppository.	Median pain scores at time of first analgesic request (analgesic vs placebo): 1.0 vs. 4.0 (p <0.0001). Median pain scores at 24 hours after operation (analgesic vs. placebo): 0 vs. 2.0 (p <0.0001). Number of patients requiring analgesic suppositories (analgesic vs placebo): 6 vs 44 (p<0.0001).	“We suggest that preoperative administration of ampiroxicam improves pain control during the early post-operative phase.”	Sparse methods. Data suggest administration of ampiroxicam significantly reduced the post-operative pain and need for increased pain medication.
Cornesse 2010 RCT No mention of sponsorship or COI.	6.0	N = 60 undergoing minor hand surgery (carpal tunnel release or synovial cyst resection) under intravenous regional anesthesia. Mean age 1 g 51±15 years, 2 g 55±18 years.	1 g intravenous paracetamol before surgery (n = 30) vs. 2 g intravenous paracetamol before surgery (n = 30). Discharged after 4 hours. Once at home, patients instructed to take 1 g of paracetamol orally every 6 hours. Follow-up for 24 hours after surgery.	Pain scores: lower in 2 g paracetamol intravenous group vs. 1 g paracetamol intravenous (p=0.04).	“[A]n intravenous loading dose of 2 g paracetamol provides better analgesia than 1 g in adult patients undergoing minor hand surgery.”	Unclear if loading doses were blinded to treater. Data suggest increasing the loading dose of paracetamol from 1g to 2 g improves post-op analgesia after minor hand surgery.
Rawal 2001 RCT	6.0	N = 120 ASA I-II undergoing ambulatory hand surgery with IV regional	Group T: tramadol 100 mg orally every 6 hours (n = 40) vs. Group M: metamizol 1 g every 6 hours (n = 40) vs. Group	Mean ±SD number of study tablets (tramadol vs. metamizol vs. paracetamol) day 1/ day 2: 5.5±1.1/ 5.0±2.6 vs. 4.9±1.1/ 6.0±2.9 vs. 2.8±1.2/ 3.1±0.6 (p<0.05 metamizol vs. tramadol	“None of the study drugs provided adequate analgesia for all patients, as about 40% required rescue analgesia.”	Data suggest tramadol most effective in pain relief of ambulatory hand surgery patients. It was associated with the greatest number and highest severity of adverse events, thus highest patient dissatisfaction largely related to severity of nausea and dizziness.

No mention of sponsorship or COI.		anesthesia. Mean age tramadol 42.1±14.1 years, metamizol 44.5±13.8 years, paracetamol 46.0±14.2 years.	P: paracetamol 1 g every 6 hours (n = 40) from discharge. Follow-up after 2 days.	on day of surgery; p<0.001 paracetamol vs. tramadol and metamizol on both days).		
Spagnoli 2011 RCT No mention of sponsorship or COI.	6.0	N = 114 with postoperative pain following hand and foot surgery under brachial plexus block. Mean age 56 years.	Group TP: tramadol/paracetamol 37.5/325mg (n = 57) vs. Group P: paracetamol monotherapy 1000 mg (n = 57) 2 tablets a day for 3 days. Follow-up 7 days after discharge.	Mean VAS (paracetamol vs. tramadol/paracetamol): post-op 0-6 hours 1.92 vs. 0.40 (p <0.005). Number requiring extra dose analgesic post-op (paracetamol vs. tramadol/paracetamol): 0-6 h 32 vs. 4 (p<0.005); 6-12 h 11 vs. 0 (p <0.005); 12-24 h 7 vs. 0 (p <0.01).	“The association of tramadol and paracetamol appears to have more efficacy when compared with paracetamol monotherapy for acute postoperative pain after hand and foot surgery.”	Data suggest some benefit in use of tramadol and paracetamol combination compared to paracetamol therapy alone for the management of acute postoperative pain post hand and foot surgery.
Jankovic 2008 RCT No mention of sponsorship or COI.	5.5	N = 45 ASA physical status I-II undergoing ambulatory hand surgery. Mean age Group L 34±12 years, Group LK 33±12 years, Group LDK 35±13 years.	Group L: 3mg/kg 2% lidocaine for intravenous regional anesthesia (IVRA) (n = 15) vs. Group LK: 3mg/kg 2% lidocaine + 30 mg ketorolac for IVRA (n = 15) vs. Group LDK: 3 mg/kg 2% lidocaine + 8 mg dexamethasone + 30 mg ketorolac for IVRA (n =15). All groups received 0.9% NaCl added for total volume of 40mL. All patients allowed 10mg ketorolac every 6 hours as needed at home. Follow-up 24 hours after surgery.	Median postoperative VAS scores post anesthesia care unit admittance (PACU ad.) 120 min (Group L vs. Group KL vs. Group LDK): 3 vs. 3 vs. 2 (p<0.05, Group LDK vs. Group L). Mean±SD 24 hour total ketorolac tablet consumption (Group L vs. Group LK vs. Group LDK): 3.8±1.3 vs. 2.2±1.6 vs. 1.3±0.6 (p<0.05 Group LDK vs. Group L; p<0.05 Group LDK vs. Group LK).	“The addition of both ketorolac and dexamethasone to lidocaine IVRA provided improved tourniquet tolerance, prolonged analgesia in the postanesthesia care unit during the first 2 h after the medical procedure, and diminished the need for analgesic supplements during the first day after ambulatory hand surgery.”	Sparse methodology. Data suggest IVRA of lidocaine, ketorolac, and dexamethasone provides effective perioperative analgesia for ambulatory hand surgery patients.
Reuben 1995 RCT No mention of sponsorship or COI.	5.0	N = 60 undergoing hand surgery (carpal tunnel release, excision of a ganglion cyst, or tenolysis). Mean age control 49±17 years, IV-K 46±21	Control group: 0.9% intravenous (IV) saline 2mL and intravenous regional anesthesia (IVRA) with saline added to it (n = 20) vs. Group IV-K: ketorolac 60 mg IV and saline added to IVRA solution (n = 20) vs. Group IVRA-K: saline IV	Median postoperative pain scores (control vs. IV-K vs. IVRA-K): VAS 30: 1.1 vs. 0.9 vs. 0.3 (p <0.0001 IVRA-K vs. other groups); VAS 60: 1.0±1.6±0.7 (p = 0.0131 IVRA-K vs. other groups). Mean±SD 24 hour total medicine (control vs. IV-K vs. IVRA-K): 4.6±1.3 vs. 3.0±1.1 vs. 1.9±1.4 (p=0.0003 IVRA-K vs. other groups). Mean±SD time to first medicine	“[T]he addition of K to 0.5% lidocaine for IVRA provided better control of intraoperative tourniquet pain, improved analgesia in the PACU during the first postoperative hour, and diminished the heed for analgesic supplements during the first postoperative day.”	Sparse methods. Data suggests addition of ketorolac to 0.5% lidocaine provided better control of intraoperative tourniquet pain, improved PACU pain relief during the first hour post-op and up to 24h post-op compared to either lidocaine alone or placebo.

		years, IVRA-K 50±19 years.	and ketorolac 60 mg added to IVRA solution (n = 20). All patients allowed Tylenol No. 3 tablets every 4 hours as needed for pain at home. Follow- up 24 hours.	(control vs. IV-K vs. IVRA-K): 281±2.44 vs. 356±255 vs. 653±501 (p=0.0241 IVRA-K vs. other groups).		
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Evidence for the Use of Arnica Post-Operatively

There is 1 high-(772) and 1 moderate-quality(1696) RCT incorporated into this analysis.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Arnica, Montana, Postoperative Period, post-operative, rehabilitation, upper, extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 9 in Scopus, 19 in CINAHL, 6 in Cochrane Library and 144 in Google Scholar. We considered for inclusion 1 from PubMed, 0 from Scopus, 0 from CINAHL, 2 from Cochrane Library 0 from Google Scholar, and 0 from other sources. Of the 180 articles considered for inclusion, 2 randomized trials and 2 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Stevinson 2003 RCT Sponsored by Dr Susil Kumar and Jamila Mitra Charitable Trust (UK); homeopathic and placebo tablets supplied by A Nelson & Co Ltd. No mention of COI.	8.5	N = 62 (49 female and 13 male) CTR patients. Ages of 18 and 70 years.	Arnica 30C (n = 21) vs. Arnica 6C (n = 21) vs. Placebo TID for 7 days pre-op and 14 days post-op (n = 22).	No pain differences (p = 0.79) and bruising (p = 0.45) at Day 4. Swelling and analgesic use did not differ. Adverse events reported by 2 patients in arnica 6C group, 3 in placebo, 4 in arnica 30C. Results do not suggest homeopathic arnica has an advantage over placebo in reducing post-op pain, bruising and swelling in patients undergoing elective hand surgery.	“Since the experiences of patients who receive no benefit from Arnica are less likely to be reported, the myth becomes reinforced.”	One surgeon operated. Data suggest no efficacy.
Jeffrey 2002 RCT Ian Wiggle and Weleda Ltd provided arnica and placebo preparations. No mention of COI.	6.0	N = 32 Endo-scopie CTR patients Arnica group had 12 men:8women, and Placebo group had 6 men: 11 women. Average male age 51, and female age is 55.	Arnica D6 3 tablets TID plus Arnica 5% ointment TID vs. double placebo Follow-up was 2 weeks after surgery	Wrist circumferences and grip strengths both non-significant. Pain reduced in Arnica compared with placebo at 2 weeks (p <0.03).	“The role of homeopathic and herbal agents for recovery after surgery merits further investigation.”	Baseline data not given and 1 week data suggest trend. Possible inadequate randomization. Objective measures showed no differences.

Evidence for the Use of Cryotherapy/Cooling Blanket During Post-operative Rehabilitation

There is 1 moderate-quality RCT incorporated into this analysis.(1697)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Cryotherapy OR Cooling Blanket / Post-operative rehabilitation and rehabilitation of patients with functional deficits: CTS and other disorders; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 17 articles in PubMed, 0 in Scopus, 2 in CINAHL, 0 in Cochrane Library, 3883 in Google Scholar, and 0 in other sources. One RCT met the inclusion criteria.

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
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Conflict of Interest (COI)						
Hochberg 2001 RCT No sponsorship or COI.	4.0	N = 72 (46 males/26 females) adults presenting Carpal Tunnel Syndrome who were legible for single open surgical procedures; No specification on mean age of study sample.	Temperature –controlled cooling blanket vs. standard ice pack for 3 days. Follow-Up immediate following post-op and after three days.	Pain ratings (baseline/day 3): cooling blanket (8.3±1.8/4.5±2.3) vs. ice (8.3±1.3/7.3±2.5), p <0.001.	Use of a “(temperature-controlled cooling blanket) compared with traditional ice therapy, provides patients with greater comfort and lessens the need for narcotics.”	Incisional length of 6cm large compared with most recent trials which may have affected results and limits study generalizability to treatment of larger open CTR incisions.

Evidence for Mobilization During Post-operative Rehabilitation

There are 13 moderate-quality RCTs(958, 1385, 1388, 1698-1707) (Wakefield 00) incorporated into this analysis. There are 4 low-quality RCTs(1708-1711) in Appendix 2.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, physical therapy, occupational therapy, upper extremity, postoperative period, postoperative, post-operative, rehabilitation, upper extremity; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1,005 articles in PubMed, 6,515 in Scopus, 53 in CINAHL, 499 in Cochrane Library, 50,100 in Google Scholar, and 0 from other sources. We considered for inclusion 5 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 13 from other sources. Of the 119 articles considered for inclusion, 17 randomized trials and 2 systematic studies met the inclusion criteria.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Mobilization vs Immobilization Post-op						
Rath 2009 RCT Sponsored by the LEPRO Society. No COI.	5.0	N = 50 (11 female/39 male) with supple claw hand deformities, ulnar nerve paralysis for >1 year and completion of multi-drug therapy for Hansen’s disease undergoing tendon transfer. Mean age IAMP 31±10 years,	Immediate active motion protocol (IAMP) 2 days after tendon transfer for 3 weeks (n = 25) vs. immobilization after tendon transfer for 3 weeks with therapy beginning 22 days after surgery (n = 25). Follow-up monthly for 3 months after discharge and then at 3 month intervals for 1 year, then once a year.	Mean±SD PIP joint angles in open hand position: total digits at discharge IAMP 1±9° vs. immobilization 5±9° (p = 0.005). Mean±SD PIP joint angles in the intrinsic plus position: total digits at discharge IAMP 10±10° vs. immobilization 16±10° (p = 0.00). Mean±SD zero pain level (VAS scores) achieved, week: IAMP 3±1 vs. immobilization 6±1 (p <0.001).	“The current study demonstrates that an early motion protocol results in quicker restoration of function.”	Data suggest IAMP group yields earlier pain relief and quicker restoration of function.

		immobilization group 28±10				
Giessler 2008 RCT No mention of sponsorship. No COI.	4.0	N = 21 (10 female/11 male) with a closed extensor pollicis longus (EPL) tendon rupture in zones T4 and T5 treated with tendon transfer. Mean age DY 51 years, AC 59 years.	Dynamic extension splinting (DY) starting 2 days postoperative with limited ROM of IP joints vs. early active (AC) protocol starting 2 days postoperative: early active thumb extension with limited flexion in a splint. Both groups wore a dynamic extension splint between exercises and saw hand therapist at least 3 times a week. Splints completely removed after 3 weeks. Follow-up 3, 4, 6, 8 weeks post-op.	Total ROM in IP joint at 3 weeks (splint removal): higher in DY group vs. AC group (p=0.027). Relative ROM of CMP and IP joints vs. contralateral thumb week 3: active ROM of IP joints DY group 72% of contralateral side vs. AC group 49% of contralateral side (p=0.005).	“Considering the small group sizes, both regimens (dynamic vs early active) achieved comparable clinical results. The early active protocol does not have a notably higher complication rate but fails to accelerate rehabilitation.”	Small sample (N = 21). Data suggest comparable efficacy between groups although the early active protocol reported a higher complication rate without rehabilitation rate acceleration.
Physiotherapy Post-op						
Souer 2011 RCT No sponsorship. COI, one more of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of an aspect of this work.	5.0	N = 94 with unstable distal radial fracture treated with open reduction and volar locking plate fixation and screws alone within 4 weeks of injury. No mention of gender distribution. Mean age occupational therapy 50.7 years, independent exercise 48.6 years.	Surgeon-directed independent exercises: wrist splint until full finger and forearm motion and then wean out wearing splint to regain wrist motion; performed exercises for finger flexion, forearm supination and pronation 3-4 times a day for at least 30 minutes (n = 48) vs. occupational therapy: supervised exercises to regain digit, wrist, and forearm motion and strengthen hand (n = 46). Follow-up at 6 weeks, 3 months and 6 months after surgery.	3 month outcomes (independent exercise vs. occupational therapy): grip strength (lb) 55±22.6 vs. 45±17.4 (p <0.05); grip strength (% of value on uninjured side) 81±18.9 vs. 66±16.0 (p<0.05); pinch strength (% of value on uninjured side) 90±23.7 vs. 80±22.7 (p<0.05); Gartland and Werley score (points) 2±1.3 vs. 2±2.2 (p <0.05). 6 month outcomes (independent exercise vs. occupational therapy): wrist flexion-extension arc (deg) 129±22.6 vs. 118±17.7 (p<0.05); Wrist flexion-extension arc (% of value on uninjured side) 88±11.7 vs. 84±7.3 (p <0.05); Wrist extension (deg) 62±13.7 vs. 55±10.2 (p <0.05); Ulnar deviation (deg) 40±9.2 vs. 32±12.1 (p <0.05); Ulnar deviation (% of value on uninjured side) 93±19.4 vs.	“[T]his clinical trial supports the concept that patient education and independent exercises are, on the average, adequate for optimal recovery from a distal radial fracture treated with open reduction and volar plate fixation.”	Data suggest formal, prescribed PT is not as good as independent exercises for improving ROM and/or disability post volar plate fixation surgery for distal radial fractures.

				82±29.2 (p <0.05); Supination (deg) 90±0.9 vs. 84±13.1(p <0.05); Grip strength (% of value on uninjured side) 92±19.8 vs. 81±16.4 (p<0.05); Mayo wrist score (points) 83.4±12.7 vs. 79.0±9.9 (p <0.05).		
Krischak 2009 RCT No mention of sponsorship. No COI.	4.5	N = 46 (30 female/16 male) with distal radius fractures undergoing internal fixation with locking plates after open reduction. Mean age home exercise 53.7±17.9 years, physical therapy 56.0±11.1 years.	Physical therapy, 12 sessions lasting 20-30 minutes each, 6 weeks (n = 23) vs. unassisted home exercise program for 6 weeks, detailed instructions and demonstrations given after surgery (n = 23). All put in splint after surgery for 2 weeks. Splint removed for therapy and then back on afterward. Follow-up 1 week after surgery and after 6 weeks of treatment.	Mean±SD Patient Rated Wrist Evaluation (PRWE) score at 6 weeks: home exercise 18.5±15.9 vs. physical therapy 36.1±13.9 (p <0.001). Mean grip strength relative to opposing healthy side 6 weeks: home exercise 54% of starting base value vs. physical therapy 32% of starting base value (p=0.003). ROM of extension and flexion after 6 weeks of treatment: home exercise 79% of uninjured side vs. physical therapy 52% of uninjured side (p <0.001). Ulnar and radial abduction compared to uninjured side at 6 weeks: home exercise 70% vs. physical therapy 59% (p = 0.013).	“[I]nstructions in a home exercise program using a booklet with guidance is a valid alternative to prescribed physical therapy.”	Data suggest PT after volar plating of wrist fractures is effective for post-op rehab although data in study is self-reported in a training diary.
Physical Therapy/ Occupational Therapy						
Pomerance 2007 RCT No sponsorship. No mention of COI.	7.0	N = 150 (110 female/40 male) with NCS confirmed CTS underwent CTR. Average age 46 years.	Therapy (2 week course, 6 sessions, nerve gliding, ROM, strengthening) (n = 73) vs. No therapy. No restrictions to motion and no splints either group. RTW allowed at first post-op visit (N = 77).	RTW at first post-op visit in 80/93 (86.0%) commercial insurance vs. 15/40 (37.5%) WC vs. 12/17 (70.6%) Medicare patients. Between group’s post-op grip and pinch strengths not different. DASH scores (19±17/18±17) not different.	“The current randomized study failed to show benefit in a 2-week course of hand therapy after carpal tunnel release using a short incision. The cost of supervised therapy for an uncomplicated carpal tunnel release seems unjustified.”	Small incision. Higher costs and no demonstrable benefits from supervised therapy. Data suggest much lower prompt RTW in WC patients. Costs higher for therapy (\$600 Medicare and \$900 WC).
Provinciali 2000	5.5	N = 100 (82 female/18 male) EDS confirmed	Multimodal rehabilitative treatment vs. progressive home exercise program	“No difference in symptom occurrence between the two groups was detected after 1 and	“A rehabilitation approach after hand surgery is clinically relevant to	Study suggests no differences in outcomes.

RCT No mention of sponsorship or COI.		Average age of 54.69 years.		3 months. One month after surgery, only patients in the first group showed motor dexterity improvement according to NHPT and JTT scores. At the 3-month follow-up, the two groups did not differ but the group undergoing rehabilitation showed a shorter return-to-work interval.”	accelerate recovery but neither modifies functional recovery nor reduces symptom occurrence.”	
Mitsukane 2015 RCT No mention of sponsorship or COI.	4.5	N = 28 (19 female/9 male) with unilateral distal radial fracture. Mean age 63±13.0 years.	Experimental group: 30 repetitive wrist extensions of injured wrist with maximal isometric contraction for 3 seconds followed by 3 seconds of rest repeated 10 times for 1 minute with a minute rest, sequence repeated 3 times during a 6 minute period (n = 14) vs. control group: no exercises, 6 minutes of rest (n = 14). Follow-up after intervention and 10 minutes after that.	Mean±SD change in grip strength (kg) post intervention (experiment vs. control): 16.4±9.9 (p=0.01) vs. 15.3±8.2 (p=0.26). Mean±SD change in VAS (mm) post intervention (experiment vs. control): 2.3±5.1 (p=0.03) vs. 13.3±23.0 (p=0.13).	“This study suggests that repetitive maximal wrist extension is useful in physical examinations to reveal the maximal grip force of patients with DRF, and it is effective as a warm-up training procedure in preparation for conventional grip strength exercises.”	Small sample, sparse methods. Data suggest grip strength increased in experimental group immediately after repetitive wrist extension but not in control group. Pain decreased in experimental group vs. control group.
Rostami 2013 RCT Sponsored by the Medical Research Council in Ahvaz Jundishapur University of Medical Sciences. No COI.	4.5	N = 23 (17 female/6 male) with active ROM impairment of hand after orthopaedic injuries. Mean age 38 years.	Mirror therapy (MT): concentrating on ROM exercises on unaffected hand in mirror while performing ROM exercises with impaired hand not in mirror 30 minutes a day, 5 days a week for 3 weeks plus half hour of conventional rehab (tendon gliding exercises, blocking exercises, place-and-hold exercise, PNF techniques, dynamic splinting, functional activities, and ADLs) after each MT session (n = 15) vs. control group: conventional rehabilitation for 30 minutes plus 30 minutes direct observation of affected hand performing movements 5 days a week for 3 weeks (n = 15). Both groups performed a 15 minute home program, MT for MT group and active range of	Mean±SD change total active motion (TAM) pre to post/post to follow-up (MT vs. control): 154±32 vs 61±24 (p=0.001)/ NS. Mean±SD change DASH score pre to post/post to follow-up (MT vs. control): -34±7 vs. -15±11 (p = 0.001)/ -5±4 vs. -10±6 (p = 0.02).	“Findings suggest that adding a regular and scheduled programme of MT to classic rehabilitation techniques is effective for early and maximum improvement of motor recovery and functional abilities in the patients with orthopaedic injuries.”	Data suggest MT plus conventional rehab was than control group.

			motion (AROM) for control group, twice daily. During 3 week follow-up, both groups attended a scheduled rehab program (hand therapy) 30 minutes a day, 3 days a week. Assessments at baseline and day after 3 week intervention ended. Follow-up 3 weeks after intervention ended.			
Guzelkucuk 2007 RCT No sponsorship. No mention of COI.	4.0	N = 36 with functional loss due to hand injury. Bone, tendon, peripheral nerve injuries, with impaired hand function. No mention of gender distribution. Average age of 23±3 years.	Controls: rehab program (physical therapy, passive, active assist, active ROM, strengthening, BID) vs. therapy plus therapeutic exercises (same exercises plus 1 session of therapeutic activities). Sessions 30 minutes, 5 days a week for 3 weeks. HEP after 3 weeks; 2 month follow-up.	Grip strength (baseline/post/follow-up): Control (10±9/10±9/11±10) vs. therapeutic exercises (7±5/13±6/23±14), p <0.001. Pinch strength, Jebsen tests also all p <0.001.	“Because of the complex anatomy, determination of the most appropriate treatment may not be easy in an injured hand. Our results showed that the therapeutic activities that mimic the ADL improve the functions of the hand more effectively.”	Some sparse details. Heterogeneous disorders. Seen 1.5-6 months after injuries. More contact time in exp. group. Trend to longer time since injury in controls. Also suggests benefits of therapy with emphasis on functional exercise.
Cross-Education						
Magnus 2013 RCT Sponsored by Royal University Hospital Foundation Grant, doctoral funding from Natural Sciences and Engineering Research Council of Canada, the Dean’s Scholarship from the University of	4.0	N = 51 females with unilateral distal radius fracture <2 weeks old. All >50 years of age. Mean age 63.0±10.0 years.	Standard rehabilitation: forearm casting; 6 visits to clinic at weeks 1, 3, 6, 9, 12, and 26 post-fracture; and adoption of 3 exercise protocols targeting the fractured side; active ROM of neck, shoulder, elbow, fingers, and thumb while in cast; cast removed – exercises focused on improving active and passive ROM of fractured wrist and hand; stretching and strengthening with encouragement to continue at home after 12 weeks, control (n = 24) vs. standard rehabilitation + strength training of nonfractured limb for 26 weeks, train (n = 27). Follow-up for 26 weeks.	Mean±SD handgrip strength of fractured arm 12 weeks postfracture (training vs. control): 17.3±7.4 kg vs. 11.8±5.8 kg (p = 0.017). Mean handgrip strength of nonfractured arm at 12 weeks postfracture (training vs. control): 30.7±6.5 vs. 24.9±4.4 (p = 0.017). Mean±SD ROM data (degrees) 12 weeks postfracture (training vs. control): flexion/extension 100.5±19.2 vs. 80.2±28.7 (p = 0.017).	“This intervention study found that strength training the nonfractured limb was associated with significantly improved strength and ROM in the fractured limb via cross-education in the early stages of rehabilitation.”	All subjects were female. Data suggest at 12 weeks, strength training for non-fractured extremity after distal radius fracture was associated with improved strength and ROM.

Saskatchewan, and a Graduate Scholarship from the University of Saskatchewan. No COI.						
Paraffin Bath Therapy						
Dilek 2013 RCT No sponsorship or COI.	6.0	N = 46 (40 female/6 male) with bilateral hand osteoarthritis. Mean age paraffin 58.87±9.47 years, control 59.95±8.71 years.	Group 1: dip-wrap paraffin bath therapy at 50°C 10 dips followed by 15 minutes in a plastic bag until paraffin cooled 5 times a week for 3 weeks for both hands (n = 29) vs. Group 2: control (n = 27). All patients received education about disease and joint protection techniques and allowed paracetamol. Follow-up at 3 and 12 weeks.	Median pain at rest: 3 weeks paraffin group 2.00 vs. control 4.00 (p = 0.01); 12 weeks 0.00 vs. 5.00 (p <0.001). Median grip strength: right hand 12 weeks paraffin group 20.00 vs. control 13.33 (p = 0.004); left hand 12 weeks 18.00 vs. 12.00 (p = 0.010). Median pinch strength: right hand chuck pinch 12 weeks 5.33 vs. 3.66 (p = 0.03; right hand lateral pinch 12 weeks 6.00 vs. 4.33 (p = 0.01); left hand chuck pinch 4.83 vs. 3.66 (p=0.01); left hand lateral pinch 12 weeks 5.15 vs. 4.33 (p=0.05). Median painful joint: 12 weeks 3.00 vs. 10.00 (p = 0.04).	“Paraffin bath therapy seems to be effective both in reducing pain and tenderness and maintaining muscle strength in hand osteoarthritis.”	Data suggest paraffin bath therapy had significant benefit in hand OA both for pain reduction and muscle strength retention suggesting paraffin may be a short term therapy option.
Massage Therapy						
Field 2011 RCT Sponsored by Johnson & Johnson Pediatric Institute and Massage Envy. No mention of COI.	4.0	N = 46 with hand pain. No mention of gender distribution. Mean age 50 years.	Massage therapy once a week for 15 minutes for 4 weeks and taught self-massage to be done once daily vs. standard treatment control. Assessments on the first and last days of the 4 week study	First day post: mean pain massage 2.4 vs. control 2.6 (p <0.05); mean grip strength 7.7 vs. 6.3 (p <0.05); mean anxiety 27.19 vs. 30.2 (p <0.001); mean depression 1.9 vs. 3.9 (p <0.01). Last day post: mean pain 1.3 vs. 2.8 (p <0.01); mean grip strength 8.5 vs. 6.7 (p <0.005); mean anxiety 28.4 vs. 29.7 (p <0.01); mean depression 1.4 vs. 3.9 (p = <0.05).	“The current study suggests that the combination of therapist and self-massage as a more intensive therapy is effective and would likely be more cost-effective for reducing pain and enhancing grip strength.”	Data suggest massage therapy group experience less pain, greater grip strength and a more positive mood vs. control group causing less anxiety and better sleep.
Physical Therapy/Mobilization						

Wakefield 2000 RCT No sponsorship OR COI.	6.5	N = 96 (72 female/9 male) with fracture of distal radius, previously treated by plaster immobilization Mean age of 72 years (55 – 90).	Taught and given standard sheet of home exercises by physiotherapist, referred for course of physiotherapy (n=49) vs Taught and given standard sheet of home exercises only Follow up Week 6, Month 3, Month 6	Only flexion/extension at 26 weeks was significantly different (p=0.001) in the two group comparison via ANOVA. No significant differences were observed in parameters between groups. The physiotherapy group displayed significantly higher flexion/extension improvement at six months (p=0.044). There were no significant differences between each group at six months.	“Our study has shown that home exercises are adequate rehabilitation after uncomplicated fracture of the distal radius, and routine referral for a course of physiotherapy should be discouraged. The role of physiotherapy in patients at high risk of a poor outcome requires further investigation.	Data suggest home exercises for uncomplicated fractures are beneficial.
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Evidence for use of Radiotherapy for Prevention of Progression of Dupuytren’s Disease

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: radiotherapy, dupuytren contracture, dupuytren disease, hand; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 4 articles in PubMed, 32 in Scopus, 1 in CINAHL, 0 in Cochrane Library, 2784 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, CINAHL, Cochrane Library, Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic studies met the inclusion criteria.

Evidence for the use of Collagenase Injections for treatment of Dupuytren’s disease

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: collagenase injections, dupuytren contracture, dupuytren disease, hand; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 68 in Scopus, 0 in CINAHL, 2 in Cochrane Library, 1126 in Google Scholar, and 0 from other sources. We considered for inclusion 2 from PubMed, 9 from Scopus, 0 from CINAHL, Cochrane Library, Google Scholar, and 0 from other sources. Of the 11 articles considered for inclusion, 7 randomized trials and 3 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: collagenase injections, dupuytren contracture, dupuytren disease, and hand; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 5 articles. Of the 5 articles we considered for inclusion 1. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Collagenase Injections vs. Placebo										
Badalamente 2002 (score=8.0)	Collagenase Injections	2 RCTs	Supported by grants from the U.S. Food and Drug Administration, the National Institutes of Health (General Clinical Research Center Grant, and the Advance Biofactures Corporation, Lynbrook, NY. No COI.	N = 36 with MP joint contractures.	Mean age: 65 years; 31 males, 5 females.	IIA trial: Single dose of Collagenase injection of 10,000 U (n = 18) Vs Placebo consisted of sterile normal saline containing 2 mmol/L calcium chloride (n = 18). IIB trial: Collagenase injection of 10,000 U, (n = 23) vs Collagenase injection of 5,000 U (n= 22) vs Collagenase injection of 2,500 U (n = 18) vs Placebo included sterile normal saline containing 2 mmol/L calcium chloride (n = 17).	Follow-up occurred on days 7 and 14 and at months 1, 2, 3, 6, 9 and 12.	1 month after injection, 14/18 (77.8%) collagenase group had contracture correction to 0-5° vs. 2/18 (11.1%) placebo. Retreatment of 16 placebo patients who did not respond to 1st blinded injection had flexion contracture correction to 0-5° in 10 after a 1st open-label 10,000-U injection; in 2 after 2nd injection; in 1 after 3rd. 2nd trial data suggests 10,000 U dose superior.	“(C)ollagenase injection into the cord causing MP and/or PIP joint contractures in Dupuytren’s disease is a safe and effective method in the majority of patients in restoring normal finger extension and thus improving range of finger motion.”	Phase 2 trials. Suggests collagenase effective.
Hurst 2009 (score=7.5)	Collagenase Injections	RCT	Sponsored by Auxilium Pharmaceuticals and grant support from BioSpecifics	N = 308 with joint contractures of 20 degrees or more	Mean age: 62.7±9.5 years; 245 males, 63 females.	Treatment Group 0.58mg collagenase clostridium Was injected into affected cords	Follow-up at 1, 7, and 30 days post-injection.	Collagenase injected cords compared to placebo injections meeting primary endpoint (64.0% vs.	“Collagenase clostridium histolyticum significantly reduced contractures and	Cord I study. Data suggest that compared to placebo collagenase clostridium

			Technologies. COI, Dr. Hurst received consulting and advisory-board fees from Auxilium Pharm.; Dr. Badalamente, receiving consulting and advisory-board fees from Auxilium Pharm.; Dr. Kaplan, receiving consulting and advisory-board fees from Auxilium Pharm.; Drs. Rodzvilla and Smith, are employees of and holding stock options with Auxilium Pharmaceuticals; Drs. Meals, Hentz, and Hotchkiss, receiving consulting fees from Auxilium.			via 0.25ml of sterile diluent (MCP joints) or 0.20ml sterile diluent (PIP joints). Maximum of 3 injections every 30 days. Treatment cycle included injection, finger extension, and 30 day follow-up (n = 204) vs Placebo Group 10 mM TRIS per 60 mM sucrose in diluent administered similarly to treatment group (n = 104).		6.8%, P<0.001). Collagenase joint ROM compared to placebo, 43.9 to 80.7 degrees vs. 45.3 to 49.5 degrees, (p <0.001).	improved the range of motion in joints affected by advanced Dupuytren's disease."	histolyticum significantly reduced contractures and increased ROM of joints in patients with Dupuytren's disease. Adverse effects (treatment related outcomes) significantly higher in collagenase group.
Badalamente 2007 (score=7.5)	Collagenase Injections	RCT	Supported by BioSpecifics Technologies Corp. Plus grants from the US Food and Drug Administration and the National	N = 35 with fixed flexion deformity of 20° or greater of the MCP or PIP joints in at least 1 finger. Age ≥ 18 years	Mean age: 61 years; 28 males, 7 females.	Collagenase injection (10,000 U) maximum of 3 injections in the primary joint were (n = 23) Vs Placebo 10,000 U of collagenase was established as the minimum	Follow-up at 1, 7, 14, and 30 days.	21/23 (91%) collagenase vs. 0/12 (0%) achieved clinical success (p <0.001) with up to 3 injections in the primary joint for MCP and PIP contractures. Average number of injections 1.4.	"The collagenase injections safely and effectively corrected MCP and PIP contractures in patients with 1 or more DC-affected joints. Recurrence rates after treatment appear to be low."	Some details sparse. Data suggest efficacy.

			Institutes of Health. Editorial support was provided by Auxilium Pharmaceuticals, Inc.			safe and effective dose (n = 12).				
Gilpin 2007 (score=7.0)	Collagenase Injections	RCT	Sponsored by Auxilium Pharmaceuticals. COI, D.G. and S.C. own shares in Auxilium. J.K. is on advisory board of Auxilium. N.J. is an employee of and owns stock options in Auxilium Pharmaceuticals.	N = 66 with contractures affecting metacarpophalangeal (MCP) or proximal interphalangeal (PIP) joints	Mean age: 63.8 ± 9.0 years; 56 males, 10 females.	Treatment group: 0.58mg collagenase clostridium histolyticum per injection. Injected directly into Dupuytren's affected cords. Maximum of 3 injections every 30 days. Treatment cycle included injection, finger extension, and 30 day follow-up (n = 45) vs Placebo group received Lyophilized Tris and sucrose in sterile diluent (n = 21).	Follow-up at 1, 7, and 30 days post-injection.	Significantly more primary joints in the treatment group had reduced contracture from 0° to 5° (44.4% vs. 4.8%; p < .001). Treatment MCP joint vs placebo MCP joint contracture reductions (13/20 vs. 1/11; p = 0.003)	“Collagenase clostridium histolyticum is a highly tolerated and effective non-surgical treatment for Dupuytren's disease. In addition to collagenase injections, regular finger extension exercises and night splinting may have additional benefits.”	A randomized placebo controlled trial with 9 month open label phase (CORDII). Data suggest collagenase clostridium histolyticum when compared to placebo has benefit for treating Dupuytren's contractures and is well tolerated.
Mickelson 2014 (score=4.0)	Collagenase Injections	RCT	No sponsorship or COI.	N = 43 or 46 digits with MCP or PIP joint contracture, or both of at least 20°	Age range 43-85 years; 35 males, 8 females.	All received 0.58mg CCH a few millimeters apart at 3 contiguous locations along Dupuytren cord on day 1. Day 1 group MCP and	Follow-up day 1 or 7 and 30.	No significant difference in MCP flexion between day 1 and 7 groups in follow-ups. Contracture was significantly lower in the 7 day group (23° vs. 40°). PIP	CCH correction of Dupuytren contractures was shown when manipulation was performed on day 7 with no differences in correction, pain or	Baseline comparability has significant differences. Patients may have had different digits randomized differently. No

						PIP joint contractures measured and pain scores recorded (n = 22) vs Day 7 group MCP and PIP joint contractures measured and pain scores recorded (n = 24)		joints showed no significant differences between 1 and 7 day groups during follow-ups.	skin tears. This suggests that manipulation can be scheduled anytime within 7 days of injection.	placebo or sham arm.
McGrouther 2014 (score=4.0)	Collagenase Injections	RCT	Sponsored by Auxilium Pharmaceuticals Inc. Medical writing and editorial was funded by Pfizer Ltd. D.A.M. has acted as a professional advisor to Pfizer, A.J., S.B., R.A.G., and P.S. are employees of and own stock in Pfizer. B.C. is an employee of and owns stock in Auxilium Pharmaceuticals.	N = 58 with Dupuytren's contracture or DC.	Mean age: 61.4 (8.89) years, 40 males, 18 females.	Collagenase clostridium histolyticum or CCH injection treatment, one joint (n = 49) vs CCH Treatment Primary 2 Joints (n = 9).	Follow-up for 90 days.	Mean number of injections per patient for up to 2 affected joints was 1.84, mean injections per joint was 1.62. Of the 56, 66% reported that they were 'very satisfied' and 27% 'quiet satisfied', 4% 'neither', and 0% 'very dissatisfied'. Commonly reported adverse events; edema peripheral reported by 79%, contusion by 55%, pain in extremity by 41%, injection site hemorrhage by 29% and injection site pain by 29% of patients.	"Collagenase clostridium histolyticum injection is a minimally invasive procedure that can be performed on an outpatient basis."	Data from open label trial. Data suggest CDH has some efficacy for management of DC.
Witthaut 2011 (score=N/A)	Collagenase Injections	Post Hoc RCT	Sponsored by Pfizer Inc. Cord study sponsored by Auxilium Pharmaceuticals,	N = 308 with Dupuytren's disease and joint	Mean ± SD age for collagenase 62±10 and placebo	Maximum of 3 collagenase 0.58mg (N = 204) vs Placebo injections into	Follow-up on day 1 or 7 and 30.	Mean increase in ROM 36.7° in the collagenase-treated joints (p<0.001) and 4.0° in the placebo-	"Injectable collagenase significantly improves ROM and treatment	Post Hoc analyses of Cord I Study. Injectable collagenase

			Inc. Jorg Witthaut is an investigator for the collagenase Clostridium histolyticum clinical trial programme. The remaining authors are employees of Pfizer Inc. Groton, CT, USA.	contractures $\geq 20^\circ$.	63±9 years; 245 males, 63 females.	cord of affected hand at 30-day intervals (n = 104).		treated joints (not significant).	satisfaction versus placebo. ROM improvements are clinically relevant as well as statistically significant.”	clostridium histolyticum compared to placebo significantly improves ROM which are both clinically and statistically significant.
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Evidence for the Use of 5-Fluorouracil for Dupuytren’s Disease

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: fluorouracil, 5 fluorouracil, dupuytren contracture, dupuytren disease, hand; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 7 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 1522 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, Scopus, CINAHL, Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: intra-operative 5-fluorouracil, dupuytren contracture, dupuytren disease, and hand; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 0 articles. Zero articles met the inclusion criteria.*

Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
5-Fluorouracil vs. Placebo Intraoperative										
Bulstrode 2004 (score=5.0)	5-Fluorouracil Injections	RCT	Sponsored by the RAFT Institute of Plastic Surgery, Mount Vernon Hospital, Northwood, Middlesex. No mention of COI.	N = 15 patients with two-digit disease.	Mean age: 61 years; 15 males, 0 females.	Treatment rays, 5-Fluorouracil a 1 cm section of the Dupuytren’s tissue was marked and excised, plus excision either 0.5 ml of 5-fluorouracil (25 mg/ml) or 0.5 ml Vs Control rays, Normal saline instilled in the excision.	Follow-up at 3, 6, 12 and 18 months.	Metacarpophalangeal joint movement improved from 68° (range, 20-109°) to 85° (range, 32-133°) for control rays and 69° (range, 29-100°) to 79° (range, 64-113°) for 5-fluorouracil treated rays at 3 months. MCP joint range of motion did not differ at 18 months.	“The follow-up data have not demonstrated a significant difference between the control 5-fluorouracil treated rays for either total active motion, or metacarpophalangeal or proximal interphalangeal joint movement or loss of extension.”	Small sample size. Data suggest 5-FU ineffective.

Evidence for the use of NSAIDs and Acetaminophen for Post-Op Dupuytren’s Disease

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: anti-inflammatory agents, non-steroidal, dupuytren contracture, dupuytren disease, hand; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 articles in PubMed, 2 in Scopus, 0 in CINAHL, 1 in Cochrane Library, 440 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 0 from Scopus, CINAHL, Cochrane Library, Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trials and 0 systematic studies met the inclusion criteria.

Evidence for Dupuytren’s Disease - Surgery

There are 2 high-(639, 1725) and 15 moderate-quality(1685, 1718-1720, 1723, 1724, 1727-1729, 1731, 1735-1739) (McGrouther 14; Kemler 12; van Rijssen 12; Kan 16) RCTs incorporated in this analysis. There is also one other study included.(1726)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: splints, dupuytren contracture, dupuytren disease, hand; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 70 articles in PubMed, 285 in Scopus, 17 in CINAHL, 1 in Cochrane Library, 633 in Google Scholar, and 1 from other sources. We considered for inclusion 6 from PubMed, 1 from Scopus, 0 from CINAHL, Cochrane Library, Google Scholar, and 1 from other sources. Of the 8 articles considered for inclusion, 6 randomized trials and 2 systematic studies met the inclusion criteria.

We searched PubMed, CINAHL, EBSCO, Cochrane Review, and Google Scholar with no limits on publication dates and an updated search was conducted using PubMed for publication between 1/1/2014 to 2/15/2018 using the following terms: surgery, regional, selective fasciectomy, percutaneous needle fasciotomy, needle aponeurotomy, firebreak, full-thickness skin graft, extensive fasciectomy, dermo fasciectomy, dupuytren contracture, dupuytren disease, and hand; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random, randomized, randomization, randomly; systematic, retrospective, and prospective studies to find 14 articles. Of the 14 articles we considered for inclusion 1. Of the 1 considered for inclusion, 0 are randomized controlled trials and 1 systematic reviews.*

Table 1a. Quality Studies for the Treatment of Dupuytren’s Disease

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Radiotherapy						
Seegenschmiedt 2001 RCT No mention of sponsorship or COI.	6.0	N = 129 (67 male and 62 female) with clinically evident and progressive early-stage DC. Mean age for Group A and B: 65 ± 11 / 61 ± 14 years.	Group A, radiotherapy 10 x 3 Gy (total dose, 30 Gy) in 2 series (5 x 3 Gy) separated by 8 weeks (N = 63) vs Group B, 7 x 3 Gy (total dose, 21 Gy) in 1 series within 2 weeks (N = 66). Follow-up 3 and 12 months.	At 12 months, reduction of symptoms, nodules and cord observed in both treatment groups (p < 0.01). For subjective responses, 76 (59%) patients (Group A, 41; Group B, 35) stated “regression of DC symptoms” in 120 (61%) sites (A, 60; B, 60); range of regression equal for both groups: <25% regression for 74 of 120 (62%) sites (A, 35; B, 39), 25-50% regression for 37 (31%) sites (A, 35; B, 19), 51-75% regression in 7 (6%) sites (A, 5; B, 2), and >75% regression in 2	“Both tested RT regimens have been well accepted and tolerated by patients. Acute toxicity was slightly more enhanced in the low-dose group (21 Gy) than in the mediumdose group (30 Gy), probably due to the dose-time factor..”	No placebo group. RT therapy individualized. Data suggest RT may be effective due to reported regression, but that cannot be proved.

				(2%) sites (all in group A); 46 (36%) patients (A, 19; B, 27) had “stable condition” in 65 (33%) sites (A, 30; B, 35), whereas 7 (5%) patients (A, 3; B, 4) suffered “progression of DC symptoms” in 13 (7%) sites (A, 5; B, 8).”		
Splints						
Jerosch-Herold 2011 RCT Sponsored by Action Medical Research Charity and the National Institute for Health Research (NIHR). No COI.	5.5	N = 154 (120 male and 34 female) undergoing fasciectomy of dermofasciectomy for Dupuytren’s disease. Mean age hand therapy only 67.5±9.2 years, splint 67.2±10.0 years.	Hand therapy only within 2 weeks after surgery plus removal of sutures (N = 77) vs Hand therapy with night splinting worn for 6 months (N = 77). Follow-up for 12 months after surgery.	There were no statistically significant differences at 12 months between the two groups in DASH score (0.66, -2.79 to 4.11, p = 0.703), degrees of total active flexion of operated digits (-2.02, -7.89 to 3.85, p = 0.493), degrees of total active extension deficit of operated digits (5.11, 2.33 to -12.55, p = 0.172. The mean number of therapy sessions was 5.1 in the splint group and 5.6 in no-splint group.	“No differences were observed in self-reported upper limb disability or active range of motion between a group of patients who were all routinely splinted after surgery and a group of patients receiving hand therapy and only splinted if and when contractures occurred..”	Data suggest comparable results from self-reported outcomes.
NEW Kemler 2012 RCT No sponsorship or COI.	4.5	N = 54 with proximal interphalangeal (PIP) joint flexion contractures of at least 30°. Mean age 63 (9) and 64 (11) for hand therapy alone group, 8 female and 46 male.	Splint plus hand therapy (N = 28) vs Hand therapy alone (N = 26). Follow-up for 3 months.	After 1 year, the splint-plus-hand therapy had mean reduction of 21° in flexion contracture vs 29° in the group receiving hand therapy alone, (p = 0.1). 18 or 64% reported not less than “much improve” vs 19 or 73% of the 26 hand therapy alone, (p = 0.5). At 6 months pain did not differ significantly between group, VAS score 1.9 (2.0) vs 2.1 (2.4), (p = 0.7).	“After operative release of a Dupuytren’s contracture, a postoperative protocol using a splint and hand therapy was no better than hand therapy alone in minimizing postoperative flexion contractures.”	Data suggest lack of benefit of adding a splint to hand therapy vs. hand therapy alone for treating Dupuytren’s contracture.
Post-Operative NSAIDs and Paracetamol vs. Placebo						
Husby 2001 RCT	8.0	N = 35 (33 male and 2 female) Dupuytren’s contracture (plus 42 CTS). Mean	Paracetamol 1000mg 4 times daily (N = 12) vs	Postoperative Dupuytren’s swelling as a percentage of preoperative volume: 5.6±3.8 vs. 6.9±3.7 vs. 8.2±5.1. Additional analgesics used were 0, 2 and 8	“[N]aproxen might have a clinical relevant effect on swelling when used on minor surgery in the hand, unlike paracetamol. Naproxen might be a	Results suggest a beneficial effect of naproxen over paracetamol, which is superior to placebo, which the studies were not powered to detect.

No mention of sponsorship or COI.		age (range): 61 (29-81).	Post-op naproxen 500mg BID twice daily (N = 12) vs vs Matching placebo for three days (N = 11) Follow-up at 72 hours after surgery.	in naproxen, paracetamol, and placebo groups.	useful analgesic during the immediate postoperative phase.”	
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Author Year (Score):	Category:	Study type:	Conflict of Interest:	Sample size:	Age/Sex:	Comparison:	Follow-up:	Results:	Conclusion:	Comments:
Surgical Procedures										
van Rijssen 2006 (score=6.0)	Surgery (regional or selective fasciectomy); percutaneous needle fasciotomy (needle aponeurotomy); "Firebreak" Full-thickness Skin Graft for Dupuytren's Contracture surgery, Extensive Fasciectomy, Dermofasciectomy	RCT	No sponsorship and no mention of COI.	N = 121 (94 male and 19 female) or 125 hands, with Dupuytren's disease	Mean age: 63 years; 94 males, 19 females	Percutaneous needle fasciotomy (PNF) (n = 57) vs. Limited fasciotomy under either regional anesthesia or general anesthetist using tourniquet in all cases (n = 56)	Follow-up for at 1 and 6 weeks for the primary outcome perimeters	PNF: Largest mean TPED per ray contractures 1 week after PNF 30° (58% reduction), p = 0.001. Follow-up at 6 weeks, results better. Limited fasciotomy: mean TPED at 1 week 15° (73% reduction), p = 0.001. Largest reduction for PNF at MCP, but DIP for LF.	"In the short term and in cases with a TPED of 90° or less PNF is a good treatment alternative to LF for treatment of Dupuytren's disease."	No non-operative or placebo intervention. Suggests equal (in) efficacy.
van Rijssen 2012 (score=5.5)	Surgery (regional or selective fasciectomy); percutaneous needle fasciotomy	RCT	No mention of sponsorship and no COI.	N = 111 with affected hands and minimal passive extension deficit of 30 degrees	Mean age: 62.93 years; 76 males, 17 females	Limited fasciotomy (LF) (n = 41) vs. Percutaneous needle fasciotomy (PNF) (n = 52)	Follow-up at 1 and 6 weeks, 6 months, and 1, 2, 3, 4 and 5 years.	At 5-years, 33 hand in 31 patients treated with limited fasciotomy didn't develop recurrence or 76.8% vs 20.9%. Recurrence rate in the limited fasciotomy group was significantly	"Percutaneous needle fasciotomy is the preferred treatment for elderly patients with Dupuytren's disease and for those willing to accept a possible early recurrence in	Data suggest that at 5 years, the recurrence rate in the needle fasciotomy group was (84.9%) compared to the limited

	(needle aponeurotomy); “Firebreak” Full-thickness Skin Graft for Dupuytren’s Contracture surgery, Extensive Fasciectomy, Dermofasciectomy							smaller, ($p < 0.001$; 95% CI, 1.597 - 2.628), and recurrence occurred significantly later after limited fasciotomy than after percutaneous needle fasciotomy, ($p = 0.001$). At the time of treatment, older age decreased the recurrence rate, ($p = 0.005$).	the context of the advantages, such as fast recovery, a low complication rate, and minimal invasiveness.”	fasciotomy group (20.9%) and recurrence occurred earlier the needle fasciotomy group.
Kan 2016 (score=6.0)	Surgery (regional or selective fasciectomy); percutaneous needle fasciotomy (needle aponeurotomy); “Firebreak” Full-thickness Skin Graft for Dupuytren’s Contracture surgery, Extensive Fasciectomy	RCT	Sponsored by Fonds NutsOhra and Stichting Coolsingel. No mention of COL.	N = 80 with primary Dupuytren’s contracture. Mean age 63 ± 9 for PALF and 63 ± 8 for LF group.	Mean age: 63 years; 62 males, 14 females	Procedure consisting of extensive percutaneous aponeurotomy and lipofilling (PALF) (n = 40) vs. Limited fasciectomy (n = 40)	Follow-up at 2 weeks, 3 weeks, 6 months and 1 year.	At 1 year, 15/85 PALF treated joints or 18%, had some recurrence vs 5/58 limited fasciectomy treated joints or 9%, ($p = 0.107$). The overall complication rate not significantly different between the groups ($p = 0.402$).	“PALF demonstrates a significantly shorter convalescence, similar operative contracture correction, lower incidence of long-term complications, and no significant difference regarding 1-year postoperative results compared with limited fasciectomy.”	Data suggest PALF showed shorter recovery times, fewer complications, comparable results to standard fasciotomy group. However, at one year post procedure the PALF group had more recurrence (18% vs.9%)

	y, Dermofasci ectomy									
Ullah 2009 (score=6.0)	Surgery (regional or selective fasciectomy); percutaneo us needle fasciotomy (needle aponeuroto my); “Firebreak” Full- thickness Skin Graft for Dupuytren’ s Contracture surgery, Extensive Fasciectomy, Dermofasci ectomy	RCT	No sponsorship. No mention of COI.	N = 79 with Dupuytren’s contracture of the proximal interphalange al joint	Mean age: 62.9 years; 65 males, 14 females	Dermofasciecto my or “Firebreak” skin graft performed on one finger (n = 39) vs. Fasciectomy was performed on second finger (n = 40)	Follow up at 12, 24 and 36 months.	Mean range of movement of PIP 34.6° (1-80°) preoperatively, improved to 65° (2- 98°) at 3 years. Progressive recurrence of PIP contracture over 3years in 11 (12.2%); 5 had fasciotomy with Z- plasty; contracture recurred in 5.4 months vs. 8months for full-thickness skin graft (p = 0.6).	“[N]o difference in recurrence rates between the two methods of treatment at three years and were surprised at the low recurrence rate after fasciectomy and Z-lasty alone.”	Suggests full thickness graft not more effective.
Citron 2005 (score=5.0)	Surgery (regional or selective fasciectomy); percutaneo us needle fasciotomy (needle aponeuroto my);	RCT	No mention of sponsorship or COI.	N = 100 with Dupuytren’s disease in one ray only and any degree of resultant contracture	Mean age: 65 years; 63 males, 16 females (only had gender demographi cs on those with follow-up data)	Modified Brunner incision closed with multiple Y-V plasties (n = 62) vs. Z-plasty group had longitudinal incision, closed with Z-plasties (n = 38)	Follow-up for 2 years.	Mean post-op deformity on final review or at recurrence 25° in modified Bruner group vs. 24° in Z- plasty group (NS). Recurrence rate 33% modified Bruner vs. 18% Z- plasty group (NS).	“There is no evidence to suggest that the type of incision influences the time distribution of recurrent disease but this possibility cannot be discounted.”	Data suggest no differences between the 2 procedures.

	“Firebreak” Full-thickness Skin Graft for Dupuytren’s Contracture surgery, Extensive Fasciectomy, Dermofasciectomy									
Bhatia 2002 (score=4.5)	Surgery (regional or selective fasciectomy); percutaneous needle fasciotomy (needle aponeurotomy); “Firebreak” Full-thickness Skin Graft for Dupuytren’s Contracture surgery, Extensive Fasciectomy, Dermofasciectomy	RCT	No mention of sponsorship or COI.	N = 31 (28 male and 3 female) undergoing surgery for Dupuytren’s disease	Mean age: 61 years; 28 males, 3 females	Staple group: staples via an automatic stapling device. Time spent closing recorded. Pain levels recorded during staple removal at 1 week follow-up (n = 13) vs. Suture group: received 4-0 monofilament polybester sutures. Time spent closing recorded. Pain levels recorded during suture removal at 1 week follow-up (n = 18)	Follow-up at weeks 1 and 2 following surgery.	Mean skin closure time with sutures 51 seconds per cm and 25 seconds per cm with staples (p <0.001). The mean pain score for removal 2.4 for suture removal and 5.2 for staple removal, (p = 0.008).	“As staples can be inserted in half the time of conventional sutures we recommend their use for closure of extensive palmar wounds following long operative procedures.”	Data suggest patient pain was higher for staple removal over suture removal but staples took less time to insert and no significant differences in wounds once staples or sutures removed.

Appendix Two – Medical Studies

(Low-quality Randomized Controlled Trials and Non-randomized Studies)

The following low-quality randomized controlled studies (RCTs) and other studies were reviewed by the Evidence-based Practice Hand, Wrist, and Forearm Panel to be all inclusive, but were not relied upon for purposes of the development of this document’s guidance on treatments because they were not of high quality due to one or more errors (e.g., lack of defined methodology, incomplete database searches, selective use of the studies and inadequate or incorrect interpretation of the studies’ results, etc.), which may render the conclusions invalid. ACOEM’s Methodology requires that only moderate- to high-quality literature be used in making recommendations.(1740)

ERGONOMIC INTERVENTIONS

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Ripat 2006 RCT Sponsored by Manitoba Hydro. No mention of COI.	3.0	N = 68 with two or more symptoms of WRUED (Work Related Upper Extremity Disorders). Mean age 42.2 years.	Adapted Group- Microsoft Natural MultiMedia Keyboard adapted to reduce activation force required to depress keys (light touch) (n = 43) vs. Unadapted Group- Standard keyboard with no adaptations made (n = 25). Follow-up for 6 months.	No significant differences between two groups for Symptom Severity (SSS) and Functional Status Scales (FSS) between groups (p <0.05). When data from groups combined, SSS and FSS-typing measures significant at both 12 and 24 week (p <0.0001) at both time points.	“Positive results in reduction of symptom severity and improvement in functional status were identified for participants in both keyboard study groups, providing further evidence to support the use of ergonomic keyboards for individuals with WRUED. The vast majority of participants were satisfied with their study keyboard.”	Both keyboard groups improved over time, however, there were no differences between groups. Some randomized to experimental group were “forced” to use the LT keyboard.
Hedge 1999 RCT Sponsored by Honeywell, Inc., Proformix, Inc., Global, Global Contrac and Teknion. No mention of COI.	2.5	N = 38 professionals who used a computer work average of 5.4 hours per day. Mean age 37.4.	DT Group- DT keyboard tray. User measurements taken to put keyboard at comfortable height. (n = 23) Vs. Control Group- conventional adjustable keyboard with or without a padded wrist rest (n = 15). Measurements taken immediately following intervention.	No significant differences between pre- and post-test measurements in the control group for wrist extension and ulnar deviation (p >0.05). Significant difference between pre and post wrist extension in DT group; 17.6 vs. 12.1 (p <0.05). No significant difference for ulnar deviation. (p>0.05). In post-test upper posture index (UPI) there was a significant difference in favor of the DT group vs. control for number of subjects reporting a UPI < 4; 60% vs. 90% (p = 0.044).	“Overall, the wrist movement data, the RULA data and the self-reported musculoskeletal discomfort data all point to improvements within a short time after using the DT system.”	Methodological details sparse.

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Lincoln 2002 RCT Supported by grant from Robert Wood Johnson Foundation and Workers' Compensation Health Initiative grant 034366 and cosponsored by US Department of Labor. No mention of COI.	2.5	N = 101	Nurse case manager training in ICN vs. no ICM training.	"Trained nurses were more likely to recommend accommodations addressing workstation layout, computer-related improvements, furnishings, accessories, and lifting/carrying aids, whereas the untrained nurses were more likely to suggest light duty and lifting restrictions. This study indicates that the training was associated with a change in the practice behavior of case managers regarding the workplace accommodation process."	"More research is needed to identify barriers to implementation and develop more effective approaches to facilitate worksite accommodations in disabled workers with carpal tunnel syndrome and other persistent upper extremity disorders."	
Galinsky 2007 RCT No mention of sponsorship or COI	1.5	N = 51	All workers spent 4 weeks with conventional breaks (2 15-minute breaks a day) and 4 weeks with supplementary breaks (2 15-min breaks plus 4 5-minute breaks per day). One group performed brief stretching exercises during breaks; control group did no stretching during breaks.	Mean rate of data entry under supplementary rest break schedule significantly faster than rate under conventional rest break schedule (p <0.0002). No significant effects of stretching on discomfort or performance observed. Discomfort and eyestrain significantly lower with supplementary breaks; supplementary breaks attenuated accumulation of discomfort and eyestrain during work sessions.	"These results provide further converging evidence that supplementary breaks reliably minimize discomfort and eyestrain without impairing productivity."	Short-term study in temporary workers who may be unaccustomed to work. Compliance rates were low – 25 to 39%.

WORK RESTRICTIONS

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Ripat 2006 RCT Sponsored by Manitoba Hydro. No mention of COI.	3.0	N = 68 with two or more symptoms of WRUED (Work Related Upper Extremity Disorders). Mean age 42.2 years.	Adapted Group- Microsoft Natural MultiMedia Keyboard adapted to reduce activation force required to depress keys (light touch) (n = 43) vs. Unadapted Group- Standard keyboard with no adaptations made. (n = 25) Follow-up for 6 months.	No significant differences between two groups for Symptom Severity (SSS) and Functional Status Scales (FSS) between groups (p <0.05). When data from groups combined SSS and FSS-typing measures were significant at both 12 and 24 week (p <0.0001) at both time points.	"Positive results in reduction of symptom severity and improvement in functional status were identified for participants in both keyboard study groups, providing further evidence to support the use of ergonomic keyboards for individuals with WRUED. The vast majority of participants were satisfied with their study keyboard."	Both keyboard groups improved over time, however, there were no differences between groups. Some randomized to experimental group were "forced" to use the LT keyboard.
Hedge 1999 RCT Sponsored by Honeywell, Inc., Proformix, Inc., Global, Global Contrac and	2.5	N = 38 professional workers who used a computer at work for an average of 5.4 hours per day. Mean age 37.4.	DT Group- DT keyboard tray. User measurements taken to put keyboard at comfortable height (n = 23) vs. Control Group conventional adjustable keyboard with/without	No significant differences between pre- and post-test measurements in control group for wrist extension and ulnar deviation (p >0.05). Significant difference between pre- and post-wrist extension in DT group; 17.6 vs. 12.1 (p <0.05). No significant difference for ulnar deviation. (p >0.05). In post-test upper posture index (UPI) there was a	"Overall, the wrist movement data, the RULA data and the self-reported musculoskeletal discomfort data all point to improvements within a short time after using the DT system."	Methodological details sparse.

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Teknion. No mention of COI.			padded wrist rest. (n = 15). Measurements immediately following intervention.	significant difference in favor of DT group vs. control for number of subjects reporting UPI <4; 60% vs. 90% (p = 0.044)		
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RETURN-TO-WORK PROGRAMS

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Feuerstein 1993 Non-randomized comparative study	N/A	N = 49	Eligible for multi-component rehab program (n = 34) vs. not eligible (n = 15)	Findings indicated “74% of the treatment group returned to work or were involved in state-supported vocational training in contrast to 40% of the control group (p <0.05).”	“These findings suggest the need to modify treatment components to facilitate an increased return-to-work rate. Areas that may prove useful include a greater emphasis ergonomic modifications at the workplace to reduce the risks of repetitiveness, force, awkward posture, and insufficient work/rest cycles, as well as efforts to modify work style directly in order to reduce the impact of ergonomic stressors on the ability to perform essential job tasks.	

CARPAL TUNNEL SYNDROME – DIAGNOSTICS

Electrodiagnostic Studies

Author/Year Study Type Conflict of Interest (COI)	Score	Study Design	Population/ Case Definition	Investigative Test	Gold Standard / Comparative Test	Results	Conclusion	Comments
Jackson 1989	3.5	Diagnostic	N =162 divided into groups: Group 1 (n = 38)	Electrodiagnostic studies including Palm median	Screening history as well as physical diagnostic testing	Abnormality percentages of different tests Group 1, 2, 3, 4: Palm (m):	“Certainly supplemental studies can serve as a discriminating	Study suggests use of comparing median and radial distal sensory latencies in digit 1 and comparing median and ulnar distal sensory latencies in digit 4 when CTS referrals have normal nerve conduction studies.

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			<p>healthy volunteers. Group 2 (n = 40) with positive clinical testing but negative Electromyography (EMG) and Nerve Conduction Studies. Group 3 (n = 53) clinical confirmed CTS, positive NCS, Negative EMG. Group 4 (n = 30) clinically confirmed CTS, positive NCS and EMG.</p>	<p>nerve latency (Palm (m). Distal Sensory latency difference between median and radial nerve (DSL (m-r)). Palmar latency difference between median and ulnar nerve (Palm (m-u)). Distal Sensory latency difference (DSL (m-u)). Amplitude of sensory action potential ratios and the 2nd and 5th digit. (Amp).</p>	<p>was used to ensure the existence of Carpal Tunnel Syndrome, as well as eliminate patients with peripheral neuropathy.</p>	<p>2.6%, 16%, 96%, 94%. DSL (m-r): 0%, 44%, 89%, 100%. DSL (m-u): 5.3%, 44%, 100%, 100%. Palm (m-u) 5.3%, 30%, 98%, 94%. Amp: 0%, 2.3%, 33%, 61%. Group 2 abnormalities using a combination of tests: DSL (m-u) and DSL (m-r): 51%. DSL (m-u) DSL (m-r) and Palm (m-u) 51%.</p>	<p>instrument, distinguishing between individuals on a dimension of interest (NCS) when no gold standard is available for validating these measures.”</p>	
Zaher 2012	3.0	Diagnostic	<p>N=52 with CTS. Follow-up at 12 weeks.</p>	<p>Electrodiagnostic Studies (n = 20)</p>	<p>MRI (n = 10) vs. Ultrasound (n = 22).</p>	<p>17/20 (85%) had electrodiagnostic findings of prolonged motor and sensory latencies of the median nerve, reduced sensory and motor conduction velocities, and median-ulnar sensory latency difference. 10/10 (100%) underwent MRI showed swelling of media nerve, increased signal intensity, and palmar bowing of transverse carpal ligament. 19/22 (86.3%) with ultrasounds showed enlargement of median nerve at proximal carpal tunnel with increased cross-sectional area over</p>	<p>“Ultrasound is superior to other investigation tools as it provides accurate and rapid diagnosis of CTS with the least cost.”</p>	<p>Study enrolled only subjects with mild CTS. Study suggests ultrasound is superior to other diagnostic techniques for mild CTS due to its relatively low cost and rapid results MRI and electrodiagnostic studies did have better diagnostic outcomes.</p>

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						12 mm ² , and palmar bowing and thickening of flexor reticulum.		
Homann 1999	3.0	Diagnostic	N = 824 workers recruited from 6 different companies, with a mean job tenure 8.9±9.1	Electrodiagnostic testing of median-Ulnar sensory peak latency difference >0.5 ms, more severe was a difference of >0.8 ms.	Self-administered surveys and hand diagrams. Questionnaire asked about symptom severity, and persistence. Workers indicated pain, numbness, and areas of tingling on hand diagram.	Electrodiagnostic (EDX) positive results (n = 139, 16.9%), Physical Examination (PE) positive (n = 165, 20.1%), Wrist, Hand, and Finger Symptoms (WHF Sx) positive (n = 305, 37.0%). Correlation between PE and EDX (n = 36), between WHF Sx and PE (n = 90), EDX and WHF Sx (n = 55). Between all 3 tests (n = 23).	“The combination of results from electrodiagnostic testing and symptom survey procedures appears to provide the best criterion for defining CTS for epidemiologic investigations in which the intent is to evaluate either the impact of intervention or the exposure-response relationship.”	Study reports poor correlation between electrodiagnostic findings, symptom surveys and symptom presentation from physical exams in diagnosing CTS.

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Uncini 1989	2.5	Diagnostic	43 with symptoms and signs of CTS and 33 controls. Group 1: (26 hands) mild abnormalities DPSNL >2.9 msec onset, 3.5 msec peak; group 2: (16 hands) normal or borderline median nerve results D2SNL <2.9 msec, onset or 3.5 msec peak.	Electrodiagnostic studies: median DML, wrist to abductor pollicis brevis (APB); ulnar DML, wrist to abductor dititi minimi (ADM); median sensory nerve latency (SNL) D2 to wrist and D2 to palm; ulnar SNL D5 to wrist; median and ulnar SNL D4 to wrist.	N/A	Both groups had longer median latencies from digit 4 to wrist than digit 2 to wrist. D4 latencies more significant in group 1 (D4 latency onset: 3.7±0.5 and D2: 3.3±0.2) and group 2 (3.0±0.4 and 2.6±0.2) than D2 latencies, suggesting D4 more sensitive than D2-Wr. Significant differences in paired nerves (adjusted for controls) of median D4 SNL - ulnar IV DSL vs. median DML - ulnar DML (group 1: p <0.05 and group 2: p <0.05), and median D4 SNL - ulnar D4 SNL vs. median D2 SNL - ulnar DV SNL (group 1: p <0.05 and group 2: p <0.05). Meant D4 technique most sensitive for disease detection.	“In conclusion, stimulating digit 4 and comparing latencies to median and ulnar nerves is a simple method that is more sensitive than other techniques in detecting CTS. Detection of the double peak potential recorded over the median nerve allows immediate diagnosis of CTS. Even when the double peak is not recognized, a median and ulnar D4 latency difference greater than 0.5 msec suggests CTS.”	Study suggests stimulation of digit 4 is useful in identification of CTS. D4 latency is longer in CTS patients compared to other digits.
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Ultrasound

Author/Year Study Type Conflict of Interest (COI)	Score	N	Area of Upper Extremity	Diagnoses	Type of Ultrasound	CT used	MRI Used	More than on rater	Blinding of rater	Mechanography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when reported)	Results	Conclusion	Comments
Wiesler 2006 Diagnostic	3.0	N=44 wrists (26 patients), N=86 wrists (43 controls).	Wrist	Patients with symptoms, clinical exam findings, and nerve conduction study findings for CTS. Mean duration of symptoms 12 months (range 1.5-72 months). Mean age 56 years CTS, 36 years controls.	Philips HDI 5000 with 12/5-MHz linear-array transducer	-	-	-	-	-	-	-	-	Pearson correlation coefficient ultrasound vs. nerve conduction study (NCS): 0.37 (p = 0.013). Sensitivity and specificity: cutoff point of 11+ mm ² = sensitivity 91%, specificity 84%; PPV 74%; NPV 95%.	“[H]igh-resolution ultrasound is informative in the evaluation of CTS and shows enlargement of the median nerve at the distal wrist crease in symptomatic patients.”	A 1:2 (CTS vs. normal). Suggests HRUS may be used to diagnose CTS and enlargement of the median nerve at the wrist crease in symptomatic patients is usually predictive for CTS.

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<p>Yesildag 2004 Diagnostic</p>	<p>3.0</p>	<p>N=86 (148 wrists), N=45 (76 wrists) controls</p>	<p>Wrist</p>	<p>CTS symptoms. Mean age CTS 49.8±8.7 years, controls 42.7±11.3 years.</p>	<p>12 MHz linear array transducer (ATL 1500 HDI)</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>-</p>	<p>Mean±SD cross-sectional area by tracing method: CTS 14.9±4.7 vs. control 7.8±1.6 (p<0.001). Mean±SD cross-sectional area by ellipsoid formula: CTS 14.2±4.5 vs. control 7.5±1.8 (p<0.001). Cutoff for sensitivity and specificity: 10.5mm² for mean cross-sectional area; using tracing method – sensitivity (95% CI) 89.9 (85-94.8), specificity 94.7 (89.7-99.7), PPV 97 (94.3-99.9), NPV 82.7 (74.8-90.6); using indirect method – sensitivity 86.5 (81-92), specificity 93.4 (97.88-99), PPV 96.2 (92.9-99.4), NPV 78.1 (69.5-86.6).</p>	<p>“The ultrasonographic measurement of the median nerve cross-sectional area is a sensitive, specific and useful non-invasive method for the diagnosis of carpal tunnel syndrome.”</p>	<p>2:1 matched study suggesting ultrasonographic of median nerve may be useful in CTS initial diagnosis of CTS made via EMG.</p>
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Zaher 2012	3.0	52	W	CTS	Not described	-	+	-	-	-	+	-	12 weeks	17/20 (85%) had electrodiagnostic findings of prolonged motor and sensory latencies of median nerve, reduced sensory and motor conduction velocities, and median-ulnar sensory latency difference. 10/10 (100%) underwent MRI showed swelling of media nerve, increased signal intensity, and palmar bowing of transverse carpal ligament. 19/22 (86.3%) with ultrasounds showed an enlargement of median nerve at proximal carpal tunnel with increased cross-sectional area over 12 mm ² , and palmar bowing and thickening of flexor reticulum.	“Ultrasound is superior to other investigation tools as it provides accurate and rapid diagnosis of CTS with the least cost.”	Study enrolled only subjects with mild CTS. Study suggests ultrasound superior to other diagnostic techniques for mild CTS due to its relatively low cost and rapid results MRI and electrodiagnostic studies did have better diagnostic outcomes.
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Magnetic Resonance Imaging and Diffusion Tensor Imaging

Author/Year Study Type Conflict of Interest (COI)	Score	Number	Area of Upper	Diagnoses	Type of MRI used	Type of CT used	T1 weighted images	T2 weighted images	X-ray	Myelography	More than one rater	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
Guggenberger 2012 Diagnostic	3.5	N = 15 patients and 45 healthy individuals	W	CTS	3.0 T MR imager	-	+	-	-	-	+	-	-	+	Factorial anisotropy or FA decreased and apparent diffusion coefficient or ADC increased when moving from proximal to distal locations, (p <0.001). Significant difference between healthy volunteers and those with CTS, (p <0.001 for both FA and ADC). FA threshold of 0.47 and ADC threshold of 1.054 X 1023 mm ² /sec might be used in diagnosis of CTS.	“Normative diffusion values for MR neurography of the median nerve with DTI depend on the anatomic location and age but not on sex.”	1:3 matching of cases to controls suggests significant difference between controls compared to CTS groups for both FA and ADC that may be useful in diagnosing CTS. FA decreased and, AC increased when moving from proximal to distal and with age.
Hornig 2012 Diagnostic	3.5	N = 50 with CTS and 45 healthy volunteers.	W	CTS	GE 1.5 T Signa Excite MRI system	-	+	-	-	-	-	-	-	-	4 subjects had abnormal NCS results. Pain scale (VAS) / and DASH questionnaire; CTS Patients and Healthy Volunteers: 59±20 and 7±15, and 26±19/4±5. Grasp strength (kg)/Palmar pinch strength (kg)/Lateral pinch strength (kg)/Monofilament sensory test: 15.7±1.2 vs. 14.8 ±1.1/17.1±7.5 vs 22.9±7.8/ 2.7 ± 1.6 vs 3.8±1.4/4.1±2.3 vs. 5.3 ±1.7/and 29.7±3.5 vs 32.3±3.1.	“The accuracies of MRI and ultrasonography for diagnosing CTS were improved by measuring the bowing of the flexor retinaculum in the grasp position.”	Study suggests ultrasonography comparable to MRI in diagnosing CTS only if both rest and grasp position are combined. Sample size small.

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Bak 1997 Diagnostic	3.5	20 with suspected CTS	W	CTS	1.5 T Philips ACS-NT superconductive MR unit.	-	+	-	-	-	-	-	-	-	Electrophysiological examination suggested median nerve entrapment in 18 wrists. These then compared to remaining 22 electrophysiologically normal wrists. No significant differences between groups for swelling, flattening, bowing ratio and carpal tunnel index (p > 0.05).	“Neither symptoms nor electrophysiological findings in CTS were related to specific MR parameters.”	Small sample size. Study did not demonstrate a correlation between MR images to electrophysiological changes in CTS. No difference found between CTS group to normal group with respect to swelling ratio, flattening ratio, bowing ratio or carpus tunnel index.
Deryani 2003 Diagnostic	3.0	N = 55 wrist, of those N = 30 with CTS and N = 25 healthy subjects. The mean age for CTS / healthy subjects: 48.69 ± 2.12 / 50.20 ± 8.21.	W	CTS	MRI	-	+	+	-	-	-	-	+	-	Statistically significant differences between median nerve diameters (at pisiform bone level: 8.47 ± 1.41 mm; and distal radio ulnar joint level: 4.04 ± 1.06 mm and 2.42 ± 0.95 mm), the diameter ratios and flexor retinaculum bulging ratios (26.21 ± 5.98% and 7.27 ± 4.53%), (p < 0.001). Hyperintensity was found in 4 of 25 controls and isointensity in 21, (p < 0.001).	“[M]RI examination of structural changes that occur in the carpal tunnel, neighboring structures and the median nerve would be useful in the diagnosis of CTS, especially in case with suspected clinical and electrophysiological diagnosis.”	Small sample size. Study suggests MRI in tandem with electrophysiological evaluation to make CTS diagnosis.

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Zaher 2012	3.0	52	W	CTS	MRI (n = 10) vs. ultrasound (n = 22) vs. Electrodagnostic Studies (n = 20)	-	-	+	-	-	-	+	-	12 weeks	17/20 (85%) had electrodiagnostic findings of prolonged motor and sensory latencies of median nerve, reduced sensory and motor conduction velocities and median-ulnar sensory latency difference. 10/10 (100%) underwent MRI showed swelling of media nerve, increased signal intensity, and palmar bowing of transverse carpal ligament. 19/22 (86.3%) with ultrasounds showed an enlargement of the median nerve at proximal carpal tunnel with an increased cross-sectional area over 12 mm ² , and palmar bowing and thickening of flexor reticulum.	“Ultrasound is superior to other investigation tools as it provides accurate and rapid diagnosis of CTS with the least cost.”	Study enrolled only subjects with mild CTS. Study suggests ultrasound superior to other diagnostic techniques for mild CTS due to its relatively low cost and rapid results MRI and electrodiagnostic studies did have better diagnostic outcomes.
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CARPAL TUNNEL SYNDROME – TREATMENT

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Exercise						
Hornig 2011 RCT No mention of sponsorship. No COI.	3.5	N = 60 with CTS. Mean age 50.5+9.4 years.	Group 1 received paraffin therapy, a splint, and instructions for tendon gliding exercise (n = 20) vs. Group 2 received	Difference between before and after treatment: Symptom severity – Group 1: -0.7+0.8; Group 2: -0.3+0.6; Group 3: -0.6+0.6; p = 0.56; Functional status – Group 1:	“To improve the functional status and quality-of-life of CTS patients, the combination of tendon gliding exercises, paraffin therapy, and	Baseline comparability differences in functional status scores of the three groups.

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			paraffin therapy, a splint, and instructions for nerve gliding exercise (n = 20) vs. Group 3 received only paraffin therapy and a splint (n = 20). Follow-up at 2-months.	-0.4+0.5; Group 2: 0.1+0.5; Group 3: -0.2+0.7 p = 0.04; Pain scale – Group 1: -19.7+24.6; Group 2: -10.5+18.0; Group 3: -17.2+26.2; p = 0.44	splinting might be more effective than the combination of nerve gliding exercises, paraffin therapy, and splinting.”	
Heebner 2008 RCT No mention of sponsorship or COI.	2.0	N = 60 diagnosed with CTS by physician. Mean age 52 years. Age range 32-75 years.	Group 1 received standard care including education, splinting, and tendon-gliding exercises (n = 28) vs. Group 2 received the same standard care along with active neurodynamic mobilization exercises (N = 32). Follow-up at 6 months.	No statistical difference reported between groups. P-values not provided. Compared to baseline, follow-up scores for median nerve provocation test, DASH, and CTSQ not significantly different (p-values ranged from 0.308 to .966) in both groups. Values not provided.	“The results of this study suggest that persons with CTS in a community hospital do not benefit from a one-time nonsurgical intervention that includes splinting instruction and standard tendon-gliding exercises alone or splinting and tendon gliding along with neural mobilization exercises.”	Methodological details sparse.
Tal-Akabi 2000 RCT	2.0	N = 21 with CTS mean duration of 2.3+2.5 years from surgery waiting list.	Neurodynamic mobilization (ULTT2a) (n = 7) vs. Carpal bone	Only the post-intervention Pain Relief Scale (PRS) demonstrated significant	“The study has failed to show significant differences in the effectiveness	Small sample size (N=21). Inclusion criteria of ULTT2a was also a treatment arm, potentially providing a fatal study flaw. Methodological details sparse.

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No mention of sponsorship or COI.		Mean age: 47.1+14.8 years.	mobilization (n = 7) vs. No treatment (n = 7). Follow-up and intervention length are unclear.	difference between the three groups (p<0.01). Mean PRS – Neurodynamic: 3.14; Carpal Bone: 3.71; Control: 0.	between mobilization of the median nerve and carpal bone mobilization in the treatment of patients presenting with carpal tunnel syndrome.”	
Bardak 2009 RCT Sponsored by Sanofi Aventis. No mention of COI.	1.5	N = 111 (111 hands) with CTS. Mean age 49.14+9.6 years.	Group 1 standard conservative treatment (SCT) (n = 41) vs. Group 2 SCT plus tendon and median nerve gliding exercises (n = 35) vs. Group 3 tendon and median nerve gliding exercises (n = 35). Follow-up 2 and 11 months.	Symptom total point change – Group 1: -7.4; Group 2: -10.5; Group 3: -2.9. Significant difference between Groups 1 and 3 and Groups 2 and 3 (p<0.001). Functional status scale change – Group 1: -6.7; Group 2: -6.7; Group 3: -3.8. Significant difference between Groups 1 and 3 and Groups 2 and 3 (p <0.001).	“In conclusion, in cases of idiopathic CTS, conservative treatment is clinically effective. Adding tendon and nerve gliding exercises is also beneficial to the management of long-term CTS. Tendon and nerve gliding exercises alone are inferior to other modalities.”	Methodological details sparse. Largely female population.
NSAIDs						
Gurcay 2009 RCT No mention of	3.5	N =32 female, housewife patients with clinically and EDS confirmed mild or moderate CTS. Mean age	Group A: local injection of 6mg betamethasone through 25-gauge needle near distal wrist-flexion	No significant difference found between the groups for Functional Status Scale (FSS) scores, Jebsen Taylor Test (JTT) scores, or	“[T]he two treatment methods resulted in some functional gains in hand dexterity and	Small sample size in each group. Neither treatment was superior to the other.

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sponsorship or COI.		40.8±11.2 years.	crease (n = 18) vs. Group B: meloxicam 15 mg/day, PO, for 3 weeks (n = 14). Both groups advised to wear wrist splints in neutral position at night for 3 weeks. Follow-up at 3 months.	electrophysiologic findings at 3 months (p>0.05).	improvement in electrophysiological data, but with neither of the methods demonstrating superiority.”	
Vitamins						
Stransky 1989 RCT No mention of sponsorship or COI.	3.5	N = 15 EDS confirmed	200mg of Vitamin B ₆ vs. placebo	“Significant changes in nerve conductions and EMGs did not occur when initial and follow-up data were compared. Clinical findings did not correlate with electrodiagnostic findings.”	“Vitamin B ₆ seems to have no advantage over conservative therapy for carpal tunnel syndrome.”	
Lidocaine Patches						
Moghtaderi 2009 RCT No mention of sponsorship or COI.	2.5	N = 65 with clinical and electrodiagnostic evidence of CTS. Aged 18-75 years.	Group 1 received ELMA cream (n = 30) vs. Group 2 received one injection of methylprednisolone acetate 40 mg at wrist (n =	Significant changes reported in pain in both groups, (p <0.001). Treatment-related adverse events (AEs) reported in 2 patients in group 1 (5.7%)	“ELMA cream was effective in reducing pain associated with CTS and well tolerated and it may offer patients with CTS an effective, noninvasive	Methodological details sparse.

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			35). Follow-up for 4 weeks.	and 10 patients in group 2 (28.5%).	symptomatic treatment.”	
Jensen 2006 RCT/Parallel-group/Open label Sponsored by grant from Endo Pharmaceuticals, Inc (M.P.J.). M.P.J. and S.R.N. received research support and/or consulting fees. A.R.G., N.O. and B.S.G. hold stock options in Endo Phar.	1.5	N = 40 with CTS. Age 18-75.	Lidocaine patch 5% daily (n = 20) vs. Lidocaine 1% single injection of 0.5mL plus methylprednisolone acetate 40mg at start of study (n = 20). Follow-up for 4 weeks.	Statistically significant decreases in 10 of 20 PQAS pain descriptor ratings occurred with both treatments, (p <0.0025); 8 ratings showed no significant trends for decreasing before treatment to after treatment. No significant differences found between treatment conditions on any of the PQAS items.	“The results support the validity of the PQAS items for assessing the effects of pain treatment on pain qualities of carpal tunnel syndrome.”	Methodological details sparse.
Magnets						
Combination Magnetic Field Therapy						
Weintraub 2008 RCT Sponsored by Nikken, Inc. No COI.	3.5	N = 36 at least 18 years of age with CTS. Mean age: 62.3 years.	Combination of simultaneous static and time-varying dynamic magnetic field stimulation (Biaxial Super Mini	Magnet vs Sham – NPS Total Composite reduction: 42% vs 24% (p = 0.04). VAS reduction: 39% vs 27% (not significantly different). NPS 8 Total Descriptor reduction: 43% vs	“In conclusion, there is little doubt that time-varying PEMF produce neuro-biological effects, and our novel data suggest that this unique	Limited study enrollment and small sample size. Dropouts led to uneven participation between groups.

			[Mx ² R]) 4-hours/day (N = 17) vs. Sham device (N = 19). Follow-up at 2 months.	24% (p = 0.04). No difference between groups for Nerve Conduction.	physics-based device generating AC and DC magnetic fields simultaneously directed to the carpal tunnel is an attractive nonsurgical approach this is safe, and can achieve statistically significant short-, intermediate-, and long-term pain relief and mild changes in neuromodulation.”	
Pulsed Magnetic Field Therapy						
Arikan 2011 RCT No mention of sponsorship or COI.	3.5	N = 57 hands from 38 patients with idiopathic CTS. Mean age: 48.8 years.	Pulsed Magnetic Field Therapy 30 minutes/day for 3 weeks using BTL-09 device (n = 28 hands/19 patients) vs. Sham therapy same procedure without running device (n = 29 hands/19 patients). Assessment at baseline and	When compared, no significant change was observed between groups for either clinical parameters or electrophysiologic studies (p> 0.05).	“(W)e conclude that magnetic field and placebo magnetic field treatments in the patients with idiopathic carpal tunnel syndrome are effective to both clinical and electrophysiological endpoints in short term, but not superior to each other.”	Baseline comparability data suggest randomization failure and possible quasi randomization “every other”.

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			end of treatment. Follow-up 1 month post-treatment.			
Dakowicz 2011 RCT No mention of sponsorship or COI.	2.5	N = 38 with diagnosed idiopathic CTS confirmed by ENG. Mean age 50.8±10.3 years.	Low-level laser therapy (LLLT) using Ga-As Physioter D-50 for 5 minutes and 33 seconds (N = 18) vs. Pulsed magnetic therapy (PMF) with Magnetronic MF-10 for 15 minutes (N = 20). Two series of 10 sessions, with 2 week break between. Assessment after each series and at 6 months post-treatment.	No between-groups comparisons were made. In both groups, VAS improved after each series and at 6-months post-treatment (p <0.05).	“The presented study demonstrated that a clinical improvement in CTS patients was observed after LLL as well as PMF.”	Sparse baseline comparability data. At 6 months, both groups showed comparable (in)efficacy
Splinting						
Bhatia 2000 RCT	3.5	N = 102	Plaster splint vs wool and crepe bandage.	“There were no reported problems with wound breakdown or other symptoms at the 2 week follow-up. Using the Mann-Whitney U test, there were no significant statistical differences in the	“This prospective randomized study has not supported the use of plaster. We believe that patients undergoing carpal tunnel release should be treated	States single blinded, but unclear how blinding was done.

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				[pain scores or number of tablets ingested up top 3 days postoperatively between the two groups.”	postoperatively with a bulky wool and crepe bandage.”	
<p>Homg 2011 RCT</p> <p>No mention of sponsorship . No COI.</p>	3.5	<p>N=60 patients with symptoms (pain, numbness within median nerve distribution, nocturnal pain), positive Phalen sign or positive Tinel sign, and electrophysiology evidence of CTS. Mean age 50.5±9.4 years.</p>	<p>Group 1: paraffin therapy (in hospital 2x a week, administered by none-dip method at 55°C) plus splint (custom made neutral volar wrist splint to be worn at night for at least 8 weeks) plus tendon gliding exercise three times daily holding each position for 7 seconds and then repeating the exercises 5 times per session (N=20) vs. Group 2: paraffin therapy plus splint plus nerve gliding exercise (N=20) vs. Group 3: paraffin</p>	<p>Functional status difference before/after treatment (mean±SD): Group 1; -0.4±0.5 vs. Group 2; 0.1±0.5 vs. Group 3; -0.2±0.7 (p = 0.04). NS between groups for symptom severity score (p = 0.56), pain scale (p = 0.44), Disability of the Arm Shoulder, and Hand (DASH) questionnaire (p = 0.29), World Health Organization Quality of Life Questionnaire Brief Version (WHOQOL-BREF) physical domain (p = 0.31), WHOQOL-BREF psychologic domain (p = 0.53), WHOQOL-BREF social domain (p = 0.88), and</p>	<p>“To improve the functional status and quality-of-life in CTS patients, the combination of tendon gliding exercises, paraffin therapy, and splinting might be more effective than the combination of nerve gliding exercises, paraffin therapy, and splinting.”</p>	<p>Baseline comparability differences in functional status scores among the 3 groups.</p>

			therapy plus splint (N=20). Follow up 2 months after treatment.	WHOQOL-BREF environmental domain (p = 0.45).		
Koca 2014 RCT No mention of sponsorship or COI.	3.5	N=75 patients with idiopathic CTS; presence of paresthesia, pain, and/or vasomotor symptoms of hand through distribution of median nerve for longer than 6 weeks; positive Phalen’s maneuver and/or Tinel’s sign and/or carpal compression test. Mean age Group I – 35.4±4.2 years, Group II – 34.2±5.2, Group III 34.9±4.8 years.	Group I: splint therapy, neutral position wrist splint with aluminum bar at night for 3 weeks (n = 25) vs. Group II: transcutaneous electrical stimulation, TENS on the carpal ligament and palmar area of hand at pulse rate of 100 Hz frequency and stimulation period of 80 ms, 20 minute sessions for 15 total sessions (n = 25) vs. interferential current, IFC therapy at base frequency of 4,000 Hz with a modulation frequency range of 20 Hz,	NS between TENS and splint therapy for improvement in clinical scores (p >0.05). VAS (mean±SD) at 6 weeks: IFC 4.80±1.18 vs. splint 6.37±1.18 (p = 0.001); IFC vs. TENS 6.68±1.42 (p <0.001). Median nerve motor distal latency (mMDL) mean±SD at 6 weeks: IFC 3.89±0.88 vs. splint 4.06±0.61 (p = 0.001); IFC vs. TENS 4.06±0.88 (p = 0.003). Median sensory nerve conduction velocity (mSNCV) mean±SD at 6 weeks: IFC 41.80±1.76 vs. splint 40.75±1.48 (p = 0.010); IFC vs. TENS 41.38±1.78 (p = 0.021). Symptom severity (mean±SD) at 6 weeks: IFC	“[O]ur results indicate the potential for the use of IFC as a new and safe therapeutic option for the management of CTS.”	Small group sizes and short follow-up time.

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			<p>electrodes placed on 1/3 mid portion of volar area of forearm, palmar area of hand, and thenar area of hand, 20 minute sessions for 15 sessions (n = 25). Assessments at baseline and 3 weeks after completion of treatment.</p>	<p>2.70±1.03 vs. TENS 3.37±1.21 (p = 0.015). Functional capacity (mean±SD) at 6 weeks: IFC 1.90±1.21 vs. TENS 2.50±0.78 (p = 0.039).</p>		
<p>Gurcay 2012 RCT No mention of sponsorship or COI.</p>	3.5	<p>N= 54 female housewives with mild-to-moderate CTS diagnosed with clinical and electrophysiological evidence. Mean age 43.7±8.4 years.</p>	<p>Group I: phonophoresis with 0.1% betamethasone applied over carpal tunnel at frequency 1 MHz and intensity 1W/cm² for 10 minute sessions, 3 days a week for 3 weeks (n = 18) vs. Group II: iontophoresis with 0.1% betamethasone, 2 mA for 10 minutes a day, 3 days a week for 3 weeks (n = 16) vs. Group</p>	<p>Boston Symptom Severity Scale (BSSS): significant at 3 months, phonophoresis vs. control in favor of phonophoresis (p = 0.012). NS between groups for grip strength (p = 0.280) and 9-hole peg test, NHPT (p = 0.811).</p>	<p>“[W]e observed no added benefit or increased motor skills or hand dexterity in the groups after treatments.”</p>	<p>Sparse baseline data and comparable efficacy.</p>

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			III: wrist splint only, custom-made volar thermoplastic splint in neutral position worn at night only for 3 weeks (n = 18). Assessments at baseline, 3 months after treatment.			
Sevim 2004 Prospective, randomized, blinded trial	3.0	N = 120 EDX confirmed	Betamethasone injections 4cm proximal to the carpal tunnel vs. injections distal to carpal tunnel vs. just splinting vs. control	“Splinting provided symptomatic relief and improved sensory and motor nerve conduction velocities at the long-term follow-up when the splints were worn almost every night. Proximal and distal injections of steroids were ineffective on the basis of both clinical symptoms and electrophysiologic findings.”	Steroid injections may be beneficial short-term in mild and moderate CTS. However, splinting provided long term symptomatic relief and improved sensory and motor nerve conduction.	
Stralka 1998 RCT	3.0	N = 120	Splint vs. Splint with energized high voltage pulse unit	“In the energized group, post-treatment evaluation showed statistically significant decreases in the	“HVPC appears to be an effective method for minimizing the severity of repetitive	Methods details sparse. Diagnoses not clear. Study would seem to be blinded; however, that is not described.

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				amount of stimulation required to stimulate the median nerve and the amount of hand edema and pain. The energized group also had improved repetitive task times. None of these improvements occurred in the non-energized group.”	stress injuries of the wrist.”	
Madjdinasa b 2008 RCT No mention of sponsorship or COI.	3.0	N = 48 idiopathic CTS patients. Mean age 42.19 years.	Splint group: neutral position splint at night and during the day if possible for 6 weeks (n = 24) vs. steroid group: oral prednisolone 20mg/day for 2 weeks (n = 24). Assessments at baseline and 6 week follow-up.	No significant differences between groups for median nerve sensory, motor distal latency, and conduction velocity (p >0.05).	“Both treatment methods (splint and oral steroids) are effective but they don’t have any significant difference between two methods after six weeks follow up.”	Sparse baseline data, short follow-up. At 6 weeks, comparable efficacy, but duration of treatment is different.
Dincer 2009 RCT No mention of sponsorship . No COI.	2.5	N = 60 females with bilateral mild to moderate CTS diagnosis made by electromyography and clinical examination.	Splinting only (Sp), (N= 40) Vs. Splinting + Ultrasound therapy, A total of 10 US treatment sessions were	After profile analysis (MANOVA), results showed that improvements in SpUS and SpLLL groups statistically	“In conclusion, the results of this study demonstrate the effectiveness of conservative treatments for mild to	Methodological details sparse

		<p>Mean age: 34 years for Sp, 30 years for SpUS, 36 years for SpLLL group.</p>	<p>performed once a day, 5x a week for 2 weeks (SpUS), (N=40) vs. Splinting plus low level laser therapy (SpLLL), (N=40). Follow up visits: in first month, and third month, after treatment. Patients were instructed to wear the splints at night for 3 mo. Ultrasound therapy was administered to each other for 3 min per session, on the area over carpal tunnel at a frequency of 3 MHz and an intensity of 1.0W/ cm² in continuous mode with a transducer 5 cm² in size with gel.</p>	<p>significantly better than those seen in Sp group (p = 0.0429 and p = 0.0001). Also, difference between SpUS and SpLLL groups significant (p =0.03). Both SpUS and SpLLL groups had statistically significantly better improvement than Sp group at 3 months (p <0.0001 for both groups) On the other hand, no significant differences between SpUS and SpLLL group profiles. VAS pain scores improved in all groups at 1 and 3 month vs. baseline. Both SpUS and SpLLL groups improvements significantly better than Sp group improvement over time (p = 0.0001 for both). SpLLL group showed significantly better</p>	<p>moderate CTS. Combining US or LLL therapy with splinting appeared to be more effective than splinting alone in our study. However, the combination of LLL therapy with splinting appeared to be superior to splinting plus US, especially for improvements in symptom severity, pain alleviation, and patient satisfaction. Further research with larger patient samples and longer follow-up periods are required to independently confirm our findings, and to determine the most effective doses and protocols for LLL and US therapies.”</p>	
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				improvement than SpUS group.		
Burke 1994 RCT	1.5	N = 59	Splints vs. optimal angle	“The results indicate that the neutral angle provided superior symptom relief, and that the relief did not often improve between 2 weeks and 2 months of wear.”	“All splints were custom made volar cock-up style splints constructed of thermoplastic splinting material.”	Randomization unclear, study states blinded but that seems unlikely.
Pinar 2005 RCT No mention of sponsorship or COI.	1.5	N = 26 females with NCS positive CTS	Tendon gliding exercises (n = 6) vs. thermoplastic volar splint plus instructions to reduce physical activities for 10 weeks	Grip strength TGE vs. splint plus reduced use (pre/post): 17.8±6.1/22.0±6.8 vs. 20.4±4.7/21.7±4.3 (p <0.05) between groups. Most results negative.	“Significant progress was detected in both control and experimental groups during the posttreatment phase compared with the initial phase (P<0.05). However, when the 2 groups were compared, the experimental group in which nerve gliding exercises were added to conservative therapy approaches demonstrated more rapid pain reduction; these patients also showed greater	Low sample size. Blinding unclear. Diagnostic criteria unclear, including NCS and 9 other criteria that seem unlikely fulfilled for all. No non-treatment comparison. No between group differences. Conclusion for ultrasound not clearly supported. If bilateral CTS (12/30), both treated the same and double-counted in results, weakening conclusions.

					functional improvement, especially in grip strength (P<0.05).”	
Acupuncture						
Khosrawi 2012 RCT Study funded by research chancellor of Isfahan University of Medical Sciences. No COI.	1.5	N = 72 with mild to moderate CTS confirmed using Tinel’s and Phalen’s tests and electrophysiological testing; mean age: Acupuncture Group 41.7±9.3; Control Group 41.1±9.6	Acupuncture Group underwent treatment in eight sessions of 60 minute duration over 4 weeks and also night splinting (n = 32) vs. Control group was given vitamins B1, B6 and sham acupuncture. Also had night splinting (n = 32). Follow-Up at baseline 2 weeks and 4 weeks.	Global Symptom Score (GSS) acupuncture group vs. control group at Week 4: 14.6±5.4 (p <0.001) vs 22.5±8.9 (p = 0.17). Nerve Conduction Velocity at 4 weeks, Acupuncture vs control: 37.6±8.3 vs 33.2±5.9 (p <0.02)	“Our findings indicated that the acupuncture can improve the overall subjective symptoms of carpal tunnel syndrome and could be adopted in comprehensive care programs of these patients.”	Methodological details sparse.
Ho 2014 RCT Study supported by the grant of the National Science Council, China Medical University	1.5	N = 26 confirmed CTS via electrodiagnostic testing; mean age Acu Group: 49.5±9.7; Electro-Acu Group: 50.1±10.1	Acupuncture Group Given 24 sessions of 15 minute duration over 6 weeks (n = 15) vs. Electro-Acupuncture Group given same acupuncture points and sessions	Symptom severity scores baseline vs. 2 week follow-up. Electroacupuncture decreased significantly (p <0.02). Distal Motor Amplitude acupuncture group, baseline to 4 weeks after treatment. 6.49±2.70 to 7.62±2.87 (p =	“Despite the limitations in this study, we found that safety depth acupuncture and electroacupuncture could exert different positive therapeutic effects for patients with	Methodological details sparse.

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<p>Hospital, and Taiwan Department of Health Clinical Trial and Research Center of Excellence.</p>			<p>along with duration however stainless steel needle negative charged inserted in middle of wrist while positive was inserted in forearm. Follow-up at baseline, 2 weeks after treatment session and electrodiagnostic testing done 4 weeks after treatment.</p>	<p>0.02), Electro-Acu no significant increase. Shortened median sensory latency, baseline-4 week follow-up. Acu 3.70±1.15 to 3.22±1.02 (p = 0.04) vs electro-Acu not statistically significant. Median Nerve F wave mean latency, baseline to 4 weeks. Acu group 29.11±3.38 to 28.27±3.76 (p = 0.002) vs. electro-Acu no significant difference. Grip strength baseline to 4 weeks post treatment, Acu 23.3±9.85 to 27.88±12.44 (p = 0.01) vs electro-Acu no significant difference.</p>	<p>CTS. As evidenced by the improvement of Symptomology using electroacupuncture and improvements of grip strength, electrophysiological findings, and physical provocation sign of using acupuncture, the findings of this study provide references in clinical decision making when selecting proper treatment programs for symptomatic CTS patients.”</p>	
<p>Cai 2009 RCT No Mention of COI or sponsorship .</p>	<p>0.5</p>	<p>N = 98 cases of CTS all history of strain or traumatic injury of wrist joint. Mean age: Warm Needling Group Range 32-67 years; Control Group 35-71 Years old</p>	<p>Acupuncture group: warm needling techniques and Tuina relaxing manipulations . 10 30 minute sessions (n = 60) vs. Control Group Given</p>	<p>Clinically cured (clinical symptoms disappeared, movement restored, negative in Carpal canal irritating test. Acu group 49 (81.67%) vs control 18 (47.37% (p<0.01).</p>	<p>“Acupuncture plus Tuina manipulation is a simple therapy for carpal tunnel syndrome, but with remarkable therapeutic effects.”</p>	<p>Methodological details sparse.</p>

			block therapy with 10mg Triamcinolone A and lidocaine once every 3-5 days, Dibazol and Vitamin B1 were taken orally 3 times daily until trial over. (n = 38). Follow-up only mentioned only after 1 course of treatment. (no specific time frame)			
Low-level Laser Therapy						
Stasinopoulos 2005 RCT No mention of sponsorship or COI.	3.0	N = 25 with unilateral idiopathic carpal tunnel syndrome, mild to moderate nocturnal pain, and paraesthesia lasting >3 months. The mean age was 47.4 years.	Polarized polychromatic noncoherent light or Bioptron light administered perpendicular to carpal tunnel area for 6 minutes at operating distance 5-10cm from carpal tunnel area, 3x weekly for 4 and 6 weeks (n = 25). Outcome measures used were	At 4 weeks, 2 (8%) had no change in nocturnal pain, 6 (24%) were in slightly less nocturnal pain, 12 (48%) were much better in regard to nocturnal pain and 5 (20%) were pain-free. At 6 months, 3 patients (12%) were slightly better in regard to nocturnal pain, 13 (52%) were much better regarding nocturnal pain, and 9 patients	“Nocturnal pain and paraesthesia associated with idiopathic carpal tunnel syndrome improved during polarized polychromatic noncoherent light (Bioptron light) treatment.”	Open trial with sparse methodological details. Small sample size and no placebo group.

			participants' global assessments of nocturnal pain and paraesthesia, respectively, at 4 weeks and 6 months. Follow-up at 4 weeks, and 6 months.	(36%) were pain-free.		
Manipulation and Mobilization						
Pratelli 2015 RCT No mention of sponsorship or COI.	2.5	N = 70 symptomatic hands clinically diagnosed and electromyographically proven CTS. Mean age 54.2 (38-74)	Group 1 (n = 35) treated with Fascial manipulation (FM) 45 minute session 3x a week for 3 weeks vs. Group 2 (n = 35) Low Level Laser Therapy 5x a day for 10 minute sessions. Follow-up 10 days before treatment, and 1 week and 3 months after treatment.	BTCQ symptomatic and functional and Visual Analogue Scale scores baseline – first follow up, group 1: 3.027, 3.097, and 6.00 vs 1.362, 1.40, 0.80 (p <0.0001). Baseline vs second follow up 3.027, 3.097, and 6.00 vs 1.27, 1.31, 0.714 (p <0.0001). Group 2 BTCQ symptomatic and functional as well as Visual Analogue Scale baseline vs follow up 1: 3.52, 2.90, 5.51 vs 2.66, 2.58, 5.00 (p <0.001). Worsening of symptoms in group 2 from follow up 1 to 2.	“FM appears to be an appropriate treatment not only for musculoskeletal dysfunction but also for common nerve entrapments as in carpal tunnel syndrome. The method is effective and non-invasive. It gives excellent results for the relief of local symptoms and for restoring functionality with benefits that remain at three month follow up.	Methodological details sparse.
Heebner 2008	2.0	N = 61 with CTS confirmed	Group 1 (n = 28) standard	No statistical significance	“The results of this study	Methodological details sparse. High dropout rate.

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<p>RCT</p> <p>No mention of sponsorship or COI.</p>		<p>using Nerve Conduction Velocity testing; mean age 52 (32-75)</p>	<p>care provided by hospital (night splinting, tendon gliding exercises) vs. Group 2 (n = 32) same as group 1 but addition of neurodynamic mobilization exercise median nerve bias. Follow-up baseline, 1 and 6 months after initial treatment.</p>	<p>between the Disabilities of the Arm Shoulder and Hand scores and CTSW symptom severity scale (SSS). CTSQ functional scale (FSS) group 1 vs group 2, 2.2 vs 2.9 (p=0.016).</p>	<p>suggest that persons with CTS in a community hospital do not benefit from a one-time nonsurgical intervention that includes splinting instruction and standard tendon-gliding exercises alone or splinting and tendon gliding along with neural mobilization exercises.”</p>	
<p>Bialosky 2011</p> <p>RCT</p> <p>Study supported by grant from National Institutes of Health National Center for Complementary and Alternative Medicine.</p>	<p>1.5</p>	<p>N = 40 females; mean age for individuals with CTS: 40.75±10.38, 38.25 ± 12.32 for healthy individuals.</p>	<p>Group 1 (n = 20) with clinically diagnosed CTS (Tinnel’s, Phalen’s, Carpal Compression Tests) vs. Group 2 (n = 20) age matched and no sign of CTS. Follow-up 2x a week for 3 weeks.</p>	<p>No statistically significant change in outcome measures associated with Neurodynamic Intervention. Baseline relationship between clinical pain and pain sensitivity w/ signs and symptoms of CTS: MP flexor retinaculum after sensation 0.88 (p <0.01). Change in usual pain over 3 weeks in MP flexor retinaculum</p>	<p>“Participants with signs and symptoms of CTS differed from healthy age- and sex-matched controls in suprathreshold measures of pain sensitivity suggesting a central mechanism of pain. Immediate change in mechanical pain</p>	<p>Included both healthy subjects and those with CTS. Methods poorly described. Few meaningful results.</p>

				after temporal summation -0.57 (p = 0.05) and after sensation -0.55 (p = 0.01).	sensitivity and after sensation and 3-week change in temporal summation were associated with improvements in clinical pain intensity suggesting prognostic factors and a potential mechanism for improvement respectively”	
Massage						
Moraska 2008 RCT Sponsored by Massage Therapy Foundation (Evanston, IL) No mention of COI.	3.5	N = 27 with CTS for at least 6 months.	General massage (GM, n = 13) focused on reducing muscular tension and enhancing circulation to back, neck, and both upper extremities v. targeted massage (TM, n = 14) aimed at probable sites of nerve entrapment along afflicted upper	Grip strength: TM showed significantly greater strength increase compared to GM, p=0.04.; improvement for TM first seen after 7 th massage and maintained following 11 th massage and for at least 4 weeks after last treatment, p<0.01 for all time points.	“The results from this study suggest that massage therapy may be a useful part of a conservative care treatment regimen, although additional research support is needed.”	No meaningful differences between treatment groups. Small sample size (N=27).

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			extremity. 12 30 minute structured massage treatments over 6 weeks.			
Moraska 2010 RCT	3.5	Same as Moraska 2008	Same as above (Moraska 2008)	Same as above (Moraska 2008)	Same as above (Moraska 2008)	Same population as pilot report of Moraska 2008.
Therapeutic Touch						
Blankfield 2001 RCT Sponsored by grant from Ohio Academy of Family Physicians and General Clinical Research Center grant from NIH. No mention of COI.	1.5	N = 21 with electro diagnostically confirmed CTS. Mean age 57.4 for therapeutic touch treatment group, 55.2 for sham treatment.	Therapeutic touch (TT) group (n = 11) vs. sham (n = 10), 1x a week for 6 weeks. Follow-up period not mentioned.	Mean motor distal latencies (baseline/follow-up): TT (5.4±0.9/5.2±1.1ms) vs. sham (6.1±1.8/5.9±1.0ms), p >0.15. Pain/relaxation scores NS.	“[T]T was no better than placebo in influencing median motor nerve distal latencies, pain scores, and relaxation scores.”	Suggests lack of benefit. Small sample size. Methodological details sparse. Data concerning for possible randomization failure.
Ultrasound						
Ultrasound vs. Placebo						
Armagan 2014 RCT	3.5	N = 46 with CTS. Mean age: group 1: 45.20 years, group 2: 43.31	First group received 0 W/cm2 ultrasound treatment (placebo) (n =	Significant improvements in all groups as per post-treatment Functional Status Scale score (p	“The results of this study suggest that splinting therapy combined	Methodological details sparse. No differences seen between groups.

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<p>No mention of sponsorship. No COI.</p>		<p>years; group 3: 44.53 years.</p>	<p>15) Vs. second received 1.0W/cm² continuous ultrasound treatment (n = 16) Vs. third received 1.0 W/cm² 1:4 pulsed ultrasound treatment (n = 15). Administered for 5 days a week for a total of 15 sessions. All patients also wore night splints during treatment period. Follow up: not mentioned.</p>	<p><0.05 all groups), Symptom Severity Scale score (first group: p <0.05, second group: p <0.01, third group: p <0.001) and Visual Analogue Scale score (first and third groups: P<0.01, second group: p <0.001). Sensory conduction velocities improved in 2nd and 3rd groups (p <0.01). Distal latency in 2nd finger showed improvement only in 3rd group (p <0.01) and action potential latency in palm improved only in 2nd group (p <0.05)</p>	<p>with placebo and pulsed or continuous ultrasound have similar effects on clinical improvement. Patients treated with continuous and pulsed ultrasound showed electrophysiological improvement; however, the results were not superior to those of the placebo.”</p>	
<p>Oztas 1998 RCT No mention of sponsorship. No COI.</p>	<p>2.5</p>	<p>N = 18 females with CTS in 30 hands. Mean age: Group A: 53.2 years; Group B: 51.3 years; Group C: 49.0 years.</p>	<p>Group A: continuous ultrasound therapy with intensity of 1.5 W/cm² (n = 10) Vs. Group B: US therapy with intensity of 0.8 w/cm² (n = 10) Vs. Group C: US therapy with intensity of 0.0 W/cm² (n = 10). 5</p>	<p>Night pain/paresthesia before treatment/after treatment: Group A: 2.30±.68/1.40±.52; Group B: 2.60±.70/1.70±.82; Group C: 2.60±.69/1.40±.97. Mean distal latency: Group A: 5.85±1.87/6.00±1.95; Group B: 5.90±1.29/6.10±1.46; Group C:</p>	<p>“Ultrasound therapy in CTS was comparable to placebo ultrasound in providing symptomatic relief, and the probability of a negative effect on motor nerve conduction needs to be considered.”</p>	<p>Single blind (patient). Suggests ultrasound not effective. Small sample size of 18 women. Methodological details sparse.</p>

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			minutes, 5 days a week for 2 weeks.	5.60±1.61/5.36±1.48.		
Ultrasound vs. Other Treatments or in Combination(s)						
Duymaz 2012 RCT No sponsorship or COI.	3.5	N = 58 unemployed with CTS confirmed by provocation tests and EMG and symptoms of numbness, tingling, weakness, and pain in hands for at least 3 months but not more than 1 year. Mean age 51.85±7.29 years.	Group I: iontophoresis with dexamethasone 0.4% at a current 2 mA for 20 minutes (n = 20) vs. Group S: iontophoresis sham using water at current 2 mA for 20 minutes (n = 18) vs. Group U: underwater ultrasound 5 minutes per session using direct current at an intensity of 0.8 W/cm ² , 3 applications once a day 5x a week for 3 weeks (n = 20). All received: training on performing tendon and nerve gliding exercises to be completed for 3 sets of 10 everyday; ergonomic	Mean±SD VAS on movement difference between pre and post treatment values Group I vs. Group S vs. Group U: 2.75±1.71 vs. 0.66±1.13 vs. 1.30±1.83 (p<0.001). Mean±SD VAS at rest difference between pre and post treatment values Group I vs. Group S vs. Group U: 2.55±1.76 vs. 0.50±0.78 vs. 1.20±1.73 (p <0.001).	“Our study results suggest that dexamethasone iontophoresis administration combined with tendon gliding exercises, splint and activity modification is reliable and effective in the treatment of patients with mild CTS.”	Only differences observed are for VAS 2 point discrimination test and monofilament test.

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			training for daily living activities; and neutral wrist splinting at night. Follow-up after 3 months.			
Dincer 2009 RCT No mention of sponsorship. No COI.	2.5	N = 60 females with bilateral mild to moderate CTS diagnosis made by electromyography and clinical examination. Mean age 34 years for Sp, 30 years for SpUS, 36 years for SpLLL group.	Splinting only (Sp), (n = 40) vs. splinting + Ultrasound therapy, Total 10 US treatment sessions performed once a day, 5x a week, for 2 weeks (SpUS), (n = 40) vs. Splinting plus low level laser therapy (SpLLL), (n = 40) Follow up: 1st and 3rd month after treatment. Patients to wear splints at night for 3 months. Ultrasound therapy administered to each other for 3 minutes per session on area over carpal tunnel	After profile analysis (MANOVA), results showed improvements in SpUS and SpLLL groups were statistically significantly better than those in Sp group (p = 0.0429 and p = 0.0001, respectively). Also, difference between SpUS and SpLLL groups significant (p = 0.03). Both SpUS and SpLLL groups had statistically significantly better improvement than Sp group at 3 months (p = <0.0001 for both groups) On other hand, no significant differences between SpUS and SpLLL group profiles. VAS pain scores improved in all groups at 1 and 3 month compared	“In conclusion, the results of this study demonstrate the effectiveness of conservative treatments for mild to moderate CTS. Combining US or LLL therapy with splinting appeared to be more effective than splinting alone in our study. However, the combination of LLL therapy with splinting appeared to be superior to splinting plus US, especially for improvements in symptom	Methodological details sparse.

			at 3 MHz and intensity of 1.0W/ cm2 in continuous mode with transducer 5 cm2 in size with gel.	to baseline. Both SpUS and SpLLL groups' improvements significantly better than Sp group's improvement over time (p = 0.0001 for both). Also, SpLLL group showed significantly better improvement than did SpUS group.	severity, pain alleviation, and patient satisfaction. Further research with larger patient samples and longer follow-up periods are required to independently confirm our findings, and to determine the most effective doses and protocols for LLL and US therapies.”	
Iontophoresis/Phonophoresis						
Aygul 2005 RCT	3.5	N = 31 (56 hands)	Local steroid injection 1ml dexamethasone sodium phosphate vs. iontophoresis treatment with 1-4mA galvanic current and mixture of 0.1% dexamethasone sodium phosphate vs. phonophoresis frequency of 3 MHz and intensity of 1.0 W/cm2, with transducer of	Injection group had a steady significant improvement for all parameters except SNAPa, mTLI, and mMNCV at the first follow-up visit. Iontophoresis had significant improvements in the D4M-D4U and mTLL. Phonophoresis group had significant improvement of D4D-D4U and mMDL found 2	“Steroid injection in CTS is more effective than iontophoresis and phonophoresis treatment in the short- to medium-term in patients with mild to moderate idiopathic CTS, and that the most sensitive neurophysiologic parameters at follow-up were D4D-D4U and	Random in abstract, but nowhere in methods.

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			5cm ² , including mixture of 0.1% dexamethasone sodium phosphate	months after treatment.	D2M-D5U, which are objective parameters indicating the outcome of CTS treatment.”	
Gurcay 2012 RCT No mention of sponsorship or COI.	3.5	N = 52 with CTS analyzed based on clinical and electrophysiological criteria. Mean age 43.7±8.4 (range 24-57) years.	Group I, phonophoresis, 0.1% betamethasone applied over area of CT at frequency of 1 MHz and an intensity of 1 W/cm ² , plus wrist splint (n = 18) vs. Group II, 0.1% betamethasone iontophoresis from positive electrode at dosage of 2 mA for 10 minutes/day, plus wrist splint (n = 18) vs. Group III or control, instructed to use wrist splint alone (n = 18). Follow-up at 3 months.	At 3 months (T1), Boston Symptom Severity Scale (BSSS) improved in group I (p < 0.001), group II (p = 0.001), and group III (p < 0.001) compared to baseline (T0). Grip strength, and nine-hole peg test (NHPT) in all groups; I, II and III at 3 month vs baseline improved, (p > 0.05). A significant difference between groups for BSSS, F = 4.599, (p = 0.015). No statistical difference between groups for grip strength at T0 and T1, X ² = 2.546, (p = 0.280).	“Symptom severity improved in all groups after treatment, but no superiority was determined among the treatment groups with respect to motor skills and hand dexterity.”	Sparse baseline data and comparable efficacy.
Carpal Tunnel Injections						
Aygul 2005	3.5	N = 31 (56 hands)	Local steroid injection 1ml	Injection group had a steady	“Steroid injection in	Random in abstract, but nowhere in methods.

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RCT			dexamethasone sodium phosphate vs iontophoresis treatment with 1-4 mA galvanic current and mixture 0.1% dexamethasone sodium phosphate vs Phonophoresis frequency 3 MHz and an intensity 1.0 W/cm2, with transducer of 5 cm2, including mixture of 0.1% dexamethasone sodium phosphate	significant improvement for all parameters except SNAPa, mTLI, and mMNCV at the first follow-up visit. Iontophoresis had significant improvements in the D4M-D4U and mTLI. Phonophoresis group had significant improvement of D4D-D4U and mMDL found 2 months after treatment.	CTS is more effective than iontophoresis and phonophoresis treatment in the short- to medium-term in patients with mild to moderate idiopathic CTS, and that the most sensitive neurophysiologic parameters at follow-up were D4D-D4U and D2M-D5U, which are objective parameters indicating the outcome of CTS treatment.”	
Gurcay 2012 RCT No mention of sponsorship or COI.	3.5	N = 52 with CTS analyzed based on clinical and electrophysiological criteria. Mean age 43.7 ± 8.4 (range 24–57) years.	Group I, phonophoresis, 0.1% betamethasone applied over CT at frequency 1 MHz and intensity 1 W/cm2, plus wrist splint (n = 18) vs. Group II, 0.1% betamethasone	At 3 months (T1), Boston Symptom Severity Scale (BSSS) improved in group I (p <0.001), group II (p = 0.001), group III (p <0.001) vs. baseline (T0). Grip strength, and 9-hole peg test (NHPT) in groups; I, II and III at 3 month vs. baseline improved (p >0.05).	“Symptom severity improved in all groups after treatment, but no superiority was determined among the treatment groups with respect to motor skills and hand dexterity.”	Sparse baseline data and comparable efficacy.

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			iontophoresis from positive electrode at 2 mA for 10 minutes/day, plus wrist splint (n = 18) vs. Group III or control, instructed to use wrist splint alone (n = 18). Follow-up at 3 months.	Significant difference between groups for BSSS, F = 4.599, (p = 0.015). No statistical difference between groups for grip strength at T0 and T1, X2 = 2.546, (p = 0.280).		
Seok 2013 RCT No mention of sponsorship. No COI.	3.5	N = 36 with CTS with positive Tinel sign or Phalen test, and numbness and tingling at least two of first, second and third digit. At least 19 years of age.	Extracorporeal shock wave therapy or ESWT group one session with 1000 shocks at a frequency of 360 shocks per minute (n = 15) vs. Local corticosteroid or CS injection group received 1 milliliter of triamcinolone acetate 40mg (n = 16). Follow-up at 3 months.	VAS score of 7.06±1.89 in ESWT group vs 6.87±1.26 in CS injection group. VAS score improvement at 1 month/3 months; 4.56±0.81 in ESWT vs 4.13±1.50 CS group/4.18±1.05 vs 3.31±1.82. Symptom severity score at 1 month; 20.13±6.24, (p <0.05) and at 3 months; 19.73±4.48 vs 18.25±3.71 CS group, (p <0.05). Significant difference between ESWT and CS groups found only at median sensory distal latency 1	“ESWT can be as useful as CS injection for relieving symptoms of carpal tunnel syndrome.”	Methodological details sparse. Subjective improvements in both treatments but no differences between groups.

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				months after treatment.		
Sevim 2004 Prospective randomized and blinded trials	3.0	N = 120 EDX confirmed	Betamethasone injections 4cm proximal to carpal tunnel vs. injections distal to carpal tunnel vs. just splinting vs control	“Splinting provided symptomatic relief and improved sensory and motor nerve conduction velocities at the long-term follow-up when the splints were worn almost every night. Proximal and distal injections of steroids were ineffective on the basis of both clinical symptoms and electrophysiologic findings.”	Steroid injections may be beneficial short-term in mild and moderate CTS. However, splinting provided long term symptomatic relief and improved sensory and motor nerve conduction.	
Kamanli 2011 RCT No mention of sponsorship or COI.	2.5	N = 19 with bilateral CTS. Mean age for groups PIG and DIG: 42±10 and 52±13.	Proximal approach steroid injection group (PIG), with triamcinolone acetonide 20 mg (n = 10) vs. Distal approach steroid injection group (DIG), with triamcinolone acetonide 20mg (n = 9). Follow-up for 3 months.	BCTS / VAS-pain (0-10) / and HAQ at baseline and 3 months: 66.7 ± 12 and 31.6 ± 8.2 at 3 months vs 51.7 ± 14.7 and 34.9 ± 16 in DIG group/8.5 ±1.1 and 3.3 ± 2 vs 8.3 ± 1.7 and 3.9 ± 2.2 / and 0.97 ± 0.38 and 0.43 ± 0.22 vs 0.63 ± 0.53 and 0.29 ± 0.14.	“[S]teroid injection from distal approach (palmar) into the carpal tunnel on patients with CTS is very comfortable, easy, effective and alterative.”	Small sample size, all bilateral CTS patients. Conflicting information on splinting: “All patients used hand-wrist splint during 3 weeks after injection” and “Co-interventions such as splinting were withheld for the duration of the study”

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<p>Stepić 2008</p> <p>RCT</p> <p>No mention of sponsorship or COI.</p>	<p>1.5</p>	<p>N = 40 with CTS. The mean age of 51.6 years.</p>	<p>Group 1: surgical decompression of median nerve by open release of carpal tunnel (n = 20) vs. Group 1: perineural injection 1ml betamethason immediately after surgical decompression (n = 20). Follow-up 7, 30, and 90 days.</p>	<p>90 days after surgical procedure, both groups showed statistically significant better results in second group (t = -2.116; p = 0.043). Final measurements did not show statistically important difference between treatment methods applied, SCS1 = 45.347 msec in first group vs SCS2 = 47.673 msec in second group.</p>	<p>“Intraoperative application of the corticosteroid injection during the surgical decompression results in faster regaining of conduction speed of the median nerve.”</p>	<p>Methodological details sparse.</p>
<p>Surgery</p>						
<p>Worseg 1996</p> <p>Two consecutive case series</p>	<p>4.0</p>	<p>N = 126 EDS confirmed</p>	<p>64 surgeries treated endoscopically vs. 62 surgeries by open release of carpal ligament.</p>	<p>“No significant differences between the groups were obtained regarding postoperative symptom severity.”</p>	<p>“The new device provides a reliable tool for single portal carpal tunnel release, although the risk of inadvertent damage to the neurovascular structures always remains a possibility with the endoscopic carpal tunnel technique.”</p>	<p>Labeled as prospective clinical study. Not an RCT. Two consecutive case series compared.</p>

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Demirci 2002 RCT	4.0	N = 90 EDS confirmed	Intracarpal betamethasone 6.4mg injections at Weeks 0 and 2 vs. open CTR	Boston questionnaire symptoms scale (0/3/6 months): open (3.4±0.7/1.3±0.3/1.3±0.3) vs. steroid (3.3±0.7/1.5±0.5/1.7±0.8), NS months 0-3 and p = 0.003 at 6 months.	Conservative steroid treatment provides short term improvement compared to surgery. It is relatively easy to apply, has a lower cost and comparable results short term and may be considered before surgery is done.	Study does not describe a randomization process. Thus, although scored low-moderate quality, study is classed as low quality. Data suggest symptoms reduced with both treatments at 6 months, but modestly favor CTR at that point.
Nitz 1989 RCT	3.5	N = 60	Open surgery vs. surgery with tourniquet	“Three weeks after the operation 77% of the patients in the tourniquet group had denervation in other than thenar muscles. Only one patient in the control (no tourniquet) group had similar electromyographic abnormalities after surgery. Tourniquet time and pressure did not vary significantly between those patients with or without postoperative forearm denervation. Mean operative time for the tourniquet and	“These findings indicate that upper extremity tourniquet application results in subclinical, temporary changes in the muscles of the forearm, probably on the basis of nerve changes and denervation.”	

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				control groups was nearly identical.”		
Brüser 1999 RCT	3.5	N = 80 with CTS	Short (2.5cm) vs. long (4.5cm) incision	Baseline differences including longer symptoms in short incision group (48.1 vs. 33.8 months).	“The long incision resulted in a significant 10% loss of strength only at week three, otherwise no significant difference was found between the results of the two groups.”	Some patients apparently had neurolysis and some epineurolysis, which was unstructured.
Mackenzie 2000 RCT	3.5	N = 26	Open surgery vs. endoscopic methods	Grip strengths (baseline/weeks 1/2/4): endoscopic (43/29/42/44) vs. open (39/21/29/30) (p <0.01 at 2 and 4 weeks).	“Endoscopic carpal tunnel release provides faster recovery of strength than short-incision open carpal tunnel release and improves early postoperative comfort and function to a small degree.”	
Borisch 2003 RCT	3.5	N = 273 EDS confirmed	Open CTR with vs. without epineurotomy	Paraesthesias present in 93% of epineurotomy group at baseline; declined to 17%	“Study showed no significant difference in the recovery of sensory	Dropout rates were high.

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				at 3 months vs. controls' 89% which declined to 8%. EDX changes not significant.	conduction velocity and distal motor latency after open decompression of the median nerve or open decompression combined with epineurotomy. Thus epineurotomy does not appear to have any effect on neurophysiological median nerve recovery after open carpal tunnel decompression .”	
Finsen 1999 RCT No mention of sponsorship or COI.	3.5	N = 74 (82 wrists) on whom open carpal tunnel release performed. Mean age 48 in mobilized group; 51 in immobilized group.	Mobilized Group: light dressing and told to move wrist and fingers as comfort allowed. (n = 45) vs. Immobilized Group: well-padded plaster of Paris splint with wrist in slight dorsiflexion. (n = 37). Follow-up at 2 and 6	Post-op VAS pain scores indicated patients in both groups benefited from post-op treatments. But no significant differences in mean VAS pain score at any time point for mobilized vs. immobilized; Pre-op 56mm vs. 51mm; 2 weeks 6mm vs. 5mm; 6 weeks 6mm vs. 2mm; 6 months 3mm vs. 2mm.	“Thus immobilization confers no advantage with regard to regress of the original complaints postoperatively . Nor did immobilization reduce the frequency of common complications, such as scar or pillar pain.”	No advantage to splinting after carpal tunnel release surgery.

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			weeks, and 6 months.			
Hansen 2009 RCT No mention of sponsorship or COI.	3.5	N= 47 (54 hands) diagnosed with idiopathic CTS who required release of carpal tunnel. Mean age 48 years.	Novafil Group- Interrupted non-absorbable sutures. 5/0 monofilament polybutester (n = 26 hands) vs. Caprosyn Group- Continuous absorbable subcuticular 4/0 monofilament polyglytone sutures. (n = 28 hands). Follow-up assessed daily in patient’s journal until sutures removed 10-14 days after surgery. Pain monitored through this period. Cosmetic appearance measured at 3 months.	VAS pain score significantly lower in Caprosyn group vs. Novafil group at post-op day 1 (p = 0.04) and post-op day 2 (p = 0.02). However, difference in VAS pain score not significant at any other time point. Caprosyn group showed better cosmetic result with 25/28 hands showing nice appearance when being evaluated by surgeon vs. 18/26 in Novafil group. However, this difference not significant (p = 0.14).	“There was a significant reduction in pain scores on days 1 and 2 in the patients treated with an absorbable continuous subcuticular suture, and no difference in inflammation or infection. There was no difference in the cosmetic appearance between the two groups after three months.”	Sparse methodological details. At 3 months, comparable results.
Cellocco 2005 RCT	3.5	N = 185 affected by mild to moderate median nerve	Group A: Mini-open blind technique using	Group A returned to work significantly quicker in mean days than group	“Our study suggests that the mini-open blind CT release can be	Short follow up period (19 months) favored transverse procedure, but at 30 months the differences between groups decreased. Group A experienced shorter recovery rate and less pain & numbness.

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No sponsorship or COI.		compression. 222 carpal tunnel release procedures performed on 185. Mean age 59 years.	Knifelight (n = 82, 99 procedures) Vs. Group B-limited open technique (n = 103, 123 procedures). Follow-up at 19 and 30 months following surgery.	B; 16.6 days vs. 25.4 days (p <0.001). Mean score for first section of Boston Carpal Tunnel Questionnaire (BCTi) significant at 19 months for group A vs. B; 1.46 vs. 2.04 (p <0.001). Second section scores BCTi also significant at 19 months; 2.02 vs. 2.53 (p <0.001). No significant differences between groups at 30 month follow-up.	a safe procedure, even when performed using a small transverse wrist incision.”	
Heidarian 2013 RCT No sponsorship or COI.	3.5	N = 59 with indication for carpal tunnel release. Mean age 47.6 years.	Open Group: Open carpal tunnel release surgery (n = 30) vs. Knifelight Group: (n = 29). Follow-up immediately after surgery and 3 weeks and 6 months.	Knifelight group vs. open group showed significantly shorter operation time; 8.5 min vs. 21 min (p <0.001), significantly shorter mean scar length (mm); 14.8mm vs. 40.7mm (p <0.001). Knifelight also significantly quicker return to daily activity vs. Open; 34.4 days vs. 51.9 days (p = 0.015). VAS pain score at 3 weeks	“In conclusion according to the results of this study, compared to the open release method, Knifelight technique could significantly decrease the mean duration of surgery, incision length and time to return to work.”	Sparse methodological details. Short follow-up time (3 weeks). Knifelight “appears” to decrease surgical time, scar length and time to resume normal activities, but pain ratings for both groups were comparable.

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				not significant between groups (p = 0.24).		
Ucar 2012 RCT No mention of sponsorship or COI.	3.0	N = 90 with CTS syndrome. Mean age 46.75 years.	G1 Group-Distal approach. A 2 cm vertical incision on the ulnar side of the thenar crease beginning at the distal wrist crease. (n = 45) Vs. G2 Group-Proximal approach. A 2 cm vertical incision made on the ulnar side of the palmaris longus tendon, beginning proximal to wrist crease. (n = 45) Follow-up at one month. Final follow up mean 30.4 months in G1 and 31.0 months in G2.	Boston Carpal Tunnel questionnaire scores used for assessment. Both groups increased significantly in Symptom and Functional scales from baseline from pre-op to 1 month follow up (p <0.001) and from 1 month follow-up to final follow-up (p <0.001). Functional and Symptom scores not significant between groups at any follow-up period (p >0.05). G2 showed significantly shorter mean operation time vs. G1; 10.7 min vs. 18.6 min (p <0.001). G2 also significantly less scar tissue pain vs. G1; 6.7% vs. 24.4% (p = 0.02).	“Finally, the absence of relapse and good clinical results make both surgical techniques used in this study suitable. For this reason, we consider that the selection of the mini-surgical technique used should depend on the experience and skill of the surgeon.”	Sparse methodology and short follow-up time (1 month). Mean surgical time and scar tissue pain were less in group 2 (the 2 cm proximal incision group).
Kang 2008 RCT	3.0	N = 72 with diagnosed CTS. Mean age 34.8 years.	Arthroscopic Excision Group- 2 stab incisions at standard 3-4	Main outcome ganglion recurrence. At 2nd follow-up, arthroscopic	“Although other patient-preferred benefits such as improved	High drop out rate. At 12 months, recurrence rates between these two procedures are comparable and arthroscopy is not superior to open procedure.

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No sponsorship or COI.			and 4-5 portal sites (n = 41) vs. Open Excision Group- Transverse skin incision 2 to 3cm in length (n = 31). First follow-up 5-7 days. Second 4-8 weeks, final follow-up at 12 months.	group 1 ganglion recurrence vs. 0 in open group (p = 0.381). Not significant at final follow up. One post-op complication in arthroscopic group vs. open group, but not significant (p = 0.381).	earlier return of motion may still exist, the results of our study suggest that the technique of arthroscopic surgery does not achieve superior rates of ganglion recurrence.”	
Tian 2007 RCT No mention of sponsorship or COI.	2.5	N = 62 (70 hands) with CTS. Mean age 52 years.	Endoscopic Group- One-portal endoscopic release (n = 32, 34 hands) Vs. Open Group- Open carpal tunnel release. (n = 30, 36 hands). Follow-up assessments taken at 3 months and final follow-up ranged from 18 to 48 months.	No significant difference between endoscopic and open groups for 2-point discrimination score at 3 months; 5.3 vs. 5.9 (p >0.05). Rate of scar tenderness significantly lower in Endoscopic group vs. Open Group; 36.0% vs. 65.0% (p <0.05). Mean operation time significantly lower in Endoscopic Group vs. Open Group; 12 vs. 38 minutes (p <0.01).	“The endoscopic carpal tunnel release is a reliable method in the treatment of idiopathic carpal tunnel syndrome. It has the advantages of slight scar tenderness, less operation time, less in-hospital stay, early functional recovery, safety and high satisfaction compared with open methods.”	Sparse methodology.
Anesthesia during Surgery						

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<p>Sorensen 2013</p> <p>RCT</p> <p>No sponsorship or COI.</p>	<p>3.5</p>	<p>N = 38 requiring endoscopic carpal tunnel release verified using neurophysiological testing; Mean (range) age 49 (31-76) for LA group and 52 (36-69) for IVRA group.</p>	<p>Local anesthesia group receiving 10ml (4mL given in proximal direction under subcutaneous fascia, 4mL subcutaneousl y in palm and 2mL subcutaneousl y in the distal wrist crease) Ropivacaine (n = 19) vs. Intravenous regional anesthesia group receiving 1% Mepivacaine (n = 19). Assess at baseline, during surgery, immediately after surgery, 2 hours and 24 hours post-op.</p>	<p>Immediately after surgery and 2 hours post-op, significant differences in mean (SD) VAS hand pain reported between LA and IVRA group: End of surgery: 0.2 (0.6) vs. 1.4 (1.8), (p <0.05), 2 hours post-op: 0.2 (0.5) vs. 1.4 (1.8), (p <0.05). During drug administration and immediately after surgery, significant differences in mean (SD) VAS arm pain reported between LA and IVRA groups: During administration: 2.1 (2.6) vs. 4.3 (1.7), (p <0.05), End of surgery: 0.6 (0.9) vs. 2.4 (2.3), (p <0.05).</p>	<p>“[L]A is generally a safe and effective method for ECTR after installing the LA in the subcutaneous tissue and under the subcutaneous fascia (in a proximal direction) alone, without installation of LA into the carpal tunnel...LA was more effective than IVRA at reducing patient-experienced overall pain at the end of the operation and pain in the hand 2 hours later. Furthermore, patients required less additional analgesia after surgery with LA than those treated under IVRA.”</p>	<p>Follow up time of 24 hours</p> <p>Methodological details sparse</p>
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<p>Lee 2013</p> <p>RCT Double-blind</p> <p>Sponsored by the Seoul National University Hospital research fund. No COI.</p>	<p>2.5</p>	<p>N = 25 (50 hands) with bilateral carpal tunnel syndrome; Mean (\pmSD) age 57 (\pm10) for all participants.</p>	<p>Right handed injection (n = 25 hands) vs. Left handed injection (n = 25 hands). All participants received allocated hand treatment upon randomization, followed by treatment on opposite hand 6-12 weeks later. Assessment at baseline and after each injection.</p>	<p>In comparison of mean (\pmSD) unadjusted VAS scores and adjusted VAS scores for buffered and non-buffered lidocaine, there were significant differences: Buffered lidocaine unadjusted- 4.60 (\pm1.50), adjusted- 4.63 (\pm1.32), vs. Nonbuffered lidocaine unadjusted- 6.48 (\pm1.53), adjusted- 6.61 (\pm1.68), (p <0.001) and (p <0.001).</p>	<p>“[T]he results proved the buffered lidocaine could reduce the pain experienced during local anesthetic injection before carpal tunnel release.”</p>	<p>Methodological details sparse. Small sample size (N=25)</p>
<p>Braithwaite 1993</p> <p>Randomized trial (?)</p> <p>No mention of sponsorship or COI.</p>	<p>2.5</p>	<p>N = 23 requiring carpal tunnel release; Participant ages not reported.</p>	<p>0.5% Bupivacaine injection alongside 1:200,000 adrenaline without tourniquet (n = 23 arms) vs. 0.5% Bupivacaine alone and pneumatic tourniquet (n = 23 arms). All received both treatments, but on randomized arms.</p>	<p>During procedure, participants demonstrated higher mean (SD) VAS pain scores with tourniquet compared to adrenaline limb: 4.7 (2.8) vs. 2.3 (1.7), (p <0.01). Participants’ symptom diaries had no difference in paresthesia, post-op pain or bruising when comparing adrenaline and tourniquet limbs 14 days post-op.</p>	<p>“The use of adrenaline-containing local anaesthetic provides a satisfactory operative field, avoids the discomfort of a tourniquet and allows bilateral simultaneous carpal tunnel release to be accomplished without the need for general anaesthesia.”</p>	<p>There was no control group. Participant arms were only randomized. Methodological details sparse</p>

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			Assessments at baseline, post-op and 14 days.			
Ozer 2005 RCT No mention of sponsorship or COI.	2.5	N = 40 requiring surgical decompression of carpal tunnel. Mean age 48.2 (30-64) alkalised group; 52.8 (42-67) non-alkalised group.	Alkalised group received 10ml prilocaine hydrochloride 2% buffered with 1ml sodium bicarbonate 8.4% (n = 20) vs. non-alkalised group receiving 10ml prilocaine hydrochloride 2% (n = 20). Assessment baseline, hourly for 6 hours post-op and 12 hours.	At 1, 3, 6, 12 hours post-op, alkalised group exhibited significantly lower mean (SD) VAS scores vs. non-alkalised: 1 hour- 0 vs 0.5 (0.52), (p = 0.02), 3 hours- 0.12 (0.35) vs. 1.75 (1.05), (p = 0.001), 6 hours- 1.12 (0.35) vs. 2.16 (1.33), (p = 0.036), and 12 hours- 2.12 (0.83) vs. 2.75 (0.75), (p = 0.06).	“Buffered prilocaine provides a longer pain-free period for patients following surgical decompression of the median nerve. It is easy, safe, and cost-effective and it appears that the routine use of alkalised prilocaine solution in patients undergoing carpal tunnel surgery may improve the comfort and prolong the duration of analgesia.”	Follow up of 12 hours. Methodological details sparse.
Watts 2004 RCT No mention of sponsorship or COI.	1.5	N = 64 undergoing local anesthesia for open carpal tunnel decompression; Mean (range) age 57 (28-89) years for both groups.	Buffered lidocaine group receiving 5ml of 2% plain lidocaine plus 0.5ml sodium bicarbonate 8.6% (n = 32) Vs. Plain lidocaine	Although both groups reported pain improvement, here were no statistically significant results reported between groups for mean VAS pain scores,	“[T]he pain of injection is not actually a major problem for most patients undergoing carpal tunnel decompression and there is no benefit in	Methodological details sparse.

			group receiving 5ml of 2% plain lidocaine plus 0.5 ml of sodium chloride 0.9% (n = 32). Assessments at baseline and post-op.	verbal pain scores or anxiety scores.	injecting buffered lidocaine. The pain scores for both groups were low and most patients reported that they were “not at all” anxious about having a similar injection again in the future. We did however note a correlation between increased pain score and increased anxiety about future injections.”	
Watts 2005 RCT No mention of sponsorship or COI.	1.5	N = 86 undergoing local anesthesia for open carpal tunnel decompression; Mean (range) age 56 (30-83) for both groups.	27-gauge dental needle group (n = 46) vs. 23-gauge needle group (n = 40). Both groups received 4.4ml of 2% xylocaine with adrenaline 1:80,000 with pre-filled 2.2ml vials. Assessments at baseline and post-op.	Participants receiving injection via 27-gauge dental needle had significantly lower mean (SEM) VAS pain scores vs. standard 23-gauge needle: 22 (2.4) vs 33 (3.8), (p <0.02). Not significant when analyzing verbal response scale. Participants also self-reported less mean (SEM) anxiety with 27-	“[P]atients reported less anxiety about future injections when the pain of the injection was reduced.”	Methodological details sparse.

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				gauge needle vs. 23-gauge: 7 (1.4) vs. 15 (3.4), (p <0.05).		
Yiannakopoulos 2004 RCT No sponsorship or COI.	1.5	N = 64 requiring carpal tunnel decompression verified by electrodiagnostic and clinical evidence alongside local anesthesia; Mean (SD) age 61 (8) years for all participants.	Group A; Lidocaine 1% mixed with normal saline group (n = 20) Vs. Group B; 10ml alkalized lidocaine 1% at room temperature (22°C) (n = 22) Vs. Group C; 10 ml alkalized lidocaine warmed in 40°C water bath for 30 minutes (n = 22) All groups received allocated treatment into palmar skin. Assessments at baseline and post-op.	Mean (SD) infiltration pain scores were significantly lower in Groups B& C compared to Group A: A- 21(11) & 42 (12), B- 25 (12) & 19 (7) vs. C- 21 (4) & 10 (4), (p<0.001). Group C also had significantly lower values compared to Group B, (p<0.001).	“We have found that buffering lidocaine with bicarbonate and warming the anesthetic solution helps to reduce pain on infiltration in patients undergoing carpal tunnel decompression .”	Methodological details sparse.

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Carpal Tunnel Injections										
Karaahmet 2017 (Score=3.0)										Methodological details sparse.
Glucocorticosteroid vs. Surgery										
Sabor 2015 (Score=2.0)	Injection/Decompression	RCT								Methodological details sparse. No difference.
Splinting vs. Steroid vs. Surgery										
So 2018 (Score=3.0)	Splint/Steroid	RCT								Methodological details sparse. Only significant difference was for patient satisfaction.
Carpal Tunnel Release vs Non-surgical Therapy										
De Kleermaeker, 2017 (score=3.0)										Methodological details sparse. Non-surgical treatments not defined and may have been usual care biased. Data suggest surgical intervention may be better than nonsurgical splint or injection for EDS normal median sensory issues consistent with CTS.
Endoscopic vs. Open Release										
Michelotti, 2014 (score=3.5)										Methodological details sparse, small sample size. No meaningful differences between surgical approaches.
Zhang, 2015 (score=3.5)										Excluded all patients who could not complete follow up. No reporting of dropout. No adjustment for multiple comparisons.

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Rab 2006 (score=2.5)										Small sample size, methodological details sparse.
Malhotra 2007 (score=2.5)										Methodological details sparse.
Incisional and Other Intraoperative Techniques										
Castro-Menéndez 2016 (score=3.0)										Methodological details sparse. No statistically significant differences between groups.
Anesthesia during Surgery										
Sørensen 2012 (score=3.0)										Methodological details sparse.

MALLET FINGER

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Splinting						
Gruber 2014 RCT No mention of sponsorship. No COI.	3.5	N = 51 with fractured or unfractured mallet finger. Mean (±SD) age 49 (±14) for splint group and 51 (±14) for control group.	Full-time custom-made thermoplastic splint group (n = 25) vs. No splint control group (n = 26). Follow up at 4 weeks.	No significant differences reported between splint and control groups for average final extensor lag, disability or treatment satisfaction.	“[T]here is not much benefit to additional night splinting after completing the standard splinting protocol for mallet finger. The extra cost and time associated with obtaining a custom-made removable splint should be balanced with the patient’s preferences. It is possible that a subset of patients might benefit from night splinting, although we did not find any such trends in our data. Patients should be aware that effective treatment of a mallet finger results in a slight extensor lag in	Data suggests night splinting did not improve mallet finger outcomes in terms of extensor lag, disability or treatment satisfaction.

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					most patients and a substantial probability of a lag of 20 degrees or greater.”	
Garberman 1994 RCT	2.5	N = 75 excluded large fractures	Stack splint vs. Dorsally placed aluminum-foam splint. Splinted continuously for 6-10 weeks, then nightly for 4 weeks.	Splint treatment success (with no more than 10° extensor lag) in 17 of 21 (81.0%) in early group and 15 of 19 (78.9%) in delayed splint group. Fractures and type of splint immaterial.	“Splinting was as effective in the delayed treatment population as it was in the early treatment population.”	Study design unclear as described as both retrospective and randomized. Dropout rate also unclear.
Kinninmonth 1986 RCT	2.5	N = 44	Perforated vs. stack splint. Splinted at least 6 weeks.	Successes were 79% Stack vs. 84% perforated splint.	“The perforated mallet finger splint can produce consistently good results even in those patients who would not tolerate a conventional splint. The fact that it is unnecessary to remove it for hygiene purposes is to its advantage.”	High success rates, but methods sparse.

Surgery											
Gruber 2014 (score=3.5)											Data suggests night splinting did not improve mallet finger outcomes in terms of extensor lag, disability or treatment satisfaction.
Batibay 2017 (score=2.5)											Small sample size. Methodological details sparse.

FLEXOR TENDON ENTRAPMENT (TENOSYNOVITIS AND TRIGGER DIGIT)

Injections											
Shinomiya 2016 (score=3.0)											Methodological details sparse

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Gutierrez 2015 (score=2.5)										Methodological details sparse
Ammitzboll-Danielson 2016 (score=2.5)										Methodological details sparse
Surgery										
Kloeters 2016 (score=2.5)										Methodological details sparse.

EXTENSOR COMPARTMENT TENOSYNOVITIS

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Glucocorticosteroid Injections						
Sawaizumi 2007 RCT	3.0	N = 36	Intra-sheath triamcinolone injection (1ml TC and 1ml of 1% lidocaine hydrochloride)	The 1-point injection excellent in 9 hands (50%), and 2-point injection excellent in 15 hands (75%); p <0.001).	Accurate injection of triamcinolone into sheath of both extensor pollicis brevis and abductor pollicis longus tendon considered very effective for deQuervain’s disease.	Selection for treatment based on consecutive cases rather than randomization.
Avci 2002 RCT with pseudo-randomization	3.0	N = 19 wrists (18 females) with de Quervain’s positive Finkelstein’s. All pregnant or lactating.	Glucocortico-steroid injection (methylprednisolone 10mg plus 0.5mL 0.5% bupivacaine vs. thumb spica splint. Follow-up until asymptomatic and had stopped nursing (mean 12 months).	Complete relief in 100% of injection group vs. 0% splint group, though pain reportedly relieved while wearing splint. Recurrences in one injected patient.	“Splinting does not provide satisfactory pain relief.”	Population was pregnant or lactating. Small sample size. Sparse details. Randomization was every other. Data suggest injection superior to splinting.
Kosuwon 1996 RCT	2.0	N = 140 with de Quervain’s. Duration of symptoms unstated.	Steroid injection (dose and medication not specified) with vs. without wrist immobilization	Satisfactory results in 74% splinted vs. 75% unsplinted (NS). Lost days in splinted group mean 28 vs. 11, p<0.05.	“There is no difference in the results of treatment in this condition whether the patients were immobilized in a splint or not. However, the days lost from work in the group of non immobilization is less than the group of immobilization.”	Abstract only. Sparse details. Results suggest no difference in outcomes whether wrist immobilized after injection or not.
Witt 1991 Prospective Cohort/Case Series	1.5	N = 95 (99 wrists) with de Quervain’s.	One mL injection of 1% lidocaine plus methylprednisolone acetate 40mg.	54% satisfactory. 30 wrists required surgical release. 22/30 (73%) of operated wrists had separate EPB compartment.	“Injection of one milliliter of a 1 per cent lidocaine solution and one milliliter of a suspension containing forty milligrams of methylprednisolone acetate. Twelve patients (twelve wrists) were lost to follow-up. Of the remaining	Not randomized trial. Primary purpose was to assess steroid flare. 73% of treatment failures had separate compartment for extensor pollicis

		Symptom duration unstated	Minimum 12 months follow- up.							eighty-seven wrists, fifty-four (62 per- cent) had a satisfactory outcome at a mean of eighteen months (minimum follow-up, twelve months). The duration of symptoms before treatment did not affect the outcome.”	brevis. Baseline symptom duration not predictive.
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MRI

Handidy 2009 (score=2.5)											Data suggests US is of value to validate clinical diagnosis of DeQuervain’s tenosynovitis but MRI may be beneficial in confirming cases not confirmed by US and detects other soft tissue changes but is more costly than US.
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RADIAL NERVE ENTRAPMENT

Electrodiagnostic Testing

Verhaar 1991 (score=3.5)											Data suggest patients with radial tunnel syndrome do not have evidence of compression in the posterior interosseous nerve
Spindler 1990 (score=3.0)											Small sample size (N=30) Data suggest value in stimulating the musculocutaneous nerve at the elbow when evaluating RNE.

**NON-SPECIFIC HAND, WRIST, AND FOREARM PAIN
Electrodiagnostic Studies**

Author/Year Study Type Conflict of Interest (COI)	Score	Study Design	Population/ Case Definition	Investigative Test	Gold Standard / Comparative Test	Results	Conclusion	Comments
Calder 2009 Diagnostic	3.5	Diagnostic	N = 46 (22 asymptomatic control subjects, 8 at-risk subjects, and 16 subjects with non-specific arm pain. Mean age 38.1 years.	Surface electromyographic (SEMG) activity	Comparing controls with patients and patients at risk.	Age significantly different among groups; control subjects significantly younger (p <0.05). Mean spike amplitude (MSA) significantly increased by 039 mV across all levels of % maximum contraction in patients with NSAP, showing 325% increase (p <0.05). At-risk group showed significant increase of 0.43 mV (430%) from 10% to 70% of MVC (p <0.05). In healthy controls MSA increased 1.1 mV (550%) from 10 to 70% of MVC (p <0.05).	“The NSAP group presented with differences in how the spike shape measures change with increasing contraction level that may be indicative of myogenic changes, a result that is consistent with previous quantitative EMG findings.”	Controls significantly younger than study group which may influence results. Spike shape differences in EMG testing may provide valuable information in evaluating neuromuscular disorders.

SCAPHOID FRACTURES

Bone Scans

Author/Year Study Type Conflict of Interest (COI)	Score	N	Area of Body	Diagnoses	Type of Bone Scans	CT used	MRI Used	More than on rater	Blinding of rater	Myelography	Surgery Performed	Clinical outcomes assessed	Long term follow-up (mean when noted)	Results	Conclusion	Comments
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O’Carroll 1982 Diagnostic	3.5	30	Wrist	Scaphoid fracture. Mean age 32 years.	99m Tc Methylene Diphosphonate and large field of view Gamma camera.	-	-	-	-	-	-	-	6 weeks	6 of 30 patients had scaphoid fractures. All 6 with scaphoid fractures gave positive bone scan but 5 additional patients without fractures gave positive bone scans.	“Bone scanning, however, detected all scaphoid fractures but had a relatively high false positive rate.”	Data suggest scintigraphy accurately diagnosed all true fractures and accurately detected those without fracture.
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MRI																
Kumar 2005 (score=3.5)																Small sample size. Data suggest MRI may be effective to detect occult scaphoid fractures
Imaeda 1992 (score=3.5)																Data suggest MRI depicts increased visualization of wrist anatomy which is useful for diagnosing and assessing the extent of union of scaphoid fracture.
Sharifi 2015 (score=3.5)																Data suggest pain measurement in combination with MRI for suspected bone fractures is not useful in patients with normal radiographs.
Gaebler 1996 (score=2.5)																Small sample. Data suggest MRI is useful in diagnosing scaphoid fracture.
Senevirathna 2013 (score=2.5)																Data suggest performing MRI 2 weeks after an acute wrist injury is useful in visualization of multiple wrist injuries including soft tissue and many other non-scaphoid wrist fractures.
Schmitt 2011 (score=2.5)																Very small sample. Data suggest MRI beneficial in visualization of anatomy of the three bone marrow zones in Preiser’s disease when compared to radiographs.

Fixation vs Bone Graft

Jeon 2009 (score=3.5)										Data suggest comparable efficacy.
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DISTAL PHALANX FRACTURES AND SUBUNGUAL HEMATOMA

Antibiotic Prophylaxis

Sloan 1987 (score=3.5)										Small sample size. Data suggest MRI may be effective to detect occult scaphoid fractures
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METACARPAL FRACTURES

Functional Therapies vs. Casting or Splinting

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Immobilization						
Hansen 1998 RCT No mention of sponsorship or COI.	3.5	N = 105 with fracture of neck of ring or little metacarpal bone	Dorso-ulnar plaster-of-Paris from proximal interphalangeal joint to elbow (n = 35) vs. functional brace around wrist (n = 35) vs. elastic bandage (n = 35). Study duration 4 weeks. Follow-up at 3 months.	VAS during 4 weeks treatment: plaster-of-Paris 1.5 vs. functional brace 1.8 vs. elastic bandage 2.7 (p <0.05). Median restriction of MCPJ movement at 4 weeks: plaster-of-Paris 20° vs. functional brace 0° vs. elastic bandage 10° (p <0.05). Median restriction of MCPJ movement at 3 months: plaster-of-Paris 0° vs. functional brace 0° vs. elastic bandage 10° (p <0.05).	“Patients treated with a functional brace mobilized as fast as patients treated with elastic bandage and faster than patients treated with plaster-of- Paris.”	Data suggest comparable efficacy between use of functional brace vs. elastic bandage vs. plaster-of-Paris for fractures of ring and little metacarpal neck with slightly faster mobilization with functional brace. Patient satisfaction was similar in all groups. Fracture severity was not specified.

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Strub 2010 Pseudo-RCT No mention of sponsorship. No COI.	3.0	N = 40 with 30°-70° palmar displacement of little finger metacarpal neck fracture. Mean age Group A 28 years, Group B 32 years.	Group A: closed reduction with K-wires and intramedullary splinting, palmar 2 finger splint for 5 days followed by functional mobilization in metacarpal brace for 5 weeks, wires removed after 3 months vs. Group B: conservative treatment without reduction and immobilized in a palmar 2 finger splint for 5 days followed by 5 weeks of functional mobilization and no hand therapy. Follow-up at 2 and 6 weeks, and 3, 6, and 12 months.	NS between groups at 1 year follow-up for flexion at metacarpophalangeal joint (p = 0.69), extension at metacarpophalangeal joint (p = 0.08) and grip strength (p = 0.22).	“[We] could not demonstrate any statistically significant differences in the conservative and surgical treatment of displaced boxer’s fractures in terms of range of motion at the MCP joint or grip strength.”	Small sample quasi randomization. Data suggest surgically treated group were more satisfied and had better aesthetic outcomes than non-surgically treated groups but no significant differences found between ROM or grip strength in 2 groups suggesting intramedullary splinting offers an aesthetic advantage without functional improvements.
Sørensen 1993 RCT No mention of sponsorship or COI.	3.0	N = 133 with fractures (140) of 2 nd -5 th metacarpal bones. Age range 10+.	Galveston metacarpal functional brace (n = 65) vs. dorsal/ulnar plaster cast (n = 68) for 4 weeks. Assessment at 1 week, 4 weeks, and 3 months after injury.	Percent reduced mobility 4 weeks after injury after cast removal: metacarpal brace 4% vs. cast 31% (p <0.01).	“We found that the benefits did not outweigh the risks of the functional fracture bracing, and we cannot recommend the test version of the Galveston metacarpal brace.”	High drop out in carpal-brace group (58%) compared to plaster-of-Paris (19%). Therefore, comparisons of the two treatment groups not possible. At 3 months the patients completing study reported equal mobility.

Fixation										
Cepni 2016 (score=1.5)										All patients had to have a master’s degree or be a student, all males randomization questionable. Methodological details sparse.

DISTAL FOREARM FRACTURES

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Physical Therapy Or Occupational Therapy						
Lagerström Scand J Rehabil Med 1999;31:49-54 Clinical trial	3.5	N = 33	Functional reliability measures of injured vs. uninjured arms post immobilization.	Findings include 3 or more trials per session required to measure MVC. Intersession reliability lowest first 2 months; equal at 2 years. Healthy uninjured side can be reliable reference for injured side.	“Measurement methods and the present findings may serve as guidance in physiotherapy for these patients, especially if the uninjured side is used as reference.”	Thrust of study is reliability of grip strengths.
Pasila 1974 RCT	3.0	N = 135	No physiotherapy with written and oral instructions to perform movements from doctor	No statistically significant differences were found between two groups regarding subjective	“A surgeon can effectively supervise the physical therapy of radial fracture patients by using additional printed instructions.	Heterogeneous methodology problems weaken study conclusions.

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			vs. physiotherapy with written instructions by physiotherapist	well-being and time lapse between injury and return to work. Patients in PT arm attended physiotherapy on average 4 times.	Transferring the patient immediately to a physiotherapist’s care did not affect the final result, but created extra administrative work and increased the number of visits made by the patient by approximately four.”	
Oskarsson 1997 Case series	N/A	N = 110	Written and oral physician instructions vs. same plus physiotherapy upon patient’s request.	No significant differences in matched pairs for wrist function (maximal grip score, wrist movement score); 93% of patients attending physiotherapy believed it effective.	“Following the typical distal radius fracture, only patients with severe stiffness and those who for any reason cannot execute their self-training program should be referred to a physiotherapist.”	Authors suggest PT acts as a placebo, and other less expensive placebos may be effective.
Casting/Functional Bracing						
Van Der Linden 1981 RCT	3.5	N = 250 (39 male/211 female)	Group 1: circular plaster cast, palmer flexion combined with pronation and ulnar deviation. Group 2: dorsal splint, neutral hand position, ulnar deviation preserved. Group 3: Circular plaster cast, neutral hand position, ulnar deviation preserved. Group 4: Dorsal splint, neutral hand position, without ulnar deviation. Group 5: Circular plaster cast, neutral hand position, without ulnar deviation.	Mean values for restriction of range of movement (in degrees) compared with uninjured side: Dorsiflexion Group 1 12.7; Group 2 17.4; Group 3 15.4; Group 4 12.4; Group 5 14.3.	“The technique of immobilization was found to be of subordinate importance for the final results, which are determined by the original displacement and the success of reduction.”	Study suggests anatomic results are dependent on success of reduction.
Immobilization/Fixation						
Wik 2009 RCT No mention of industry sponsorship. No COI.	3.5	N = 72 females with low-energy trauma, displaced Colles’ fractures initially considered for closed reduction and immobilization in plaster cast. Age >50.	Reduction and a complete plaster cast (n = 34) vs. Reduction and a dorsal plaster splint (n = 38). Immobilization for 5 weeks with follow-up at 1 and 10 days and 5 weeks after reduction.	Mean dorsal angulation 10 days after reduction: slightly better in the dorsal plaster splint group, (p = 0.04). Radial length at 5 weeks was better in the complete plaster group, (p = 0.02).	“[S]urgeons caring for such cases may choose the immobilization method for the first 10 days following reduction according to their individual preferences and those of the injured person.”	Data suggest comparable efficacy between 2 groups suggesting personal preference for type of immobilization method.
Casting/Bracing						
Gupta 2011 (score=3.5)						Data suggest comparable efficiency between groups (unstable distal radius fractures treated either with closed reduction plus cast vs. closed reduction and external fixation lead to same functional and anatomical outcomes.

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Surgery										
Goehre 2014 (score=3.5)	Palmar Fixation Plate/K-Wire									Methodological details sparse small sample size. Only older patients enrolled.
Gratl 2013 (score=3.5)	External Fixation/Volar Plating									Most patients were A3 fractures with few C2 and even fewer C1 and C3 fractures, virtually no baseline information. Methodological details sparse.
Roh 2015 (score=3.0)	Volar Plate/External Fixation									Only C2 and C3 fracture patients included. No baseline measures of outcomes. Meaningly more complications among external fixation groups (29%) as compared to surgical plating group (17%).
Aita 2014 (score=3.0)										Methodological details sparse.
Safdari 2015 (score=3.0)										Methodological details sparse. Several incongruous statements make us question any results from this study.
Williksen 2015 (score=3.0)	Volar Locking Plate/Pins									Methodological details sparse between groups.
Fakoor 2015 (score=2.5)	Internal/External Fixation									Methodological details sparse.
Athar 2018 (score=2.5)										Methodological details sparse.

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Brehmer 2014 (score=2.5)	Open Reduction/Internal Fixation									Methodological details sparse.
Bahari-Kashani 2013 (score=2.0)										Methodological details sparse.

GANGLION CYSTS

X-rays										
Sakamoto 2013 (score=3.5)										Data suggest plain radiographs and clinical information are important in making an accurate diagnosis of intraosseous ganglia.
Aspiration (Without Other Intervention)										
Varley 1997 (score=3.5)										Data suggest similar efficacy between groups with addition of steroid adding no benefit and may increase skin depigmentation and fat atrophy.
Aspiration and Surgical Excision and Steroid Injection										
Balazs 2015 (score=3.0)										Data suggest persistent pain post open dorsal wrist ganglion excision in active duty military personnel is common and these persons should be counselled on the risk of residual pain post procedure.

Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Aspirations						
Khan 2011 Randomized Control Trial	3.5	N = 36 with dorsal wrist ganglion;	Group 1 (N=18) Patients treated with an open surgical excision. Vs. Group 2 (N=18) Patients treated using aspiration	Success Rate, group 1 vs group 2: 17 (94.4%) vs 11 (61.1%) (p = 0.041). Rate of Recurrence, Group 1 vs Group 2: 1 (5.6%) vs 7 (39.9%) (p = 0.041). No	“Although the aspirations, triamcinolone acetonide injection plus wrist immobilization is one of the alternative methods, surgery	Small sample size. Data suggest surgical excision superior to aspiration plus triamcinolone plus wrist immobilization for treatment

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No sponsorship or COI.		mean Age 31 (17-45)	with 18G needle, followed by injection of triamcinolone acetonide. Follow-up at baseline, 1, 2, 6 weeks, and 6 months.	complications in any of study groups during study period.	was the most successful form of treatment when considering the cure rate of dorsal wrist ganglion, though we analyzed only a small group; our results can only be an indicator.”	of dorsal wrist ganglion (94.4% vs 61.1%)
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HAND ARM VIBRATION SYNDROME (HAVS)

Diagnostic Testing											
Bogadi-Sare 1994 (score=3.5)											Data suggest there is considerable variation to cold provocation in terms of the vascular response which impedes the defining of normal vs. abnormal reactions No single test could distinguish cases from controls.
Lindsell 1999 (score=3.0)											Data suggest some vascular and neurological signs occur independently but some signs like blanching and numbness and tingeling may be related as they are highly correlated
Kurozawa 1991 (score=2.5)											Data suggest skin temperature measurements pre and post immersion in cold water for 10 minutes cannot be used to estimate the severity of vibration induced white finger.
Lawson 1997 (score=2.5)											Data suggests multiple tests are required to make an accurate diagnosis of HAVS.
Serologic Testing or Connective Tissue Disorders Testing											
Kennedy 1999 (score=3.0)											Very small sample (n=11). Data suggesting patients with HAVS had higher S-ICAM-1 levels than controls.

LACERATION MANAGEMENT

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Author/Year Study Type Conflict of Interest (COI)	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Wound Repair						
Mouzas 1975 RCT	3.5	N = 104	Dexon suture vs. silk suture vs. polyethylene suture vs. nylon suture	One wound in each Dexon, polyethylene, and nylon groups was frankly injected, 4 wounds sutured with silk injected. By 7-10 days 77.3% (17/22) of Dexon wound, 68.2% (15/22) of polyethylene wound and 73.9% (17/23) of nylon wound.	“Dexon was seen to possess certain advantages in that it caused as little tissue reaction as the other sutures but did not have to be removed subsequently.”	Not clear if an RCT as randomization and allocation not described. No blinding.
Sutton 1985 RCT	3.5	N = 76	4/0 Ethilon interrupted mattress sutures vs. Steristrips applied on tincture of benzoin for closure of wounds.	“Sutures appeared to be associated with increased necrosis of the wound and slower healing than adhesive tapes, particularly when used for flap lacerations...The mean healing time for the 23 patients whose flap lacerations were closed with tapes was 39 days; 20 of these patients were neither admitted to hospital nor received grafts.”	“This study shows that for most pretibial lacerations conservative management on an outpatient basis is all that is necessary, and that adhesive tapes are to be preferred for the primary closure of such wounds.”	Lack of study details. May not be applicable to upper extremity lacerations.
Bernard 2001 RCT	3.5	N = 42	2-octyl cyanoacrylate vs. standard suture for the closure of excisional wounds	No differences in early complications between groups. Suture group scored higher on VAS (63.3mm for suture vs. 47.8mm for tissue adhesive); difference statistically significant (p = 0.02). Suture group had higher median score on Hollander Wound Scale, but not statistically significant (p = 0.09).	“The cosmetic outcome of cutaneous excisional surgery wounds closed with standard suturing was found to be superior to that of wounds closed with octyl cyanoacrylate.”	Study not random-selection based on patient choice. Study population children and adolescents, but may be appropriate for excision wounds in general, all wounds treated with subcutaneous sutures.
MacGregor 1989 RCT	3.5	N = 100	Staple vs. suture closure with local anesthetic for patients with lacerations.	Scores awarded for ease and satisfaction of closure by doctor at insertion were similar. Significantly more patients awarded staples full marks at insertion for method acceptability, although they were same at removal.	“[T]he use of staples to close traumatic skin lacerations compares favorably with the traditional method of suturing.”	Sparse study details. Lack of analytical details.

HUMAN AND ANIMAL BITES AND ASSOCIATED LACERATIONS

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
Dog Bites						
Elenbaas 1982 RCT	3.5	N = 63	Oxacillin x 5 days vs. placebo.	No significant difference in infection rates between two groups; 2 infections vs. 0 in antibiotic group. Both developed in hand.	“Good wound toilet and attention to adequate follow-up wound care will result in a minimal incidence of infection in dog bite injuries. Antibiotic prophylaxis does not further reduce this incidence.”	High dropout rate (17/63). Study details sparse, including allocation and blinding methods.
Bite Laceration Repair						

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Maimaris 1988 RCT	3.5	N = 169	Sutures vs. no sutures of dog-bite lacerations.	Overall infection rate 7.7%. No significant difference in infection rate between sutured and non-sutured lacerations. Significant difference in infection rate of hand vs. rest of body (p <0.01).	“Dog bite lacerations should receive thorough surgical treatment and can be safely sutured at presentation. However, special care should be given to hand wounds and patients with delayed presentation.”	Sparse study details. No blinding. Randomization and allocation details not provided.
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HAND/FINGER OSTEOARTHRISIS

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
SPLINTING AND EXERCISE						
Splint vs. Splint						
Berggren 2001 RCT	2.5	N = 33 wait-listed for CMC joint replacement	Three groups: 1) technical accessories, 2) semi-stabile textile splint, and 3) non-stabilizing leather splint. All received advice on ADLs.	Patients’ need for operation over 7 years were 3, 4, and 3 respectively over 7 months and 2 additional patients during rest of 7 years (1 each in each splint group).	“We therefore recommend that patients with arthritis of the carpometacarpal joint of the thumb are offered a similar programme in addition to access to accessories and splints preoperatively.”	Methodological details sparse; 7-year follow-up a strength. No differences between the groups results in suggestions of either equal in/efficacy.
Intensive vs. Standard Exercise						
Rønningen 2008 Controlled clinical trial	3.5	N = 60 hospitalized RA patients	Intensive (daily HEP, greater number of repetitions) vs. standard exercise program for 12 weeks.	At 14 weeks, grip strength favored intensive group (p = 0.04).	“[C]ompared with a traditional programme, an intensive hand exercise programme is well tolerated and more effective in improving hand function in patients with RA.”	Non-randomized, as first 30 assigned standard treatment and next 30 intensive. Suggests superiority of more intensive exercise regimen for severely affected RA.
NSAIDs						
Diclofenac vs. Amtolmetin						
Niccoli 2002 RCT	3.5	N = 90 hand, hip or knee OA	Amtolmetin 600mg BID for 3 days then 600mg a day for 11 days vs. Diclofenac 50mg TID vs. Rofecoxib 25mg QD for 2 weeks total treatment.	Diclofenac reduced creatinine clearance. Rofecoxib gained body weight, systolic blood pressure, diastolic blood pressure and serum sodium with decrease in daily urine volume. No significant changes in parameters with AMG. Diclofenac more efficacious than other 2 drugs (p <0.001).	“Diclofenac mainly impaired blood renal flow and the glomerular filtration rate, while rofecoxib negatively influenced the renal sodium-water exchange. AMG demonstrated a renal sparing effect, although the exact mechanism is unclear.”	Sparse study details; 2-week trial. Data suggest diclofenac superior.
COMPLEMENTARY AND ALTERNATIVE THERAPIES						
Chondroitin vs. Placebo						
Verbruggen 2002 2 RCTs	3.5	N = 46	Chondroitin polysulphate 50mg IM twice weekly for 8 weeks every 4 months (46) or chondroitin sulphate 500mg TID (34) vs. placebo for 3 years	Baseline differences in destructive IP joint OA with CPS 23.9% vs. placebo 47.8%. CS 35.3% vs. placebo CS 35.9% at baseline. However, data presented compared with aggregate placebo group.	“The data recorded during these pilot studies should help investigators to design future long-term clinical experiments.”	Pilot study. Some details sparse. Baseline differences in erosive changes suggest randomization failure for CPS study. Main publication purpose for system to

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				precluding analysis of CS study alone. DIPs for CS study at 3 years 2.6 vs. 3.5 placebo (p = 0.155). PIPs CS 2.3 vs. 2.8, p = 0.373. MCPs CS 0.4 vs. 0.5, p = 0.70.		assess progression of OA. High dropout rates, especially in the IM injection study.
Rovetta 2002 RCT	3.0	N = 24 DIP and/or PIP joint OA	Chondroitin sulfate 800mg a day plus naproxen 500mg a day vs. naproxen only for 2 years.	Chondroitin plus naproxen group had increase of 1 joint with erosive OA at 1 year and none at 2 years, vs. naproxen group with 6 patients, 7 joints (p <0.05).	“Chondroitin sulfate failed to stop the usual time-associated progression in the number of finger joints presenting erosions in EOA of the hands. It was, however, associated with a lower increase in the number of finger joints with erosions detected after 2 years of radiological observation.”	Small sample size. Sparse details. Results suggest delayed development of new erosive changes.
Yoga vs. No Therapy						
Garfinkel 1994 RCT	3.0	N = 26 DIP or PIP joint OA	Yoga (supervised 1x a week for 8 weeks) vs. no program. After 10 weeks, controls offered to cross over (2 did not) and remaining subjects randomized. Six remained in controls.	Tenderness improved in yoga (2.20±1.32 vs. 0.4±0.94, p = 0.001). Range of motion increased (p = 0.002). Improvements in grip strengths did not differ (yoga 4.21±4.69/control 3.36±5.89, p = 0.69).	“This yoga derived program was effective in providing relief in hand OA.”	Small sample sizes and some details sparse. Non-interventional control likely biases in favor of intervention.
Multiple Modalities vs. None						
Mathieux 2009 RCT	3.0	N = 60 early RA	Multidisciplinary (n = 6) team-led program. Video, “comprehensive OT,” motor training, skill training, joint protection, counseling, advice, assistive devices, splints, education, psychosocial support. Treatment for 3 months.	Health Assessment Questionnaire scores: OT (0.19±0.19) vs. controls (0.35±v0.32), p <0.001. Dominant hand grip strengths: OT (53.9±24.2 kPa) vs. controls (37.3±22.9), p = 0.021.	“[A]n early extended information programme improved hand function in patients with early RA.”	Multiple modalities and lack of structure preclude assessment of value of a given modality. RA patients. Presumptive marked differences in contact time (not quantified, but appear marked) bias towards intervention.

Splint vs No Splint

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Adams 2014 (score=3.0)										Abstract only. Small sample. Data suggest thumb splints showed not be used for thumb OA.
Weiss 2000 (score=3.0)										Included 8 participants who had additional problems (carpal tunnel syndrome, scaphotrapezoidal arthritis, and de Quervain tendonitis). Data suggest splinting for first carpometacarpal joint may reduce pain but functional outcomes changes such as improved pinch strength did not occur.
Exercise vs Sham										
Boustedt 2009 (score=2.5)										Data suggest combination splinting and exercise program combined with a joint protection program improves pain, stiffness and quality of life compared to a joint protection program alone.

POST-OPERATIVE REHABILITATION AND REHABILITATION OF PATIENTS WITH FUNCTIONAL DEFICITS: CTS AND OTHER DISORDERS

Author/Year Study Type	Score (0-11)	Sample Size	Comparison Group	Results	Conclusion	Comments
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POST-OPERATIVE SPLINTING						
Rocchi 2014 RCT No mention of sponsorship. No COI.	3.5	N = 30 with acute complete tear of ulnar collateral ligament (UCL) of thumb treated with surgery. Mean age 39 years.	Standard spica splint for 4 weeks with motion limited to IP joints (n =15) vs. Modified spica splint with freedom to move MCP joint for 4 weeks with motion on both the IP and MCP joints (n = 15). All patients provided flexion-extension exercises. Follow-up at 1, 2, 6, and 12 months.	No significant differences between groups (no p-values reported for study outcomes).	“This study suggests that the surgical repair of the skier’s thumb lesion, combined with the immediate restoring of active MCP ROM protected by a modified spica splint is effective and safe and allows a faster return to manual activities compared to traditional method of postoperative splinting.”	Small sample but data suggest the early motion management group had less pain at 2 months compared to controls and all functional measures became similar at 12 months. The lost work time is shortened in the early-motion group by 12 days.
Finsen 1999 RCT	3.5	N = 74 with NCS under-going open CTR	All bulky dressing for 2 days, then: 1) very light dressing and move wrist and fingers “as much as comfort allowed, but avoid heavy lifting for the first” 6 post-op weeks vs. plaster of Paris splint for 2 weeks and rigid orthosis for 2 more weeks.	“Physiotherapy was usually not prescribed,” apparently as an uncontrolled confounder. VAS pain and discomfort scores (pre/2 weeks/6 weeks/6 months): Immobilized (56/6/6/3) vs. mobilized (51/5/2/2).	Authors conclude that “4 weeks of postoperative immobilization confers no detectable benefit.”	Sparse data. Pseudorandomization on Norwegian social security number. NCS not required. Data suggest immobilization not indicated. No advantage to splinting after carpal tunnel release surgery.
Bury 1995 RCT	3.0	N = 40 open CTR patients with 43 carpal tunnel releases evaluated	2 weeks of post-op wrist splinting vs. a bulky dressing only	No statistically significant differences between two groups using subjective parameters of patient satisfaction with outcome and objective parameters of grip and lateral pinch strength, complication rates, and digital and wrist range of motion. No clinical evidence of bowstringing could be noted in either group of patients.	“We found no beneficial effect from postoperative splinting after open carpal tunnel release when compared to a bulky dressing alone.”	
Martins 2006 RCT	3.0	N = 52 EDS confirmed	Post-op immobilization vs. no immobilization for open CTR patients	Average of SSS was 33.38±7.33 in group A and 31.77±7.56 in group B. Post-op, SSS average 11.38±4.57 in group A, and 12.33±4.77 in group B (p = 0.059).	“Wrist immobilization in the immediate post-operative period have no advantages when compared with no immobilization in the end result of carpal tunnel release.”	
POST-OPERATIVE REHABILITATION						
Follow-up After CTR						
Atherton 1999 RCT	4.0	N = 100 with CTR	Follow-up with general practitioner vs. hand clinic with 2-week follow-up.	More wound infections diagnosed in general practice setting (14% vs. 0%). Authors believe “most were given antibiotics, perhaps unnecessarily.”	“The waiting time for assessment and suture removal was shorter at the GP surgery than in the outpatient department... but significantly more patients were diagnosed as having wound infections.”	Sparse details; 1 page report. Randomization unclear. No data on risks for infection. CTR procedure not described. Limitations result low-quality study despite 4.0 grading.
Physiotherapy Post-Op						

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Naik 2007 RCT No mention of sponsorship or COI.	2.5	N = 30 with Colles' fracture who underwent external fixation and removed after 2 months. Age not reported.	Maitland mobilization technique: moist heat 15 minutes followed by Maitland manipulations (Grade 1 and 2) for 1 st week of treatment then Grade 3 and 4 2nd week. (n = 15) vs. Mulligan mobilization technique: moist heat for 15 minutes, Mulligan manipulations in pain free glides (n = 15). No mention of follow-up time.	Mean±SD pain relief (Maitland vs. Mulligan): 3.93±1.09 vs. 4.73±1.03 (p = 0.029). Mean±SD ROM (Maitland vs. Mulligan): active ROM 12.060±6.37 vs. 7.730±2.37 (p = 0.020); passive ROM 14.460±8.67 vs. 9.660±2.89 (p=0.05). Mean±SD scores for functional tasks (Maitland vs. Mulligan): 3.2±0.86 vs. 4.4±1.05 (p = 0.002).	“Mulligan’s mobilization technique could be used effectively when the pain predominates while Maitland’s mobilization technique could be effectively used to restore mobility when pain is not the major concern to patients with colles’ fracture.”	Small sample (N = 30). Sparse methodology. Data suggest Mulligan’s better for pain relief.
Physical Therapy/Occupational Therapy						
Rasotto 2015 RCT Sponsored by Italian Workers’ Compensation Authority (INAIL). COI, Rassotto received a grant from INAIL.	3.5	N = 68 assembly line workers; no exercise contra-indications. Mean age 41.10±7.69 years.	Intervention group (IG): 2 exercise sessions per week for 9 months; each session 30 minutes of warm-up exercises, then tailored program (3 series of 5 exercises each), and cool-down (n = 34) vs. control group (CG): continue to perform normal daily activities (n = 34). Follow-up at 5 months and within 2 weeks from end of study.	Mean±SD difference in pain rating baseline to end of study (IG vs. CG): neck -1.29±2.72 vs. 0.39±2.51 (p = 0.0164); shoulder -0.94±1.09 vs. 0.17±2.02 (p=0.0224); wrist -1.40±1.87 vs. -0.39±0.93 (p = 0.0007).	“This personalized approach suggests a greater effect than a non-personalized standard protocol; however any potential longer term value of customized exercise program deserves further investigation.”	Very high dropout and non-compliance in exercise arm. Individualized treatment. Data suggest strength training may reduce neck and wrist pain among those relatively few who remained compliant. Data subject to non-interventional control bias.
Taylor 1994 RCT No mention of sponsorship or COI.	3.5	N = 30 following removal of plaster after Colles’ fracture. Mean age 62.6±8.8 years.	Experimental group: 5 minutes Maitland passive joint mobilization; superficial heat; active exercises; home advice to use affected wrist/hand for all daily activities vs. control group: sham mobilization (soft tissue massage), superficial heat, active exercises, home advice treated 2x a week. Included in study until discharged from physiotherapy.	N no significant differences between groups.	“This clinical trial found that the inclusion of passive joint mobilisation into a physiotherapy treatment regime was no more effective than soft tissue massage at increasing the range of active wrist extension in Colles’ fracture patients following removal of plaster.”	Pilot study with small sample size. Data suggest comparable efficacy between passive joint mobilization and soft tissue massage.

Appendix Three - References

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