



# Hand, Wrist, and Forearm Disorders Guideline

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## Impact

Hand, wrist, and forearm symptoms in the workforce are common problems presented to health care providers and are among the five most common causes of reported work-related health symptoms and workers' compensation claims. According to 2010 US Census data, there was an incidence rate of 67.6 upper extremity fractures per 10,000 persons.<sup>(1)</sup> In 2013, there were 345,560 work-related upper extremity disorders for an incident rate of 32.5 per 10,000 full-time workers.<sup>(2)</sup> This was the leading cause of work-related injury,<sup>(2)</sup> and it is estimated that 20% of the population in any given month will complain of at least one type of upper limb disorder.<sup>(3)</sup> In 1998, a study involving more than 10,800 participants concluded that 30.5% had a self-reported neck or limb disorder.<sup>(4)</sup> Results from another study concluded that in 2000, 5.3 out of every 1,000 workers would take an absence due to sickness because of a musculoskeletal upper limb disorder; by 2004 this number had risen to 6.3.<sup>(5)</sup> These disorders account for nearly one-third (31.4%) of the missed days of work.<sup>(2)</sup> They also account for about 7 to 8% of total lost workdays in workers' compensation and 17 to 23% of cases and claims, ranking them in the top five for financial severity.

## Overview

Recommendations on assessing and treating adults with hand, wrist, and forearm disorders are presented in this clinical practice guideline. Topics include the initial assessment and diagnosis of patients with acute, subacute, and chronic hand, wrist, and forearm disorders that are potentially work-related, identification of red flags that may suggest the presence of a serious underlying medical condition, initial management, diagnostic considerations and special studies to identify clinical pathology, work-relatedness, modified duty and activity, and return to work, as well as further management considerations including delayed recovery. The majority of peer-reviewed literature categorizes acute as <1 month duration, subacute as 1 to 3 months duration, and chronic as >3 months duration. These definitions have been adopted throughout this document. Throughout the Guideline, we refer to costs in the rationale for the recommendation – costs are defined as low (<\$100), moderate (\$100-\$500), and high (>\$500).

Algorithms for patient management are included and schematize how to generally manage acute, subacute, or chronic hand, wrist, and forearm disorders. It is important to realize that there are few studies that evaluate patients with work-related hand, wrist, and forearm disorders; therefore, studies that include different populations were used to develop the recommendations. In addition, most studies that focus on pharmaceuticals, appliances, and specific devices are industry sponsored. In certain areas, this may have made little difference as the comparisons were between the medication and placebo and the results may be stark. However, in other studies, the comparison groups may have been suboptimally treated (e.g., a low-dose of ibuprofen) and produced a bias in favor of the medication or device. In addition, industry-sponsored studies have been shown to frequently have better results and lower complication rates than studies conducted by independent investigators. Readers should refer to the Low Back Disorders, Chronic Pain and Opioids guidelines for more information regarding medications, including adverse effects.

## General Approach and Basic Principles

The principal recommendations for assessing and treating patients with acute, subacute, or chronic hand, wrist, or forearm symptoms are as follows:

- The initial assessment focuses on detecting indicators of potentially serious disease, termed red flags, which require urgent assessment and treatment as indicated.
- The foci for treatment of patients with hand, wrist, or forearm symptoms include optimal medical care, monitoring for complications, facilitating the healing process, assisting stay at work or early return to work in a modified or full-duty capacity, and include surgical intervention(s) when indicated.
- Relieving discomfort can frequently and most safely be accomplished by modifying activities and using either topical or systemic nonprescription analgesics.
- Encourage patients recovering from hand, wrist, or forearm problems to stay at work or consider early return to modified work as their condition permits.
- Address occupational factors where the disorder is believed to be caused by work.
- Address nonphysical factors (e.g., psychosocial, workplace, or socioeconomic problems) in an effort to resolve delayed recovery (see Cornerstones of Disability Prevention and Management and Chronic Pain guidelines).

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

## Carpal Tunnel Syndrome

CTS is the most common and widely known of the entrapment neuropathies in which the body's peripheral nerves are compressed or traumatized,(6-11) affecting an estimated 4 to 10 million Americans.(9) Carpal tunnel syndrome (CTS) occurs when symptoms occur that are attributable to abnormal median nerve compression within the carpal tunnel – a narrow, rigid passageway of ligament and bones at the base of the hand, which houses the median nerve and flexor tendons. 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, but not the fifth digit, as well as innervation to some small muscles (lateral two lumbricals, opponens pollicis, abductor pollicis brevis and flexor pollicis brevis.) in the hand that allow the fingers and thumb to move. Often, the condition arises without apparent cause.(6, 12, 13) Patients who have open injuries, unstable fractures, wrist fractures, or acute gout attack that results in acute CTS require immediate referral to a surgeon since improvement may only be obtained through surgery. Sometimes, synovial thickening around tendons or other swelling narrow the carpal tunnel and cause the median nerve to become variously compressed or enlarged through poorly understood processes. The result may be tingling, numbness, pain, or weakness in the digits. 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.

## 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. TFCC is apparently susceptible to the same anatomic, pathophysiologic, and degenerative issues as the knee menisci. Vascular supply is similarly analogous to a meniscus with radial penetration into the meniscal periphery and central avascularity(14, 15) and evidence that degeneration increases with age.(16) Since abnormalities are commonly found on MRI and/or arthrography,(17) indications for surgical interventions are somewhat unclear.

## Crush Injuries and Compartment Syndrome

Crush injuries as well as compartment syndrome are usually surgical emergencies.(18, 19) Compartment pressure measurements are helpful. Mild cases of crush injuries may be treated similar to non-specific hand, wrist, forearm pain with particular emphasis on RICE (rest, ice, compression, elevation). Not all crush wounds, especially those more extensive and prone towards swelling are sutured as additional problems may ensue from suturing including possible tissue necrosis and the intervention may help to inhibit expansion to relieve pressure.

## 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. It is a controversial condition from the standpoint of work-relatedness, as it is a disease and there are no quality studies on cause.

## Wrist Sprains

Wrist sprains (which are partially or totally disrupted ligaments) are a common result of occupational slips, trips, and falls. Evaluation for occult fracture should be considered especially as fracture(s) may be present in a minority of cases.

## Mallet Finger

Mallet finger is a common occupational and sports injury,(20) although it may occur with minimal apparent trauma.(21) 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. The mechanism of injury most typically involves forcefully striking the tip of the extended digit on an object including balls, or from falls.(22)

## Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)

Stenosing tenosynovitis is a generally non-inflammatory condition caused by hypertrophy of the A-1 pulley with ensuing narrowing of the canal through which the digital flexors travel, with resulting symptoms of pain and snapping of the digit particularly with extension of a flexed digit.(23-28) While some cases are thought to be occupational(29) and many cases have been reportedly idiopathic, there are other less frequent reported causes and associated conditions, including diabetes mellitus, rheumatoid arthritis, CTS, Dupuytren's disease, osteoarthritis, amyloidosis, hypothyroidism, heredity, and partial tendon laceration.(30-35) There also is evidence these may be connective tissue disorders.(36, 37) Diabetes mellitus reportedly portends a worse prognosis for glucocorticosteroid injection.(38, 39) The disorder includes a spectrum from localized pain in the flexor compartment to triggering to locking of a digit.(40) The most common abnormality is thickening at or of the A1 pulley.(40) Less common pathophysiologic abnormalities include metacarpal-phalangeal joint abnormalities, disorders at the level of the carpal tunnel, and other pulley anomalies.(40)

## Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)

De Quervain's stenosing tenosynovitis involves hypertrophy of the extensor retinaculum of the first extensor compartment(41) involving the abductor pollicis longus and extensor pollicis brevis tendons with signs of tenosynovial and retinacular fibrosis usually present.(41, 42) The condition may be occupational when jobs require repeated forceful gripping or sustained wrist extension. However, most cases are not likely occupational. Extensor compartment tenosynovitis, including de Quervain's tenosynovitis, is considered a comparable disorder to trigger digit with somewhat similar pathophysiology, clinical presentation, and treatment issues. De Quervain's is the most common of the extensor compartment tendinoses. Intersection syndrome with a reported prevalence of 0.37% of all patients with arm or hand pain is substantially less common(43) and is somewhat controversial regarding the actual site of entrapment of the dorsal compartment(44-46) with the principle site appearing to involve the musculotendinous junction of the first extensor compartment and the tendons of the 2nd extensor compartment.(47)

Similar clinical and pathophysiological conditions are believed to affect the flexor carpi ulnaris and flexor carpi radialis tendons at the wrist. There is a strong predisposition in women and among those in their 5th through 7th decades of life.(41, 48, 49) De Quervain's is also considered a generally non-inflammatory condition caused by hypertrophy of extensor retinaculum and parietal layer of the tenosynovium with resulting symptoms of pain on use of the affected digit. Systemic diseases are potential causes, including rheumatoid arthritis, other rheumatic disorders, diabetes mellitus, amyloidosis, heredity and anatomic variants.

## 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 combined with symptoms. It has no quality evidence of work-relatedness, but theories of work-relatedness are proposed. Guyon's canal is the space in which the ulnar nerve accompanied by the ulnar artery traverses the wrist. It is anatomically defined as the proximal medial wall formed by the pisiform, the distal lateral wall formed by the hook of the hamate, the floor formed by the flexor retinaculum and transverse carpal ligament, and the roof formed by the pisohamate carpal ligament.(50) Within the canal, the nerve bifurcates into the superficial (sensory) branch, and the deep (motor) branch. The superficial branch leaves the canal and provides a branch to the Palmaris brevis, and then continues subcutaneously to provide sensation to the fifth digit and the ulnar half of the ring finger. The deep branch loops around the hook of the hamate, and innervates the abductor digiti quinti, flexor digiti quinti, lumbricales and interossei as it crosses the palm in a curvilinear direction.(51) 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.(52-56)

The location of the lesion affecting the ulnar nerve as it crosses through Guyon's canal and the wrist is predictive of clinical symptoms, and has resulted in several classification schemes. Much of the current literature references the classification scheme proposed by Wu, which details five locations for lesions identified in collective published case reports. Lesions proximal to the bifurcation of the ulnar nerve (Type I) will exhibit mixed motor and sensory

involvement. Type II lesions involve only the superficial branch; therefore, clinical presentations are purely sensory. Type III lesions occur at the outlet of the canal and involve only the deep branch, thus they are purely motor. Type IV lesions occur involving the deep branch distal to the branch innervating the hypothenar, thus are purely motor with sparing of the hypothenar muscles. Finally, Type V lesions occur proximal to the branches innervating the first digital interosseous and abductor pollicis muscles, so that only the distal motor symptoms are involved.(51)

Guyon's canal syndrome is relatively uncommon, occurring about 20 times less frequently than ulnar lesions at the elbow.(57) Pathological lesions resulting in ulnar entrapment at the wrist reportedly are associated with concurrent compression of the median nerve in the carpal tunnel in approximately one-third of patients;(50) although there is no quality evidence that median nerve neuropathy is similarly associated with ulnar nerve involvement.

## Radial Nerve Entrapment

There are no quality studies linking radial nerve entrapment with work factors, although direct, significant trauma would be a presumptive cause. Radial nerve palsies affecting the hand and wrist usually occur at points along the course of the arm and forearm, well proximal to the wrist.(58-60) Upper arm lesions are generally associated with humeral fractures and related trauma or subsequent callous formation. **Radial Tunnel Syndrome**, or posterior interosseous nerve entrapment, occurs in the proximal forearm (see Elbow Disorders Guideline). **Wartenberg's Syndrome**, or radial sensory nerve entrapment in the distal forearm, is uncommon.(60)

Compression of the radial sensory nerve has been attributed to wearing a tight wrist or forearm band, anomalous brachioradialis tendon,(61, 62) repeated wrist flexion and ulnar deviation, external compression and trauma,(60, 63, 64) or from mass or bony lesions.(65) Case studies have also hypothesized an association with de Quervain's tenosynovitis, which occurs in roughly 50% of cases diagnosed with Wartenberg Syndrome.(66)

## Non-Specific Hand/Wrist/Forearm Pain

Non-specific pain is thought to be common in initial presentations in primary occupational health clinical settings, although work-relatedness is naturally unclear for condition that is not well defined.(67) The initial step is a careful history and physical examination, particularly to attempt to ascertain a specific musculoskeletal disorder.

## Scaphoid Fracture

Scaphoid fractures, also known as wrist navicular fractures, are among the most common fractures of the carpal bones,(68) occurring most commonly in young males. Most are not occupational, but some clearly are work-related. The scaphoid is located at the base of the thenar eminence (thumb side), just distal to the volar wrist crease, and acts to transfer the compression loads between the hand and forearm. It also maintains normal wrist motion, carpal stability and function of the wrist flexor and extensor tendons.(69) 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.(70) 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.(71) A history of fracture, as well as non-union both increase risk for development of osteoarthritis. In cases where there is hardware placed, subsequent hardware removal is indicated in cases of: (1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

## 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.(22) Fractures may or may not be occupational. There are no recent quality incidence data available for tuft fractures, but estimates are between 15 to 30% of all hand fractures are tuft fractures.(72, 73) Tuft fractures are most often usually due to a crush injury of the fingertip,(74) resulting in comminuted or transverse fractures and are a common occupational injury. Often, they are accompanied with nail bed laceration and subungual hematoma.(75, 76) Tuft fractures are generally stable and heal uneventfully because of the soft tissue support of the fibrous septae and nail plate.(77, 78) 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.(78)

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. This common hand injury results in a flexion deformity of the distal finger joint and may lead to an imbalance between flexion and extension forces more proximally in the digit. In cases where there is hardware placed, subsequent hardware removal is indicated in cases of: (1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

## Middle and Proximal Phalangeal and Metacarpal Fractures

Fractures of the proximal and middle phalanges represent approximately 46% of fractures of the hand and wrist.(22, 79) The more severe fractures are among the most challenging injuries that hand surgeons and therapists treat.(80) Fortunately, most are uncomplicated and are non-surgical cases.(81-83) Fractures may or may not be occupational. 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,(77) 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.(84)

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,(79, 85) and fractures of the thumb constituting another 25%.(86) They occur most commonly from a direct blow to the bone causing transverse shaft fracture or through an axial loading blow such as striking an object with a closed fist. Isolated fractures of the third and fourth metacarpals are uncommon and usually involve one or more the neighboring metacarpals.

Fracture type and displacement can be partially predicted by the underlying anatomic structures of the affected digit. Fractures of the proximal phalanx, which has no tendinous attachments, typically result in volar angulation. In contrast, the middle phalanx has insertions of the flexor digitorum superficialis along the volar surface, such that fractures at the base and shaft usually have a dorsal angulation because of the action of the flexor tendons, whereas fractures of the distal neck will usually have a volar angulation as the flexors act to pull the distal fragment.(87) Fifth metacarpal fractures usually displace at a volar angle because of the action of the interosseous muscles.(88) Other metacarpal fractures tend to angulate dorsally owing to the unbalanced pull of the interosseous muscles and extrinsic finger flexors on the distal fragment.(89) In cases where there is hardware placed, subsequent hardware removal is indicated in cases of: (1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

## Distal Forearm Fractures

Fractures of the distal forearm make up a significant proportion of injuries and fractures treated in the emergency room,(90) although no quality data regarding incidence or injury type in the workplace were found. Fractures may or may not be occupational, but most distal forearm fractures are not work-related. There are several types of distal forearm fractures in adults, the most common being Colles’ fracture, named after the surgeon and anatomist Dr. Abraham Colles who described it in 1814.(91, 92) Because it is the most common, the eponym Colles’ fracture is often mistakenly used as a generic reference term for all forearm or wrist fractures in adult populations. However, Colles’ fracture specifically refers to a transverse fracture of the distal radial metaphysis, with or without extension into and disruption of the radiocarpal or radioulnar articular surfaces. ***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. A fracture of the distal radius with carpal displacement can be dorsal or palmar displaced, the latter being more common. That type of fracture is caused by a fall on an extended and pronated wrist increasing carpal compression force on the dorsal rim. Some fractures are limited to the radial styloid and some are frequently associated with fracture of the ulnar styloid,(91, 93, 94) as well as a high incidence of triangular fibrocartilage complex (TFCC) disruption.(95) In one report of 118 distal fracture cases, TFCC tears occurred in 53% of extra-articular distal radius fractures and 35% of intra-articular fractures.(96) Failure to recognize a torn

TFCC may result in inadequate immobilization or surgical repair, resulting in distal radioulnar joint instability. Despite the severity of these injuries, with proper diagnosis and management most patients will have a satisfactory outcome.(97)

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.(91, 93, 94) In modern times, this injury more often results from a fall with the hand in ulnar deviation and midway between pronation and supination, or as a result of other force that is transferred axially from the scaphoid into the radial facet. Distal radial fractures are up to 6 times more common in women, with incidence of 7.3 vs. 1.7 per 1,000 human years.(98) In addition, people who walk regularly, which increases exposure to falling, have an associated higher incidence of fractures. Osteoporosis and low bone-mineral density is also an associated risk factor for fracture,(99) and likely explains much of higher incidence of fracture in women. A large population longitudinal study of osteoporosis has shown elderly women with high risk factors such as diabetes mellitus, cognitive impairment, and history of falls are at high risk for fall and distal forearm fracture, and should be considered for selective preventive strategies to reduce the incidence of these fractures.(100)

The triangular fibrocartilage complex (TFCC) plays a somewhat analogous role in the wrist to the meniscus and collateral ligaments in the knee. It is formed by a network of ligaments and articular cartilage originating on the medial border of the distal radius with insertion into the base of the ulnar styloid, and includes a meniscus at the distal radioulnar joint (DRUJ). The TFCC plays an important role in load bearing across the wrist as well as in DRUJ stabilization,(101) and in allowing for pronation and supination of the hand.(102) In cases where there is hardware placed, subsequent hardware removal is indicated in cases of: (1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

## Fracture Classification and Diagnostic Criteria

Several classification systems for distal radial fractures have been developed in an effort to evaluate treatment outcomes. However, studies of interobserver reliability and intraobserver reproducibility for the better-known classification systems (such as Frykman, Melone, Mayo, AO, and Fernandez) have demonstrated unsatisfactory reliability and reproducibility.(103, 104) Therefore, the key to recommending a treatment course is to determine the following criteria: is a fracture open or closed, stable or unstable, or likely to become unstable. Treatment can then be provided based on these criteria until better information is available to compare outcomes using a classification system that is reliable and reproducible.

In describing or in considering a specific treatment course of distal radial fractures, it may be more useful to determine the stability of fracture patterns according to radiological measurements rather than a specific classification system.(105) Stable fractures are most often defined as dorsal angulation of less than 10°, radial shortening of 2mm maximum, and no radial shift.(106) Fractures outside of these limits generally require reduction, with larger angulation, articulation step-offs, dorsal comminution, and lateral shift of more than 2mm considered contributory factors for fracture instability and indication for more aggressive therapies.(107, 108) Despite the importance placed on these criteria, not surprisingly there are conflicting opinions regarding the reliability of these measurements, which provides reduced confidence that these are absolute criteria, and leads to some uncertainty regarding measurements used in comparison studies as well as in general practice.(109-112)

In cases where there is hardware placed, subsequent hardware removal is indicated in cases of: (1) protruding hardware, (2) pain attributed to the hardware, (3) broken hardware on imaging, and/or (4) positive anesthetic injection response.

## Ganglion Cyst

Ganglion cysts occur in nearly any joint of the hand and wrist and have an estimated prevalence rate of 14%,(113) although prevalence rates based on MRIs are approximately 50%, with asymptomatic ganglia more likely to be volar (palmar) than dorsal.(114) Symptomatic onset is a common work-related claim, but quality studies linking ganglia with work continue to be lacking. Wrist ganglia account for 50 to 70% of all wrist masses identified.(115) Other causes include giant cell tumors also known as localized nodular tenosynovitis and fibrous xanthoma, epidermal inclusion cysts and fibromas. Wrist ganglia are generally classified as either dorsal or palmar, with dorsal ganglia comprising up to 80% and



volar ganglia making up approximately 20% of clinically detected ganglia.(116) Approximately 10% of all hand and wrist ganglia are found on a flexor tendon sheath of the fingers.(117)

A ganglion is a cystic structure, although is not technically a cyst as it has no synovial lining.(118) Electron microscopy shows the walls to be composed of randomly oriented collagen fibers. The gelatinous cystic fluid is likened to synovial fluid, although the composition of hyaluronic acid, glucosamine, globulins, and albumin is not the same.(118)

The pathogenesis of ganglia is unknown and the epidemiology sparse. Contributing factors are also unknown. There are several theories of origin, although each has significant weaknesses and none have been proven. These include the cyst being formed: 1) as a simple herniation of the joint capsule; 2) as a result of an inflammatory process from overuse; 3) as a tear in the joint capsule with subsequent release of synovial fluid and subsequent reaction to the mucinous fluid; 4) as a result of mucoid degeneration of adjacent extra-articular connective tissue; and 5) from joint stress causing mucin secretion by mesenchymal cells in surrounding tissue.(118-121) Each of these theories fails to wholly explain all of the known facts, particularly because there seems to be no inflammatory process.

Most wrist ganglia are asymptomatic. Many patient visits are primarily for aesthetic reasons. A cross sectional study of asymptomatic volunteers who underwent wrist MRI revealed a ganglion prevalence rate of 51%.(114) A symptomatic ganglia were more likely to be volar (palmar) than dorsal.(114)

## Hand Arm Vibration Syndrome

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(122-124) or from vibratory rich activities such as driving off-road vehicles.(125) 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.”(126)

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.(127, 128) There are also several reports of association of CTS with HAVS and exposure to vibration.(127, 129-132)

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.(133) The direct pathophysiological basis for the observed vascular responses of HAVS is not known, but several theories are proposed including vibration causing direct trauma to smooth muscle and smooth muscle vacuoles,(134) vascular spasm related to activation of alpha-2 adrenoreceptor in the vessel walls,(135) or the release of a potent vasoconstrictor known as salivary endothelin.(136) The pathophysiology of neurologic deficits is also unknown, but presumably is related to vibration induced microvascular changes and demyelination.(133)

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.(137) According to the International Organization for Standardization, the risk for developing HAVS is proportional to the total vibration energy measured in magnitude, duration, and frequency.(138) The range of vibration frequencies thought to be harmful is 4Hz to 5000Hz(127, 139, 140) dependent on the intensity, and whether or not it is oscillatory or impact force, with impact vibratory force thought to be more hazardous. There are several exposure limit guidelines for vibration, including for the United States.(141-143) There are other guidelines adopted in the UK and Japan. There is limited epidemiological data to better define the exposure-response relationships for each of the various components of HAVS, however, recent animal models provide some insights into exposure-response patterns.(140, 144-146)

## Laceration Management

Traumatic injuries resulting in skin lacerations of the upper extremity are a common reason for patient visits to an urgent care, occupational medicine clinic or emergency department. Lacerations result from blunt or crush injuries that produce shear forces, or more commonly from sharp objects

which are abundant in the workplace.(147) The majority of lacerations can be treated on an outpatient basis. 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(148) and patient satisfaction.(149) The most optimal results are accomplished by preventing infection through thorough wound cleansing, approximating wound edges with appropriate closure techniques, and providing a proper dressing with a clean moist environment to accelerate wound healing.(150-152)

## Human and Animal Bites and Associated Lacerations

There are no recently reported rates of human and animal bites in the United States. However, extrapolation of emergency department visits and other epidemiological studies from the 1990s indicate there are an estimated 5.0 million dog bites annually, with roughly 750,000 to 800,000 of those bites of significant severity to require medical treatment.(153-155) Data on cat bites are more limited, but they are the second most common animal bite, with an estimated 66,000 emergency room visits,(156) followed closely by human bites.

Although most bites occur from animals known to the victim, occupations that may be at higher risk for animal bites include veterinarians,(157) animal handlers, police officers, utility services personnel who access private property, mail carriers, and other similar professions. Human bites are common in care givers,(158, 159) educators,(160) law enforcement officers,(161) 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. The reported incidence of infection from non-complicated bite wounds from dogs is between 3 and 10%,(162, 163) from cats is 20 to 50%,(153) and from humans is up to 50%.(164) 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. Facial injuries are not considered in this guideline and there may be somewhat different indications as the significance of complications is generally more severe.

## Hand/Finger Osteoarthritis

Hand and finger osteoarthritis is extraordinarily common affecting over 50% of the aged population. These are believed to be largely non-occupational issues,(165, 166) but some may be covered under some workers' compensation jurisdictions, usually under fairly limited circumstances. This is particularly true for mono-articular arthrosis as a consequence of an occupational injury.

## Initial Assessment

Thorough medical and work histories as well as focused physical examinations (see General Approach to Initial Assessment and Documentation Guideline) are sufficient for the initial assessment of the majority of patients with a potentially work-related hand, wrist, or forearm symptom(s). These evaluations should consider assessments of red flags, including the possibility of referred pain to the hand, wrist, or forearm from a disorder in another part of the body (e.g., cervical nerve root or heart). The absence of red flags largely rules out the need for special studies, surgical intervention, or inpatient care the first 4 weeks, as during this time, spontaneous recovery is common (provided any inciting workplace or other factors are addressed).

Hand, wrist, and forearm symptoms can be classified into one of four working categories:

- **Potentially serious hand, wrist, or forearm condition:** fracture, acute dislocation, infection, neurovascular compromise, or tumor.
- **Mechanical disorders:** derangements of the hand, wrist, or forearm related to acute trauma, such as ligament sprain or muscle-tendon unit strain.

- **Degenerative disorders:** resulting from aging or symptoms associated with use, or a combination thereof, such as osteoarthritis, other arthritides, tendinosis, or tenosynovitis.
- **Nonspecific disorders:** occurring in the hand or wrist without clear, specific pathophysiological correlates (most typically includes non-specific pain and sometimes erroneously called “forearm tendinitis”).

## Carpal Tunnel Syndrome

CTS patients typically have a constellation of symptoms with some variation in clinical presentations(8, 167, 168) and a lack of a criterion standard.(10) Symptoms most typically start gradually in the thumb, index, and middle fingers with tingling, numbness, or burning.(11, 167) Symptoms may also include subjective hand swelling.(169) Symptoms often first appear during sleep, possibly due to sleeping with wrists flexed, edema, venous pooling or a combination of factors. The patient may awaken with the desire to “shake out” the hand or wrist. As symptoms worsen, patients may experience tingling during the day particularly after a sustained hand grasp (such as when using a steering wheel or hand tool). Wrist flexors are innervated by the median nerve *proximal* to the wrist. However, decreased thumb and grip strength sometimes occurs and may make it difficult to form a firm fist, sustain grasp particularly of small objects, or perform other manual tasks. In chronic, advanced, and/or untreated cases, the muscles of the thenar eminence may atrophy. Some severely affected patients are unable to differentiate between hot and cold. Symptoms are most commonly documented through detailed recording of symptoms and digits affected or with a hand symptom diagram.(168, 170-174) With the Katz hand diagram, the patient is provided with a form that shows outlines of the arms, and the palmar and dorsal surfaces of the hands. The patient identifies areas of discomfort on the diagrams and characterizes the symptoms (e.g., pain, numbness, tingling, or other). The results are scored by the clinician as “probable,” “possible,” or “unlikely,” depending upon specified criteria.

Patients with CTS should have paresthesias (tingling and/or numbness)(10, 167, 168) but pain in the wrist hand or fingers may or may not be present. In patients with only wrist or hand pain without paresthesias, a diagnosis other than carpal tunnel syndrome may be present. Symptoms of tingling, numbness and pain in the median nerve distribution of the hand are common in the general population (prevalence approximately 14 to 37%). However, based on clinical examination and electrophysiologic testing, CTS prevalence rates range from 2.7% to as high as 13.0%(175-187) while the incidence rate for working populations is near 2.3 per 100 person-years.(188) Differences in diagnostic criteria and population characteristics between these studies may play a role in the differences in reported CTS prevalence.(189)

## Triangular Fibrocartilage Complex (TFCC) Tears

TFCC tears appear to occur either with acute discrete traumatic events and/or as degenerative cartilaginous changes. 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.

## Crush Injuries and Compartment Syndrome

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. Compartment pressure measurements are helpful. 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.

## Kienböck Disease

Patient typically presents with progressive pain and disability and have characteristic wrist x-rays demonstrating changes in the lunate.

## Wrist Sprains

Wrist sprains typically occur with acute traumatic events. The diagnosis is sometimes applied as a diagnosis of exclusion among patients with pain in the setting of trauma with negative fractures. However, the specific entity is

properly defined as a partial ligamentous disruption rather than undefined pain generators. Sprains may also occur as an accompaniment to fracture.

## **Mallet Finger**

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.(21)

## **Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)**

Flexor tendon entrapment generally presents as a relatively simple clinical presentation. Some occur after acute injury, but most occur without specific inciting event.(40, 190-193)

## **Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)**

Extensor tendon entrapment generally presents as a relatively simple clinical presentation. Some occur after acute injury, but most occur without specific inciting event.

## **Ulnar Nerve Entrapment at the Wrist (Including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome)**

Ulnar nerve entrapment at the wrist generally presents as numbness and/or tingling in the fourth and fifth digits. Certain patients may also experience a weakened grip or difficulty with finger coordination.

## **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.(58-60) The medical history should include a search for sensory symptoms. Symptoms may also include pain over the course of the nerve.

## **Non-Specific Hand/Wrist/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. This is a "diagnostic" category to be utilized when symptoms are present, but in the absence of an identified, specific disorder. Most cases will resolve without significant difficulty. 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 (see Chronic Pain Guideline).

## **Scaphoid Fracture**

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. A history of sufficient injury potential is important. Patients frequently complain of persistent swelling and tenderness near the thumb base in the area of the scaphoid. Gripping and wrist motion may be painful.

## **Distal Phalanx Fractures and Subungual Hematoma**

Patients have swelling, reduced range of motion, and tenderness of the fingertip. Patients with accompanying subungual hematoma may have severe throbbing pain and obvious discoloration of the affected nail.

## Middle and Proximal Phalangeal and Metacarpal Fractures

The initial assessment involves a search for confirmation of fracture. Limited or guarded range of motion with pain, local tenderness, swelling, deformity and possibly ecchymosis over the affected area are common.

## Distal Forearm Fractures

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.

## Ganglion Cyst

Most ganglia present as a bump or mass. Occasionally patients with noticeable ganglia will complain of mild nuisance pain, and less often of severe pain. In the assessment of wrist pain in the absence of palpable ganglia, the unexplained wrist pain may be a result of occult ganglia and should be included in the differential diagnosis. The pain from an occult dorsal lesion has been linked to the compression of the posterior interosseous nerve.<sup>(194)</sup> Ganglia have also resulted in compression of the median and ulnar nerves as they pass through the carpal tunnel and condylar groove respectively (see section on Ulnar Nerve Entrapment at the Wrist (Including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome) and Elbow Disorders Guideline).

## Hand Arm Vibration Syndrome

Initial assessment for HAVS is a detailed history and examination focusing particularly on high-amplitude vibratory exposure and sensorineural or vascular symptoms. The clinical symptoms may include episodic tingling, numbness, blanching white fingers, pain and paresthesia, burning sensation, clumsiness, poor coordination, sleep disturbance, hand weakness measured in grip strength, and diffuse muscle, bone and joint pain from the fingers to the elbow.<sup>(42)</sup> Differential diagnosis should consider other causes of Raynaud's phenomenon, including the connective tissue diseases of scleroderma, systemic lupus erythematosus, rheumatoid arthritis, dermatomyositis, and polyarteritis nodosa.

## Laceration Management

A thorough history of the injury, with particular attention to mechanism, potential degree of wound contamination, potential for foreign bodies, and presence of other trauma should be obtained. Crush wounds may be more susceptible to infection, and contamination. Additionally, inquiry of personal factors that may contribute to delayed healing or increased risk for infection, such as diabetes mellitus, chronic renal failure, or the use of immunosuppressive medications should be included.<sup>(195)</sup> Tetanus immunization status should be noted and are recommended to be updated per CDC guidelines (see Table 1. Guide to Tetanus Prophylaxis in Routine Wound Management).

**Table 1. Guide to Tetanus Prophylaxis in Routine Wound Management**

History of adsorbed tetanus toxoid (doses)	Clean minor wounds Tdap or Td†	Clean minor wounds TIG§	All other wounds* Tdap or Td†	All other wounds* TIG§
Less than 3 or unknown	Yes	No	Yes	Yes
3 or more doses¶	No**	No	No††	No

\* Such as (but not limited to) wounds contaminated with dirt, feces, soil, and saliva; puncture wounds; avulsions; and wounds resulting from missiles, crushing, burns, and frostbite.

† For children younger than 7 years of age, DTaP is recommended; if pertussis vaccine is contraindicated, DT is given. For persons 7-9 years of age, Td is recommended. For persons >10 years, Tdap is preferred to Td if the patient has never received Tdap and has no contraindication to pertussis vaccine. For persons 7 years of age or older, if Tdap is not available or not indicated because of age, Td is preferred to TT.

§ TIG is human tetanus immune globulin. Equine tetanus antitoxin should be used when TIG is not available.

¶ If only three doses of fluid toxoid have been received, a fourth dose of toxoid, preferably an adsorbed toxoid, should be given. Although licensed, fluid tetanus toxoid is rarely used.

\*\* Yes, if it has been 10 years or longer since the last dose.

†† Yes, if it has been 5 years or longer since the last dose. More frequent boosters are not needed and can accentuate side effects.

Reprinted from Tiwari T. Chapter 16: Tetanus. In: Roush S, Baldy L, eds. *Manual for the Surveillance of Vaccine-Preventable Diseases*. Atlanta, GA: Centers for Disease Control and Prevention; 2011. Available at: <https://www.cdc.gov/vaccines/pubs/surv-manual/>.

## Human Bites, Animal Bites and Associated Lacerations

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.

## Hand/Finger Osteoarthritis

Most cases of osteoarthritis are believed to result from genetic factors, although discrete trauma is a potential cause. The initial assessment is usually relatively concise and generally involves securing a diagnosis and initiating treatment.

## Medical History

Asking the patient open-ended questions allows gauging of the need for further discussion or make specific inquiries to obtain more detailed information. Hand dominance should be noted. Consider initiating the clinical visit with an open-ended question such as “What can I do for you?” to assure that the chief complaint is addressed. More specific questions for hand, wrist, and forearm conditions include:

### Symptoms:

What symptoms are you having? For how long?

- Do you have pain, numbness, tingling, weakness, or limited movement?
- For traumatic injuries: Did the area swell? If swollen, how quickly did it swell (immediately or delayed)? Was the hand/finger deformed?
- Are your symptoms located primarily in the hand, wrist, or forearm? Do you have pain or other symptoms in the elbow, shoulder, or neck? Anywhere else?
- Are your symptoms constant or intermittent?
- What causes your symptoms to increase?
- What time of the day are your symptoms best? Worst? On getting out of bed? Morning? Mid-day? At work? Evening? While sleeping?
- If symptoms awaken you, how often a week? Each night?
- What makes the symptoms better or worse?
- Have your symptoms changed? How have they changed?

- Can you quantify your pain on a scale of 1 to 10 (10 being unbearable or worse possible pain). It is important to quantify and track the patient's response to evaluate the effectiveness of treatment.
- What have you done to reduce your symptoms?

## Onset (Occupational and Avocational):

How did your symptoms begin? Was there a single, sudden event (e.g., slip, trip, or fall) when your symptoms started or did the symptoms begin gradually?

- Are you able to do your usual job? How do these symptoms limit you?
- Can you do hand intensive activities? Job? Hobbies? Housework? Yard work? For how long?
- Do you work out and use weights/weightlifting while working out?
- Can you perform activities of daily living (e.g., dressing, bathing, grooming, etc.) or instrumental activities of daily living (e.g., shopping, food preparation, housekeeping, etc.)?
- What stops you from doing activities? Are the symptoms worse with workplace activities?
- Can you grasp? How much? Are you dropping things?
- What is your job? What are your specific job activities? Do you use your hand, wrist, or forearm to perform them? What are the most forceful hand activities? How? How often?
- Are there differences in exposures between hands (are symptoms not dissimilar or vice versa)?
- (For discrete trauma): Exactly how did you injure the hand/finger? (Record in detail)
- (For non-discrete trauma): What do you think caused these symptoms? (Record in detail) Proceed with other questions, but return to record details of maximum and typical force, repetition, posture, vibration as appropriate after securing a provisional diagnosis.
- Have the symptoms limited your activities? For how long?
- What are your hobbies? How often?
- Do you use vibrating tools or devices at work or at home (especially high amplitude, low frequency such as older model chain saws)? Do you ride a motorcycle or four wheeler? Do these activities seem to affect your symptoms?

## Current Treatments Used:

What have you used to treat the current symptoms?

- Medications? Splints? Ice/heat? Rest? Relative rest?
- Has any treatment helped? Or, not helped?

## Prior Injuries and Prior Treatments:

- Have you had this problem or similar symptoms previously with this hand? The other hand?
- What makes it better and what makes it worse? Do you have symptoms at night? On weekends? On vacations?
- Have you had previous testing or treatment? Which? What were the results? What seemed to work best in the past?
- What do you think caused your symptoms? Do you think your symptoms are related to work?

## Other Relevant Disorders:

- Do you have other medical conditions? (For example, overweight/obesity, diabetes mellitus, hypothyroidism, other endocrinopathy, pregnancy, osteoarthritis, rheumatoid arthritis, other arthritides, renal disease etc.)

## Carpal Tunnel Syndrome

There are numerous purported risk factors for CTS (see Table 2: Possible Risk Factors for Carpal Tunnel Syndrome), although many have not been confirmed in prospective studies as true independent risk factors. Evidence appears most consistent in the retrospective studies for age, obesity, female gender, diabetes mellitus, and combinations of forceful and repetitive grasping.(6, 12, 196-210, 211, 212) Recent prospective cohort studies of CTS have confirmed the above five factors as apparently true risk factors, including repeated high force grasping, overweight or obesity, female gender, and psychosocial factors.(146, 213-219)

## Table 2: Possible Risk Factors for Carpal Tunnel Syndrome

This list is based on prospective, cross-sectional, and case-control studies, case series, and case reports. Note, this table is not meant to be all inclusive.

Risk Factor	
Trauma	Any past or recent fracture of the wrist Carpal-metacarpal dislocation Casting following a fracture Crush injury Repeated contusions to the wrist Volkmann's ischemic contracture
Developmental or Genetic Causes (Heredity)	Female gender, pregnancy, menopause Age >40 Persistent median artery Enlarged lumbrical or/flexor digitorum superficialis muscle(s) Smaller cross sectional carpal tunnel area – females particularly have smaller wrists Squarer wrists – wrist depth to width ratio of more than or equal to 0.70 Primary familial carpal tunnel syndrome due to thickening of the transverse carpal ligament – thus runs in families Hereditary neuropathic pressure palsies
Swelling and Masses	Ulnar bursitis Ganglion cysts Lipoma or fatty tumor/other tumors Overweight or obesity – usually measured with Body Mass Index – weight (kg)/height (m <sup>2</sup> ) Acromegaly with oversized bones and soft tissues in the wrist Hypertrophic polyneuropathy with median nerve enlargement Proximal lesion of the median nerve (double crush syndrome)
Rheumatological Disorders, including Inflammatory and Non-Inflammatory Arthropathies	Nonspecific tenosynovitis with synovial swelling and thickening Osteoarthritis Rheumatoid arthritis Scleroderma Chondrocalcinosis Dermatomyositis Amyloidosis with amyloid deposits Multiple Myeloma Paget's disease Gout, as well as other crystal arthropathies
Other Inflammatory and Infectious Conditions	Histoplasmosis Sporotrichosis Coccidiomycosis Rubella Leprosy with enlargement of the median nerve Hepatic disease Fibromyalgia Polymyalgia rheumatica Raynaud's disease Infections of the wrist joint or other compartments Lyme disease Tuberculosis
Metabolic, Nutritional, and Alterations in Fluid Balance	Diabetes Mellitus Alcoholism Vitamin B <sub>6</sub> deficiency Pregnancy – presumably due to increased body fluid and swelling Menopause with hormonal imbalance Eclampsia of pregnancy Hypothyroidism – particularly with fluid retention, although other history of thyroid disorders appears to be a risk Renal disease and renal failure – especially with fistulae for hemodialysis Oral contraceptive and estrogen use Glucocorticosteroid use



Risk Factor	
Activities and Avocations	Musical instrument use (e.g., violin, piano) Prolonged driving Prolonged writing Bowling Motorcycle riding (e.g., vibration and handle bar grasp) Snowmobiling Sewing, knitting and crocheting Bicycling
Vocational Activities	Combinations of high force and high repetition especially meat and shellfish processing and some manufacturing positions. Some grocery scanning positions may also be at risk, particularly if handling high volumes of heavy product) Highly repeated forceful grasping

## Triangular Fibrocartilage Complex (TFCC) Tears

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.(14, 220, 221) 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). Commonly reported mechanisms of injury include a fall on an outstretched hand(222-224) as well as sports.(225, 226) Thus, some work-related accidents are reported causes of these tears. Those with occupational cases will tend toward symptomatic onset after a discrete traumatic event such as a slip and fall.

## Crush Injuries and Compartment Syndrome

Patients have pain, and may have paresthesias. 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.(19, 227-231)

## Kienböck Disease

Patient complains of increasing wrist pain, pain with movement, pain with use, and limited range of motion.

## Wrist Sprains

Patients invariably have incurred an acute traumatic event, usually a slip, trip, or fall with forceful loading of the wrist joint usually in a fully deviated position (e.g., full extension). They have pain in the wrist joint, and generally have no swelling.

## Mallet Finger

The mechanism of injury most typically involves forcefully striking the tip of the extended digit on an object (e.g., balls caught by the hands in sports), as well as from falls.(22) Unless there is a fracture, most cases present without significant, post-traumatic pain. Some occur without any trauma and are thought to mostly occur with osteoarthritis and Heberden’s nodes or other chronic joint pathology.

## Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)

Epidemiological evidence is weak, thus lines of query are unclear and causal conclusions tenuous.(40, 232) The mechanism of injury for many appears to be typically idiopathic(40, 190, 192, 233) or as a complication of medical conditions (especially diabetes mellitus and rheumatoid arthritis).(33) However, available epidemiological and biomechanical evidence suggests that the disorder may also occur as a complication of repeated forceful use of a digit,(35, 40, 190, 192, 234-244) or unaccustomed use,(35, 40) thus many cases may be work-related.(29, 40, 245) A careful history of occupational tasks as well as non-occupational exposures is recommended. Symptoms are variable and may include pain, stiffness, clicking, snapping, and locking.(28, 35, 192, 234, 244, 246-249) Pain is generally in the

volar digit and/or metacarpophalangeal joint area.(244, 246-248) Certain patients report worse symptoms in the morning or after lack of use.(40)

## **Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)**

Patients present with wrist pain that is augmented by movement and generally non-radiating,(42) although occasionally pain may spread along the course of the affected tendon sheath.(41, 42) Patients rarely have paresthesias unless there is an accompanying swelling or other mechanism to affect the superficial radial nerve or other digital nerves.(41) Some repeated hand postures with thumb pinching may be associated with de Quervain's disease.(250) There is belief that superficial radial nerve entrapment may accompany de Quervain's and may then produce paresthesias in the first dorsal web space. Triggering is rare.(251)

## **Ulnar Nerve Entrapment at the Wrist (including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome)**

Ulnar nerve entrapment at Guyon's canal typically first presents with symptoms of paresthesias followed by late symptoms of weakness. It is reportedly usually not associated with pain, in contrast with carpal tunnel syndrome that appears to more frequently 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.(50)

## **Radial Nerve Entrapment**

Successful localization of radial nerve entrapment can frequently be accomplished through a careful history and physical exam. The medical history should search for sensory symptoms including paresthesias with precision of the location of the paresthesias to a typical radial nerve distribution on the dorsal hand, particularly in the first dorsal web space.(59) Symptoms may also include pain over the nerve. Distinguishing from other sources of sensory symptoms is usually possible, particularly including radiculopathies and other entrapment syndromes. An assessment of motor symptoms, including wrist extensor weakness as well as wrist drop, are also helpful, particularly in conjunction with absence of weakness in other distributions.

## **Non-Specific Hand/Wrist/Forearm Pain**

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.

## **Scaphoid Fracture**

Historical features most commonly involve a high-energy injury such as a fall on an outstretched, extended hand with immediate, non-radiating pain in the radial carpus. Other common mechanisms include grasping a steering wheel in a frontal motor vehicle crash, or direct blow to the scaphoid such as when using the heel of the wrist as a hammer.

## **Distal Phalanx Fractures and Subungual Hematoma**

Tuft fracture should be suspected when a patient presents with a crush injury or perpendicular shearing force injury to the fingertip, particularly if there is a subungual hematoma. Injuries resulting in avulsion of the nail plate can also be associated with tuft fractures.

## **Middle and Proximal Phalangeal and Metacarpal Fractures**

Careful history regarding the mechanism of injury including and direct axial blow or angular or rotational trauma will reflect substantially on the nature of the fracture and its inherent stability.(78)

## **Distal Forearm Fractures**

There are several types of distal forearm fractures (see Distal Forearm Fractures in the section on General Approach and Basic Principles). There can be a high incidence of TFCC tears with these fractures.

## Ganglion Cyst

Ganglion cysts are usually asymptomatic. The cause is unknown, although the condition appears associated with aging.

## Hand Arm Vibration Syndrome (HAVS)

HAVS can manifest as vasospasm with local finger blanching; sensory and motor disturbances such as numbness, loss of finger coordination and dexterity, clumsiness and inability to perform intricate tasks; and musculoskeletal disturbances such as swelling of the fingers, bone cysts, and vacuoles.(128, 252)

## Laceration Management

Lacerations of sufficient size, depth and those occurring over joints usually require suturing. Tetanus immunization status should be addressed.

## Human Bites, Animal Bites and Associated Lacerations

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 (CDC) and rabies prophylaxis (CDC) should be given if indicated. Most wounds are puncture wounds, but some wounds may be considered for suturing.

## Hand/Finger Osteoarthritis

Patients usually have no recalled acute traumatic event. A minority have a history of significant trauma, such as a fracture or dislocation. Regardless of cause, symptoms usually consist of gradual onset of stiffness and non-radiating pain. Gradual joint enlargement is often present, although frequently unnoticed by the patient. Swelling, erythema, warmth and other signs of infection or inflammation are not present, and if present signal an inflammatory, crystalline arthropathy, septic arthritis or other cause. The history should include symptoms affecting any other joints in the body, presence of other potential causes (e.g., psoriasis, rheumatoid arthritis, gout) to help ascertain the correct diagnosis.

## Physical Examination

Guided by the medical history, the physical examination includes:

- General observation of the patient; and
- Appropriate regional examination of upper limbs (hands, wrists, forearms, elbows, arms, shoulders, and neck).

The general observation involves specification of which distal upper extremity is affected and observation of how much the affected hand or arm is used versus how much activity is avoided – e.g., does the patient shake the examiner's hand or avoid all use of the hand or arm? Does the patient hold the arm without using it? Are there differences in use depending on whether there is active rather than casual observation and examination? These aspects of the physical examination are under-rated, yet perhaps the most important aspects for ascertainment of degrees of impairment and severity of the condition. Most components of the examination are at least in part, subjective since the patient must exert voluntary effort or state a response to a stimulus such as the sensory examination or tenderness. In many cases of hand, wrist, or forearm problems, there are no strictly objective findings. Exceptions include palpable trigger finger, ganglia, thenar atrophy, and fracture-related deformities.

The physician should seek objective evidence of pathology that is consistent with the patient's symptoms. In some cases, careful examination will reveal one or more truly objective findings, such as swelling, deformity, atrophy, reflex changes or spasm, fasciculations, trophic changes, or ischemia. Regardless of whether completely objective findings are present, all findings should be documented in the medical record.

### A. Regional Examination of Hand, Wrist, and Forearm

The inter-related hand, wrist, forearm, arm, shoulder, and neck should be examined individually and functionally together for observation of use, function, swelling, masses, redness, deformity, asymmetry, or other abnormality. The examination should extend to the proximal upper limb and neck. This examination may be followed by evaluating active and passive range of motion within the patient's limits of comfort with the area as relaxed as possible for passive range

of motion. Local tenderness may be accentuated by specific motions or stresses on specific joints, and active muscle contraction may produce pain, indicating a specific tendinosis. If this latter finding is on the dorsoradial side of the wrist, it suggests a diagnosis of de Quervain’s tenosynovitis. Specific areas of decreased pinprick sensation may indicate median or ulnar nerve compression. Flexing the wrist for 60 seconds with elicitation of dysesthesias in the median innervated digits is considered a positive Phalen’s test.

Several purported signs of carpal tunnel syndrome (CTS) have limited specific diagnostic value and the history is believed to be of critical importance in securing a presumptive diagnosis of CTS. The various signs for CTS show a broad range of positive predictive value that is especially dependent on the patient population assessed. Physicians should primarily rely on the clinical history as well as the physical examination. The most sensitive screening methods appear to combine night discomfort, abnormal Katz hand diagram, and abnormal sensibility by monofilament Semmes-Weinstein testing comparing affected with unaffected nerve distributions. Hypalgesia in the median nerve distribution and thumb abduction strength testing also have been found to be helpful in establishing the diagnosis of CTS. The flick “sign” is another diagnostic tool. It reportedly has high sensitivity and specificity; however, it is a historical finding rather than a true physical examination sign. The historical feature is positive when a patient reports shaking his or her hand in an effort to relieve paresthesias.(253) The diagnostic utility of physical examination tests for CTS is unclear as the underlying studies supporting meta-analyses have methods that are not well described. Phalen’s maneuver is thought to be superior to Hoffmann-Tinel’s (“Tinel’s”) sign over the median nerve, although neither perform particularly well.(254)

Trigger finger (tendon) nodules may be palpable with both active and passive range of motion. However, some patients only have tenderness over the flexor surface of the metacarpal phalangeal joints, which may make this examination more difficult. A ganglion may be present on either inspection, or for smaller ganglia, only on palpation. The severity of symptoms on physical examination is usually the basis for aspiration or surgical excisions.

Fractures are most commonly discovered by deformity in the context of focal pain and an inciting trauma history. Some occur without deformity and are only found on x-rays, although most have focal tenderness on a careful palpatory examination.

## B. Neurovascular Screening

The neurologic and vascular status of the hand, wrist, forearm, and upper limb should include peripheral pulses, motor function, reflexes, and sensory status. Examining the neck and cervical nerve root function is also recommended for most patients. For example, a C6 radiculopathy may cause tingling in the thumb and index finger and may affect the wrist extensors while T1 radiculopathy can present as dysfunction of the intrinsic muscles of the hand.

## C. 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

Disorder	Medical History	Physical Examination
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

## Carpal Tunnel Syndrome

The physical examination is particularly helpful for assuring other condition(s) are not present. Some believe the physical examination is highly useful(255) while others suggest the physical examination findings are of limited use in securing a diagnosis as compared with a careful history, and add little to a careful history combined with electrodiagnostic evidence.(10, 254) A recent analysis of signs of carpal tunnel syndrome reported considerable methodological issues, including spectrum biases that likely result in overstatement of the clinical utility of common tests for CTS.(256) Clinical testing for CTS may include several items outlined below. The following describes pertinent history and clinical testing:

- Thenar atrophy – Thenar eminence should appear small compared with the hypothenar eminence and the contralateral hand. This is an advanced sign.

- Hand sensibility – Multiple tests are tested to attempt to determine clinical sensibility. These include Semmes-Weinstein monofilament test, Ten Test, 2-point discrimination, paper clips and various devices. However, sensibility (ability to sense or detect cutaneous stimuli) decreases with age resulting in challenges in interpreting results. Comparison with unaffected digits or the opposite hand is often helpful.(257-260)
- Hypoalgesia in the median nerve territory – Diminished ability to perceive painful stimuli in the median nerve distribution (e.g., palmar aspect of the index finger compared with the ipsilateral fifth digit).
- 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.(261)
- 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.(262) 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.(263)
- Tourniquet Test – Paresthesias developing in the distribution of the median nerve when a blood pressure cuff is inflated above systolic pressure for 60 seconds.
- Hand volume – Hand volume change measured by water displacement in a graduated cylinder.

## Triangular Fibrocartilage Complex (TFCC) Tears

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, either by having the patient place the wrist into a position that elicits the symptoms and/or moving the wrist and forearm through a combined supination movement with simultaneous movement of the wrist from flexion to extension.

## Crush Injuries and Compartment Syndrome

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. Compartment pressure measurements are helpful.

## Kienböck Disease

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.

## Wrist Sprains

The exam may include wrist capsule tenderness, or it may be normal. Deformity suggests fracture. Scaphoid tubercle tenderness suggests scaphoid fracture.

## Mallet Finger

The patient is unable to extend the distal phalangeal segment. Swelling often signifies a fracture fragment, while most are extensor tendon ruptures(264) and have no significant swelling.

## Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)

Patients without triggering will typically have tenderness localized over the A1 pulley.(265) A palpable tendon nodule is frequently present. Triggering often occurs upon arising in the morning or after lack of use. Active movement is often required to demonstrate triggering as passive motion is often normal. Those rare cases with a locked digit are unable to extend (or flex) the digit.(31, 33-35, 40, 190-192, 198, 237, 242, 249, 266-282)

## Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)

The hand is usually normal in appearance, although there is visible tendon sheath swelling in a minority of cases. Swelling is more common with inflammatory conditions (e.g., rheumatoid arthritis) or infections. Some believe swelling and crepitus are also only present among those with peritendinitis if there is no inflammatory or infectious disease. Focal tenderness over the compartment is present. Finkelstein's maneuver is the classic provocative maneuver and is nearly always present,(41) however, the predictive values are unclear. Pain in the affected compartment is generally present with use or any provocative maneuver (e.g., resisted use of the muscle-tendon unit).(42) Triggering may be demonstrated on rare occasions.

## Ulnar Nerve Entrapment at the Wrist (including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome)

Dependent on the location of the lesion, motor, sensory, or mixed motor-sensory findings are detectable. Muscle atrophy may be present in the interosseous and hypothenar areas. Point tenderness may be present. Sensory loss is typically most prominent at the palmar tip of the 5th finger, in contrast with ulnar neuropathies at the elbow which present with sensory loss on the palmar and dorsal surfaces of the 5th digit. Motor weakness may be demonstrated by resisting spreading of the fingers to assess intrinsic muscle strength. A positive Tinel's is purportedly helpful, but there are no quality studies evaluating the utility of this clinical test and its utility elsewhere has been questioned. Associated carpal tunnel compression should also be examined. A vascular exam and auscultation for bruits should be performed,(283) particularly for those cases thought to involve vascular symptoms and hypothenar hammer-like symptoms.

## Radial Nerve Entrapment

The physical examination attempts to localize the site of nerve entrapment and should include sensory (especially sensation) and motor components (movement, range of motion, strength, reflexes) to localize the entrapment. Comparisons to the unaffected limb should be made. Differentiation from de Quervain's tenosynovitis is a primary differential diagnostic consideration, yet Finkelstein's is not particularly helpful as it may be positive with both conditions.

## Non-Specific Hand/Wrist/Forearm Pain

The examination is generally without any unequivocally objective evidence. Instead, tenderness is most often the only physical examination finding. Qualitative muscle strength testing may be weak compared with the unaffected side. Precise documentation of the location of the pain should be made with consideration for photographing the location for future reference. In cases where the pain does not migrate, the probability of specifically defined pathology is believed to increase.

## Scaphoid Fracture

Physical examination findings include antalgic behavior with avoidance of use of the hand, and tenderness over the scaphoid tubercle.(284-286) Scaphoid tubercle tenderness may be more sensitive and specific than snuffbox tenderness. The scaphoid tubercle is located at the volar wrist at the junction of the distal wrist crease under the flexor carpi radialis. The tubercle becomes prominent and readily palpable with radial deviation of the wrist. Patients may also have tenderness over the snuffbox, absence of tenderness in the distal radius, wrist joint effusion,(287-289) and scaphoid pain on axial loading of the thumb (“scaphoid compression test”).(285, 290) However, many of these findings may also be present without scaphoid fracture. An isolated finding of snuffbox tenderness appears to be sensitive, but has poor positive predictive value for scaphoid fracture.(71, 286, 291)

## Distal Phalanx Fractures and Subungual Hematoma

Physical examination should include inspection and identification of localized swelling and open wounds. Neurovascular status should be described. The DIP joint should be palpated in each plane to assess point tenderness over ligament insertions. Passive range of motion and joint stability should be assessed through dorsal, volar, and lateral stressing. An estimate of subungual hematoma size relative to the nail bed surface should be noted. A case series demonstrated fractures in 63% of patients with hematomas greater than 50% of surface area, 43% of patients with hematomas 25 to 50% of nail surface, and 10% in those with less than 25% of nail bed surface involvement.(75) The DIP joint should be evaluated for flexion and extension range of motion.

## Middle and Proximal Phalangeal and Metacarpal Fractures

Prior to fracture manipulation, physical examination includes evaluation of digital nerves using two point discrimination or pin prick, tendon and ligament integrity with active and passive range of motion at each joint, vascular status with capillary refill, and surrounding soft tissue structures of affected areas.(77) Finger shortening or knuckle depression may be present. Bone alignment should be checked for rotational deformity by finger flexion of hand, with the nails pointing toward the scaphoid tubercle. The natural alignment will be disrupted if a rotational fracture is present, such that one finger will overlap another.

## Distal Forearm Fractures

Comprehensive physical examination for traumatic injuries at the wrist as well as elbow, shoulder, neck, head, and hip should be included. Examination of the injured wrist and hand should include neurological and vascular exam, as well as testing for tendon and ligament integrity. The ulnar styloid should be palpated for tenderness as well as the radial head. TFCC should be suspected for displaced or complex fractures, and DRUJ instability may be noted dependent on extent of pain and nature of fracture.

## Ganglion Cyst

Wrist ganglia are usually well demarcated, firmly tethered, and have a consistency similar to a rubber ball, and are translucent. Lack of translucency should raise suspicion of other tumor type. The mass and surrounding skin should be inspected and palpated for erythema and infection. Examination should also include close inspection for mass effect, including neurovascular involvement, impairment of wrist or finger joint range of motion, impairment of tendon function, and triggering. Small occult dorsal wrist ganglia may result in tenderness over the scapholunate ligament and pain with hyperextension of the wrist.(292)

## Hand-Arm Vibration Syndrome

A complete examination should include close attention to motor, sensory and vascular functions of the affected extremities. Evaluation should be extended to the shoulder and neck for upper extremity symptoms including tests for vascular insufficiency. Particular note should be made for blanching, coordination of movement, grip strength, tenderness and swelling of the digits and forearm tissue, and trophic changes of the skin. The value of cold provocation or neurophysiological tests in the diagnosis is controversial.(293, 294)



## Laceration Management

Close inspection of the wound should be performed under proper lighting. Control of bleeding may be required, generally by applying appropriate pressure and elevation to the wound. The wound should be evaluated for damage to underlying structures including joint involvement, vessels, tendons, bone and nerves. Sensory examination should be accomplished prior to anesthetic administration. Examination of involved muscles should be conducted if nerve injury is suspected. Close inspection should be made for foreign bodies.

## Human Bites, Animal Bites and Associated Lacerations

The wound should be carefully cleaned and inspected for depth of injury, potential associated crush injury or fracture, tendon or tendon sheath involvement, foreign body (e.g., teeth, fur, soil), and joint space involvement.

## Hand/Finger Osteoarthritis

Mild cases may show few, if any abnormalities. However, as the disease progresses, more findings develop. Bony enlargement of the affected joint(s) is present on inspection and range of motion is usually reduced. The most commonly affected joint is the thumb carpometacarpal (CMC) joint, which may become enlarged and deformed. Bony enlargement of the distal interphalangeal joints is termed “Heberden’s nodes” while of the proximal interphalangeal joints is called “Bouchard’s nodes.” Crepitus on range of motion is often present. Joints are generally not warm, have no significant joint effusion and are usually non-tender.

## 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	Unique Mechanism (includes only physical factors; in some cases there are other factors)	Unique Symptoms	Unique Signs	Tests and Results
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)
Tuft Fracture	Crush injury to distal phalangeal segment	Pain and deformity of tip of digit. May have subungual hematoma or other deformity(ies)	Crush injury to tip of digit	X-rays with tuft fracture.
Mallet Finger	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.	Unable to extend digit at DIP joint. Usually pain-free if no accompanying fracture.	Incapable of extension at DIP joint. May be swollen, particularly with fracture	X-ray occasionally may show fracture, but usually normal. May not have fracture if extensor mechanism ruptured without fracturing bone

Probable Diagnosis or Injury	Unique Mechanism (includes only physical factors; in some cases there are other factors)	Unique Symptoms	Unique Signs	Tests and Results
Myotendinous Strain	Unaccustomed forceful use. May be from acute loading or fall. Worse pain with motion	Focal pain at a discrete myotendinous junction	Tenderness over myotendinous junction. Pain or weakness on strength or resistance testing of the affected myotendinous junction. Crepitus on motion particularly if accompanied by tenosynovitis or peritendinitis.	None
Tendinosis/ Tendinitis/ tenosynovitis	High force combined with repetition, repeated awkward motions, combinations of physical factors Direct pressure (unusual) Blunt trauma (rare) (Diagnosis of “tendinitis” also frequently used as a diagnostic label for “pain” without pathophysiological correlation.)	Pain localized to flexor or extensor compartment. Triggering may be present if digital flexor compartment involved	Tenderness over discrete flexor or extensor compartment tendon (usually not more than 1 or 2 compartments) Synovial thickening Triggering or locking Crepitus Pain or weakness on strength testing of the affected tendon	None
De Quervain’s Tenosynovitis	High force and repetition with forceful wrist and thumb motion Direct pressure (unusual) Blunt trauma (rare)	Pain over radial styloid in area of first dorsal compartment	Tenderness over radial styloid Mass over radial styloid (rare) Crepitus over extensor compartment Thick tendon sheath Pain upon passive abduction Triggering (rare) Pain worse with ulnar deviation, thumb flexion, adduction, stretch of first dorsal compartment (Finkelstein test)	None
Trigger Finger, Trigger Thumb	High force and repetition Blunt trauma (rare)	Triggering Pain at volar metacarpal phalangeal joint Locked finger	Triggering Tender volar metacarpal crease Tendon nodule Synovial thickening of specific parts of flexor retinaculum	None

Probable Diagnosis or Injury	Unique Mechanism (includes only physical factors; in some cases there are other factors)	Unique Symptoms	Unique Signs	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.)	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. Decreased grip strength Difficulty picking up small objects Hand symptoms diagram	Atrophy or decreased strength of abductor pollicis brevis, opponens (advanced cases) Decreased sensation in median nerve distribution (including monofilaments)	Electrodiagnostic studies
Ulnar Neuropathy at the Wrist and Hypothenar Hammer Syndrome	Repeated striking of the heel of the hand/hypothenar region on a tool or object	Pain in hypothenar region, blanching of ulnar artery distribution (especially 5th digit), Paresthesias in small and ring fingers	Tender hypothenar region, blanching of ulnar artery distribution (especially 5th digit), decreased sensation in small and ring fingers	Ulnar artery Doppler/ultrasound, electrodiagnostic studies
Hand-Arm Vibration Syndrome	Repeated, prolonged use of low-frequency, high-amplitude vibrating tool, especially in cold environments	Pain in the fingers, episodic finger blanching	Blanching of fingers, worse with cold provocation. Ulceration of finger tips when severe.	None
Nonspecific Pain	Unknown as condition is idiopathic; possibly resulting from combination of risk factors. May be psychological condition.	Pain, but non-specific	None	None
Ganglion	Unknown	Painful or painless mass on wrist, hand, or any other joint	Tender (or non-tender) mass most commonly over dorsal or volar wrist or hand	None

## Special Studies and Diagnostic Considerations

For most patients presenting with non-traumatic hand, wrist, and forearm disorders, special studies are not needed during the first 4 weeks. Most patients improve quickly, provided red flag conditions are ruled out. Exceptions include the following:

- In cases of wrist injury, with tenderness over the scaphoid (especially over the scaphoid tubercle), but minimal other findings, a scaphoid fracture may still be present. Initial radiographic images should be obtained, but may appear negative in the presence of nondisplaced scaphoid fracture. If clinical symptoms continue, a re-evaluation with new radiographs is advised in approximately 2 weeks.
- An acute injury to the metacarpophalangeal joint of the thumb, accompanied by tenderness on the ulnar side of the joint and laxity when that side of the joint is stressed (compared to the other side), may indicate a gamekeeper's thumb or rupture of the ulnar collateral ligament of the MCP joint. Radiographic images may show a fracture or stress views, if obtainable, may show laxity. The diagnosis may necessitate surgical repair of the ligament and surgical referral is warranted.

Also, of note, a number of patients with hand, wrist, and forearm symptoms will have associated disease such as diabetes mellitus, hypothyroidism, renal disease, and one or more of the arthritides which are often heretofore

undiagnosed. When medical history and/or physical examination findings indicate or other risk factors are present, testing for these or other comorbid condition(s) is recommended.

## Work-Relatedness

There are numerous occupational and non-occupational risk factors for hand, wrist, and forearm (upper limb) musculoskeletal disorders (MSDs).<sup>(6, 12, 196-198, 201, 202, 205, 206, 208-210, 212, 232, 295, 296)</sup> Most available quality evidence has been reported on CTS, with sparse information on other disorders. While some risk factors (e.g., age, obesity,<sup>(175, 213)</sup> diabetes mellitus, and metabolic syndrome<sup>(297)</sup>) generally appear in common with most MSDs, other risk factors do not appear in common across the disorders (e.g., low density lipoprotein,<sup>(298)</sup> thyroid disorders, pregnancy). The lack of common risk factors across the spectrum of disorders raises questions about the accuracy of generalizing any risk factor, whether occupational or non-occupational across all disorders. Some of these inconsistencies among studies may also be due to lack of statistical power to identify relationships between these factors and upper extremity MSDs.<sup>(29, 145, 175, 213, 215, 217, 299, 300)</sup>

Work-relatedness of hand, wrist and forearm MSDs is dependent on the precipitating exposure(s). For acute, traumatic injuries (e.g., dislocations, true ligamentous sprains, mallet finger, fractures), the work-relatedness is determined by whether the inciting event occurred out of, or in the course of employment. Such determinations of work-relatedness are rarely difficult or controversial.

Non-traumatic MSDs (e.g., CTS, tendinoses, tendinitis, trigger digit) are often difficult to attribute to work to a medical degree of certainty. There are many retrospective studies of these CTS and tendinoses. However, recently there are several prospective cohort studies evaluating risk. One cohort in industrial and clerical workers found the greatest predictors of upper extremity tendinosis were older age, body mass index over 30, shoulder or neck discomfort at baseline, history of CTS and a higher shoulder posture rating.<sup>(300)</sup> Another prospective study of production workers reported associations of hand/wrist tendonitis to repeated forceful pinching at work.<sup>(301)</sup> A prospective study of automobile workers found increased risks for incident cases of CTS included a history of wrist/hand/finger tendinoses, diabetes mellitus, nonneutral wrist and elbow postures, lower social support, and greater differences between baseline median and ulnar nerve peak latencies across the wrist.<sup>(185)</sup> One cohort study of repetitive work in Denmark found incidence rates over 3 to 4 years were too low to compare the risk among those doing highly repetitive work (0.62%) versus more variable work (0.44%).<sup>(302)</sup> However, combinations of forceful and repetitive hand activities at work as combined in the American Conference of Governmental Industrial Hygienists hand-activity level have been found to increase risk of CTS in several prospective studies<sup>(145, 146, 213, 216, 218, 219, 303)</sup> which is consistent with findings from numerous cross sectional studies.<sup>(197, 199, 204, 207, 304-310)</sup> Attributable CTS risk from high-risk occupations in France is estimated to range from 36 to 93%.<sup>(311)</sup>

A thorough work history is crucial to a foundation for establishing work-relatedness. Determining whether a complaint of a hand, wrist, or forearm disorder is related to work requires a careful analysis and weighing of all associated or possible causal factors operative at the time.<sup>(232, 312)</sup> A predominance of work factors suggests that worksite evaluation may be appropriate.

A broad range of ergonomic surveys and instruments is available for measuring range of activity, strain, weights, reach, frequency of motion, flexion, and extension, as well as psychological factors such as organizational relationships and job satisfaction (e.g., Motion Time Measurement analyses, ACGIH TLV for Hand Activity Level, Strain Index).<sup>(143, 313, 314)</sup> To date, the TLV for HAL and Strain Index have been validated. Documentation of job physical factors in conjunction with adverse health effects is often necessary to facilitate and substantiate engineering and organizational changes (see individual sections for discussions of work-relatedness of specific hand, wrist and forearm disorders).

## Carpal Tunnel Syndrome

There are numerous occupational and non-occupational risk factors for CTS, as well as other hand, wrist, and forearm musculoskeletal disorders.<sup>(197, 199, 204, 211, 212, 232, 296, 304, 306)</sup> Many studies on CTS have not used objective measures that included electrodiagnostic testing in case definitions, rather they relied solely on symptoms or combinations of symptoms and physical examination findings (e.g., Hoffman-Tinel's sign).<sup>(197)</sup>

A thorough work history is crucial to a foundation for establishing work-relatedness (see Work-Relatedness Guideline for a method to determine work-relatedness). Non-occupational risk factors that have been most consistently identified

in numerous studies for CTS include age, gender, body mass index (BMI), diabetes mellitus, and wrist depth/width ratio.(6, 12, 196-198, 201, 202, 205, 206, 208-211, 295, 311, 315-318) Physicians should also be aware of the high prevalence of CTS in the general population, its strong relationship with age, and the relatively high prevalence of nerve conduction abnormalities in the population, some of which are asymptomatic.(319) Determining whether a complaint of a hand, wrist, or forearm symptoms are related to work requires a careful analysis and all associated or possible causal factors operative at the time must be weighed.(232, 312) A predominance of work factors suggests that worksite evaluation is likely appropriate and intervention may also be appropriate. A careful ergonomic assessment, work management, and other preventive measures are also suggested when a cluster of cases in a work group occurs.

Based on recent prospective studies, the sustained or repeated application of forceful pinching or gripping is thought to be the most potent work-place activity related risk factor for CTS and hand or wrist tendinosis, particularly when combined with high rates of repetition.(145, 146, 185, 213, 216, 218, 219, 301) The risk appears present when pinch forces are greater than 10 N (1kg).(204, 216, 301) Carpal tunnel syndrome risk appears most strongly increased in jobs involving high-force gripping such as meat processing, manufacturing, and farming.(311, 320-322)

Keyboard use is often a highly repetitive, but very low-force task with very different physical exposures than non-computer work and having many mostly retrospective epidemiological studies previously reported.(302, 318, 323-336) Prospective cohort studies have failed to find associations between CTS and keyboard use,(318, 323, 337, 338) however, one of these studies reported increased risk with increased mouse use in both its baseline/cross-sectional analyses and cohort analyses.(323) Case-control studies have reported conflicting results, with one reporting reduced risk with increased hours spent typing(326) and one reporting increased risk with typing more than 4 hours per day.(333) In several large prospective studies, increasing hours of computer work was associated with tendinosis, de Quervain's disease, and non-specific hand, wrist, forearm and elbow, neck and shoulder pain.(337, 339, 340) Split keyboards have been associated with reduction in pain and disorders.(341, 342) Thus, there is insufficient evidence to relate keyboard or computer activities to CTS.

## **Triangular Fibrocartilage Complex (TFCC) Tears**

Work-relatedness of an acute TFCC tear sustained in the course of a slip, trip, fall, or heavy and awkward lift at work is generally considered an occupational injury and is not usually controversial, although apportionment is a consideration in applicable jurisdictions due to the prevalence of pre-existing degenerative abnormalities, as well as presence and degree of ulnar positive variance (longer ulna than radius, which is thought to be a risk factor for TFCC tears). However, other TFCC tears occurring without an acute, inciting event are of unclear etiology, as the injuries are more analogous to a disease or disorder and there is no quality epidemiological evidence to link them with work. Chronic TFCC tears in the presence of a positive ulnar variance are generally not thought to be occupational.

## **Acute Trauma, including Fractures (e.g., scaphoid, phalangeal, distal forearm), Crush Injuries, Compartment Syndrome, Subungual Hematomas, Lacerations, and Animal Bites**

Causation is based on the specific major incident that produced the injury. Wrist sprains do not occur without an acute, precipitating significant mechanism of injury.

## **Kienböck Disease**

This disorder is a disease without sound epidemiological support for work-relatedness. It may be reasonable to hypothesize work-relatedness in those cases where the onset is promptly after a discrete, significant traumatic event. However, in most cases, a physical cause is speculative.

## **Mallet Finger**

Work-relatedness is generally non-controversial and is based on having an acute accident at work. However, in cases without precipitating injury, work-relatedness is speculative.

## Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)

As the epidemiological evidence is weak, the etiological fraction for occupational tasks is unknown.(37) Thus, work-relatedness is somewhat unclear.(232) The available biomechanical evidence suggests pinch force may be a risk factor.(35, 40, 190, 192, 234-245)

### Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)

Work-relatedness is thought to be present in a significant proportion of cases,(277, 343, 344) although more recent studies have suggested less work-relatedness.(232) Risk factors have not been confirmed in cohort studies, but are thought to particularly involve combinations of force, repetition and posture.(41, 277, 337, 343-345) Direct trauma over the affected extensor compartment is reported in a minority of cases.(41) Risks for intersection syndrome are not well defined. Purported risks appear to be high-force sports related particularly if unaccustomed including rowing, canoeing, racket sports, and weight lifting.(346, 347) Work tasks reported to be risks appear similar with intensive agricultural workers (threshing, planting, hammering, hand washing, spraying, cementing)(43) and recent job change to supermarket cashiering being examples of reported risks.(348) Discontinuation of the high force, unaccustomed activity has been frequently reported to resolve intersection syndrome.(43, 45, 349, 350) Increasing hours of computer work has been associated with extensor compartment tenosynovitis, de Quervain's disease, and non-specific wrist and forearm pain.(337, 339) Those risks may be due to contact stress at the wrist or sustained wrist postures. Split keyboards, which reduce awkward postures, have been associated with reduction in pain and disorders.(341, 342)

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

Ulnar neuropathy at the wrist is reportedly most often caused by a space occupying lesion such as ganglion, scar, abnormal ulnar artery or aneurysm, and trauma(51, 57, 63) (i.e., resulting from hamate fracture). Experimental studies suggest that the nerve moves within the canal with wrist motion, thus traction on the nerve may be possible.(64) In a case series of 47 patients, suspected "cumulative trauma" was attributed to nearly 75% of cases. However, no definition or quantification of physical factors was given. Activities included both mechanisms with potential significant localized compression (e.g., cycling, wheelchair use), those without apparent compression (e.g., piano, truck driving), and those that may or may not have involved compression (e.g. boiler operator, machine press operator, and steel cutter).(50) Other described causes include aberrant muscles at the wrist affecting both median and ulnar nerves,(351) and distal neuropathy caused by systemic diseases, particularly diabetes mellitus and systemic sclerosis (scleroderma).(352-354) As there are no quality epidemiological studies among non-traumatic patients, work-relatedness is speculative in those populations.

## Radial Nerve Entrapment

Radial neuropathy at the wrist is reportedly caused by local mechanical compression of the nerve at the wrist from external trauma, a tight wrist or forearm band, or anomalous brachioradialis tendon.(61, 62) It has been attributed to repeated wrist flexion and ulnar deviation, however, there is no quality epidemiological evidence and thus when occurring in the absence of trauma, work-relatedness is speculative. There may be a better basis for work-relatedness for radial neuropathy with entrapment just above the wrist in the context of concomitant de Quervain's tenosynovitis that is considered work-related.

## Non-Specific Hand/Wrist/Forearm Pain

Work-relatedness is unclear as there are no quality studies of this condition. However, it is generally recommended that the condition be treated and it will generally resolve. Thus, in the absence of costly testing and/or treatment protocols or prolonged duration, the condition is generally non-controversial.

## Ganglion Cyst

No quality epidemiological studies have shown work relatedness. In a cross-sectional survey of more than 30,000 workers in the 1988 National Health Interview Survey, the prevalence of clinical ganglion cyst was estimated at 14%.(113) Of all cases, it was estimated based on patient report of physician diagnosis that nearly 6% were attributed to work. However, there were no analyses based on occupation or activity. There were no quality epidemiologic studies addressing work place or occupational physical factors.

## Hand Arm Vibration Syndrome

Work-relatedness is based on confirmation of the diagnosis and a mechanism of occupational injury where there is an appropriate exposure which is generally low frequency high amplitude vibration.

## Hand/Finger Osteoarthritis

There is one cross sectional study from the textile industry that suggests some cases of hand osteoarthritis may have a component of occupational tasks;(355) however, those jobs are likely no longer present in the U.S. In most patients, multiple joints are symmetrically affected. Yet, occupational exposures are frequently not symmetrical and do not explain this association, thus these cases are usually believed to be non-occupational. However, there are cases of monoarticular osteoarthritis occurring in a joint affected by a remote, traumatic event such as a fracture involving the joint or adjacent to the joint, dislocation or significant sprain. Work-relatedness of those cases is generally non-controversial as it is believed to be a consequence of the acute traumatic event.

## Job Analysis

Some hand, wrist, and forearm symptoms are occupational in origin, with the occupational aspect differing by industry, job task, or by the disorder in question. Decisions about which jobs to analyze, and their prioritization, is of increasing importance as the proportion of affected individuals has been identified as in excess of 50% of the workforce per annum in settings of combinations of high force and highly repeated physical activity. In general, prioritization of job analyses in workplace settings is based on the numbers of affected individuals, reported and perceived rates of MSDs, costs and severity of the disorders, and planned job redesigns. From an occupational health care perspective, ergonomic analysis of a job may also be indicated for failure to improve in the absence of other plausible explanations. The employer's role in accommodating activity limitations and preventing further problems through ergonomic changes may be a key factor in hastening the employee's return to full activity, particularly among workers with a history of high job physical factors. In some cases, it may be desirable to conduct an ergonomic analysis of the activities that may be contributing to the symptoms.

## Carpal Tunnel Syndrome

In certain cases, conduct an ergonomic analysis of the activities that may be contributing to the symptoms should be conducted. A broad range of ergonomic surveys and instruments is available for estimating duration of hand intensive activities, grasp repetition rates, pinch force, part or tool weights, reach distance, frequency of motion, wrist and hand postures, as well as psychological factors such as organizational relationships and job satisfaction.(313) As the most robust data support two of those ergonomic instruments, it would appear most wise to utilize one or both of them (i.e., American Conference of Governmental Industrial Hygienists Threshold Limit Value for Hand Activity,(218, 356) and Strain Index(314)). Such detailed measures may be necessary or useful for modifying work activity, selecting tools, redesigning the workstation, or recommending organizational and management initiatives. Such situations may call for referral to certified professional ergonomists or a human factors engineer, either through the patient or the employer. Some occupational therapists, physical therapists, occupational medicine physicians and other professionals also may have appropriate credentials and experiences to accomplish these evaluations.

## Triangular Fibrocartilage Complex (TFCC) Tears

Job analysis is generally not indicated for most cases, particularly if the focus of the analysis is unclear. However, where there is potential to eliminate a hazard that precipitated the event (e.g., slippery surface), job analysis is recommended.

## Acute Trauma, including Fractures (e.g., scaphoid, phalangeal, distal forearm), Crush Injuries, Compartment Syndrome, Subungual Hematomas, Lacerations, and Animal Bites

Job analyses may be of benefit to attempt to prevent future occurrences of these types of injuries (e.g., machine guarding, icy walkways, tool kickback). Some of these, particularly compartment syndrome and fractures should generally be analyzed for root cause and potential remediation, as these injuries are generally viewed as critical incident cases.

## **Kienböck Disease**

As physical risk factors are undefined, job analyses are unhelpful.

## **Mallet Finger**

Job analysis is generally not indicated for most cases, although where there is potential to eliminate a risk for slips, trips or falls it should be resolved.

## **Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)**

Job analyses may be useful for evaluating for forceful finger use and localized contact stress (e.g., compression by sharp objects).(35, 40, 190, 192, 234-245) There is now prospective evidence that the Strain Index is predictive for trigger digit.(29)

## **Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)**

Job analyses may be useful to identify repeated, forceful digit use, sustained extreme digit postures, or localized compression by sharp objects.

## **Ulnar Nerve Entrapment at the Wrist (Including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome)**

Job analyses may be useful to identify tasks involving considerable hypothenar area localized mechanical compression, as well as use of the hand as a hammer.

## **Radial Nerve**

Job analysis may be useful to identify tasks involving external compression of the radial nerve at the wrist due to occupational tasks.

## **Non-Specific Hand, Wrist, or Forearm Pain**

Job analysis is difficult for many of these conditions, particularly as the discrete entity to be evaluated and job analysis methods are unclear. However, job analyses may also be revealing particularly when there is a high exposure situation (i.e., high force or combinations of high force and other ergonomic risk factors). This may be especially indicated where other cases of musculoskeletal disorders are present in the workforce and may help with the treatment plan.

## **Ganglion Cyst**

There is no quality evidence that the cause of these cysts is work related, thus job analyses are not generally indicated.

## **Hand Arm Vibration Syndrome**

Job analyses are generally indicated for cases with this diagnosis, particularly for primary, secondary and tertiary prevention. The analyses are fairly technical and usually require special equipment to measure vibration exposures.

## **Hand/Finger Osteoarthritis**

Job analysis is generally not indicated for most cases, although where there is potential to eliminate a hazard that precipitated an acute event (e.g., icy sidewalk, tripping hazards), it should be resolved. There have been no quality job analysis tools developed to analyze jobs for risk of hand osteoarthritis.



## Ergonomic Interventions for Distal Upper Extremity Musculoskeletal Disorders with an Occupational Basis

In order to facilitate recovery and prevent recurrence of distal upper extremity musculoskeletal disorders, one may recommend work and activity modifications or ergonomic redesign of the workplace.(357) The employer's role in accommodating activity limitations and preventing further problems through ergonomic changes is crucial in hastening the employee's return to full activity. In some cases it may be desirable to conduct an ergonomic analysis of the activities that may be contributing to symptoms. A broad range of ergonomic surveys and instruments is available for estimating duration of hand intensive activities, grasp repetition rates, pinch force, part or tool weights, reach distance, frequency of motion, and wrist and hand postures, as well as psychological factors such as organizational relationships and job satisfaction. Such detailed measures may be necessary or useful for modifying activity, redesigning the workstation, or recommending organizational and management relief. Such situations may call for referral to a certified ergonomist or a human factors engineer. Alternate keyboard layouts have been used to reduce disorders.(358-361)

- 1. Recommendation: Ergonomic Interventions for CTS and Common Distal Upper Extremity Tendinoses*  
**In settings with combinations of risk factors (e.g., high force combined with high repetition), ergonomic interventions are recommended to reduce risk factors for CTS and common distal upper extremity tendinoses.**  
*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*
- 2. Recommendation: Typing Posture for Prevention and Treatment of CTS and Common Distal Upper Extremity Tendinoses*  
**Mandating typing in a 90° traditional posture is not recommended for prevention or treatment of CTS and distal upper extremity tendinoses.**  
*Strength of Evidence – Not Recommended, Evidence (C) – Prevention*  
*Not Recommended, Insufficient Evidence (I) – Treatment*  
*Level of Confidence – Low*
- 3. Recommendation: Split Keyboards for Treatment of Common Distal Upper Extremity Tendinoses*  
**The use of alternate or split keyboards is recommended among select patients with common distal upper extremity tendinoses.**  
*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*
- 4. Recommendation: Forearm Support for Typing to Prevent Neck/Shoulder Symptoms*  
**Forearm support for frequent computer keyboard users is recommended for potential prevention of neck and/or shoulder symptoms.**  
*Strength of Evidence – Recommended, Evidence (C)*  
*Level of Confidence – Low*
- 5. Recommendation: Trackballs for Treatment of Select Patients with CTS*  
**A trackball (instead of a mouse) is recommended for treatment of select patients with symptoms of CTS.**  
*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*
- 6. Recommendation: Computer Typing Breaks for Patients with CTS, Other Common Extensor and Flexor Hand/Wrist Tendinoses, or for Primary Prevention*  
**Computer typing breaks are recommended for select patients with symptoms of CTS or other common extensor and flexor hand/wrist tendinoses as well as for primary prevention.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

7. *Recommendation: Ergonomics Training in Moderate- or High-risk Manufacturing Settings*  
**Ergonomics training is recommended in moderate- or high-risk manufacturing settings.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

8. *Recommendation: Ergonomics Training for Prevention of MSDs in Office Settings*

**There is no recommendation for or against the use of ergonomics training for the prevention of MSDs in office settings.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

*Rationale for Recommendations*

Ergonomics interventions have been attempted in numerous occupational settings.(362-365) Randomized controlled trials (RCTs) of changes to manufacturing and production positions have not been reported. However, a few RCTs have been reported of keyboard workstations (“office ergonomics”).(342, 362, 363, 366) There is one RCT regarding comparing a dental pick and finding lower pain in the group with the lighter tool that has a wider handle.(365) There also have been quality studies reported regarding participatory ergonomics programs. However, those are mainly reports of patients with spine disorders in programs whose purpose is return to work (see Low Back Disorders Guideline).(367) Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial(365, 368) (see Work-Relatedness). There also are experimental studies of different equipment,(369) although reductions in injuries have not been shown in quality studies.

There are no quality studies of ergonomic interventions for common distal upper extremity MSDs in physically demanding occupations. Interventions which reduce forceful, repeated pinching or alleviating localized compression by sharp objects may be theoretically helpful.(35, 40, 190, 192, 234-245) Quality evidence is not available for effectiveness of ergonomic interventions on MSD injury rates in typical manufacturing settings. However, given available evidence of risk factors, interventions are recommended where there are combinations of risk factors; particularly combined high force and high repetition (see Work-Relatedness). Management/supervisor and labor/employee support are often necessary for optimal success of these programs.

Quality evidence has reported no beneficial effects of the 90° typing posture (seated erect, feet on floor, knees, hips, and elbow joints all at 90° angles), instead it has been found to have the same injury rates as a “laid back” posture.(366) “Ergonomic keyboards” involve a split design that produces a neutral wrist posture in comparison with a standard keyboard that requires approximately 15° of ulnar deviation. However, those keyboards have not been reported in quality studies to result in injury reductions, with the exception of a physically split keyboard with sharply angled keyboard faces.(362) Evidence of superiority of these interventions is currently weak. Providers should be aware that not all split designs are equivalent and there is evidence that a widely split keyboard with sharply angled keyboard faces is not well tolerated.(342) Additional quality studies are needed. Forearm supports for typing have been reported to result in fewer neck/shoulder symptoms.(363, 370) Quality evidence suggests reductions in symptoms may be realized from use of a trackball; however, providers should also be aware that there was a small, non-statistically significant increase in pain complaints among a minority of users.(363) This suggests that careful worksite or clinical observation, combined with instructions to discontinue use if symptoms materially increase, may be desired during this intervention. It also suggests that having multiple options available for workstations is desirable. Quality evidence suggests reductions in neck/shoulder symptoms may be realized through utilization of a forearm support.(363, 370)

Breaks from computer typing have been addressed in a low-quality study which reported reductions in symptoms, but no additional benefit from utilizing exercise during breaks.(371) Various types of breaks have been utilized including stretching breaks and exercise programs.(372, 373, 374{Balci, 2004 #1785, 375-380) Quality evidence supporting the efficacy of breaks is weak, especially for symptomatic patients.(371-373) One low-quality randomized study among an apparently asymptomatic population of temporary data-entry workers suggested fewer symptoms among those taking breaks; however, compliance was low (ranging from 25 to 39%). Breaks are not invasive, have no substantial adverse effects, are low cost, and do not appear to impair productivity.(371, 373, 378, 380-385) Widespread use of these

programs has not been reported in quality studies; however, with no apparent significant cost impacts and studies suggesting potential benefits, breaks are recommended for both primary prevention and treatment of symptomatic patients.

While quality evidence is lacking for the use of ergonomics training, it is thought to be beneficial in high-risk settings. One study suggested that training is inferior to a combination of other interventions in an office setting<sup>(363)</sup> and another found benefits for the neck, but not distal upper extremity.<sup>(386)</sup> Thus, other benefits of training may be possible. However, an RCT comparing wrist splinting with ergonomic education found splinting superior.<sup>(387)</sup> Thus, if there is a benefit, it may be modest, and it is suggested that such training should consist of quality information.

#### *Evidence for the Use of Ergonomic Interventions*

There is 1 high-<sup>(365)</sup> and 5 moderate-quality<sup>(342, 362, 363, 366, 370)</sup> RCTs incorporated into this analysis. There are 4 low-quality RCTs<sup>(372, 388-390)</sup> in Appendix 2.

## Return-to-Work Programs

Return-to-work programs have not been well studied among patients with hand, wrist, or forearm injuries (see Chronic Pain Guideline for discussion of principles). Several studies suggest that job physical demands, lack of job accommodation, and psychosocial conditions are the most important factors in predicting work disability.<sup>(391-393)</sup>

### 1. Recommendation: Return-to-Work Programs for Subacute or Chronic Hand, Wrist, or Forearm MSDs

**Return-to-work programs are recommended for treatment of subacute or chronic hand, wrist, or forearm MSDs, particularly patients with significant lost time.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### 2. Recommendation: Return-to-Work Programs for Acute Hand, Wrist, or Forearm MSDs

**Return-to-work programs are not recommended for treatment of acute hand, wrist, or forearm MSDs.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendations*

There are no quality studies that review the types of return-to-work programs typically found in the U.S. There is one quality study from Spain;<sup>(394)</sup> however, most patients had spine disorders and the program otherwise may have limited applicability due to longstanding, early active management of these issues in the U.S. These programs are thought to reduce morbidity and improve function. They are not invasive, have minimal potential for adverse effects, and are not costly. Return-to-work programs are recommended for management of select patients with hand, wrist, and forearm musculoskeletal disorders with lost time, and may be helpful for proactive emphases on functional recovery.

#### *Evidence for the Use of Return-to-Work Programs*

There is 1 moderate-quality RCT incorporated into this analysis.<sup>(394)</sup> There is one other study<sup>(395)</sup> in Appendix 2 (see Chronic Pain Guideline for additional studies).

## Work Activities

Key factors to consider in disability duration are age and job activities. By communicating with patients and employers, physicians can make it clear that:

- Forceful repetitive grasping may increase forearm, hand, and wrist symptoms.
- Modified work and workplace activity guides may allow for recovery or time to (re)build activity tolerance through exercise.

Significant reductions in unnecessary lost work time can occur when the patient, physician, and employer work together to develop and apply modified work activities.<sup>(396-398, 399)</sup>{ACOEM Stay-at-Work and Return-to-Work Process Improvement Committee, 2006 #3001, 400}

## Carpal Tunnel Syndrome

Some physicians place work restrictions on patients with CTS; others do not. There is no quality evidence to suggest that restrictions are required.

Recommendation: Work Restrictions for CTS

**For patients with CTS, it is recommended that their 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.**

Indications – Select patients with combined forceful and repeated use of the hands or use of high amplitude vibrating tools. Of note, these types of jobs involve a minority of patients with CTS.

Indications for Discontinuation – Resolution, lack of improvement, or desire of the patient to remove limitations.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Moderate

Rationale for Recommendation

There are no quality studies evaluating workplace restrictions; thus, whether patients improve more quickly with activity limitations has not been proven. However, based on available evidence associating combined forceful and repeated use of the hands or use of high amplitude vibrating tools with CTS, work restrictions are recommended for select patients with CTS. These types of jobs involve a minority of patients with CTS. Restrictions are not invasive, likely have few adverse effects, and may be moderate to high cost depending on length.

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.

## Triangular Fibrocartilage Complex (TFCC) Tears

TFCC tears may not require work limitations. However, the more forceful the work and more significant the symptoms, the more likely work limitations will be needed. Work limitations typically include reducing forceful use, wrist rotation, or other activities that provoke symptoms.

## Crush Injuries and Compartment Syndrome

These injuries generally require work limitations depending on task demands. More severe cases require time away from work for recovery from surgery, pain management, and generally require a gradual resumption of usual activities dependent on injury severity and rate of healing.

## Kienböck Disease

There is no evidence that work restrictions are helpful, yet as the condition often progresses, patients typically incur increasing degrees of disability with a progressive need for work limitations. Advanced cases generally require temporary removal from work and surgery, with return to work post-operatively. Post-operative limitations are generally based on a combination of the clinical results (i.e., severity of pain and symptoms) and work demands. Patients with light to medium work may require no limitations, while those with medium to heavy work, particularly with post-operative pain may require significant limitations.

## Wrist Sprains

This injury may or may not require work limitations depending on task demands. However, moderate to severe wrist sprains likely necessitate splinting and limitations.

## Mallet Finger

This injury requires splinting; however, whether there is any need for work limitations involving the digit other than a requirement to wear the splint continuously is unclear. Provided there is no difficulty with wearing the splint, no work limitations are generally needed.

## Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)

Whether work limitations are indicated or helpful is unknown, but may be reasonable for select cases, particularly where contributions from physical factors are more probable such as localized compression from sharp objects or tools.

## Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)

Job modifications are thought to be needed in most of these work-related cases to facilitate recovery.(42)

Recommendation: Modification of Work Activities for Extensor Compartment Tenosynovitis

**Removal from job tasks thought to have caused extensor compartment tenosynovitis is recommended.**

Indications – Patients with combined forceful and repeated use of the hands or combined use with substantially non-neutral wrist postures.

Indications for Discontinuation – Resolution, lack of improvement, or desire of the patient to remove limitations.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

### Rationale for Recommendation

There are no quality studies evaluating the modification of work activities for extensor compartment tenosynovitis. However, where occupational factors are significant, a trial of removal from that type of work may be indicated.(43, 45, 349)

## Ulnar Nerve Entrapment at the Wrist (including Guyon's Canal Syndrome and Hypothenar Hammer Syndrome)

Job modifications are thought to be needed in some cases to facilitate recovery.

Recommendation: Modification of Work Activities for Ulnar Neuropathy

**Removal from job tasks thought to have caused ulnar neuropathy at the wrist is recommended.**

Indications – Patients with forceful use of the hand, especially use of the hand as a hammer with striking of the hypothenar area and development of hypothenar hammer syndrome.

Indications for Discontinuation – Resolution, lack of improvement, or desire of the patient to remove limitations.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

### Rationale for Recommendation

There are no quality studies evaluating the modification of work activities for ulnar neuropathies at the wrist. However, where occupational factors are significant, especially for patients with hypothenar hammer syndrome, a trial of removal from that type of work may be indicated.

## Radial Nerve Entrapment

Job modifications are thought to be needed in a few cases to facilitate recovery.

Recommendation: Modification of Work Activities

**Removal from job tasks thought to have caused radial neuropathy at the wrist is recommended.**

Indications – Patients with radial neuropathies thought to be caused by an ongoing job physical exposure (e.g., striking the radial nerve).

Indications for Discontinuation – Resolution, lack of improvement, or desire of the patient to remove limitations.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

Rationale for Recommendation

There are no quality studies evaluating the modification of work activities for radial neuropathies at the wrist.

However, where occupational factors are significant, a trial of removal from that type of work may be indicated.

## Non-Specific Hand/Wrist/Forearm Pain

Non-specific pain may or may not require work limitations depending on task demands. For patients with high exposures, work limitations are more likely to be helpful. However, in the absence of high force or high force combined with other ergonomic factors, work limitations are at times counterproductive because they enforce debility and do not produce meaningful improvements. In those settings, work limitations may be trialed; however, in the absence of improvement, resumption of regular work activities may be helpful for long-term functional gain.

## Scaphoid Fracture

Activities should be modified to allow for the splinting and immobilization of the carpal bones. In a moderate-quality study comparing surgical fixation to non-operative treatment,(401) the mean range of time for Scottish patients with non-displaced scaphoid fracture to return to normal daily activities living with non-operative treatment was 1 week for dressing, 1 week for washing, 2.8 weeks for shopping, and 2.7 weeks for housework. The mean time for returning to full employment was 11.4 weeks, and to full sports 15.5 weeks. The mean return time of the operative group was not statistically different except to full employment and full sports, which were 3.8 weeks and 6.4 weeks respectively.(401) While operative fixation of non-displaced scaphoid fracture may reduce short term disability, there is a reported 11-fold increased risk of scaphotrapezial arthritis compared with those non-operatively treated.(402)

## Distal Phalanx Fractures and Subungual Hematoma

All work activities that can be accomplished while wearing a finger splint are appropriate. Athletes may return to sports after the initial swelling and pain have resolved, approximately 7 to 10 days. Activities requiring full distal joint mobility and forceful use may be delayed as long as 4 to 6 weeks. Residual tenderness may be present for up to 6 months.(78)

## Middle and Proximal Phalangeal and Metacarpal Fractures

Activities restrictions should provide for immobilization of affected finger or hand, but otherwise activities should be allowed.

## Distal Forearm Fractures

Functional restrictions of the affected extremity are limited by immobilization technique. Activities should be modified to allow for splinting and immobilization of the forearm. Return to work will likely be influenced by the patient and provider's subjective assessment of disability and perception of job difficulty. It may be helpful to refer the patient to an occupational therapist to address the appropriate activity modification, compensatory strategies, adaptive equipment, and environmental modification throughout the period of the patient's recovery and rehabilitation.

## Ganglion Cyst

There is no indication for limiting work activity except for ganglia that are causing significant pain, as there is no reported strong association between activity and exacerbation or causation of ganglia. Those with considerable pain may require limitations to avoid activities provoking increased symptoms, most typically involving forceful use.

## Hand-Arm Vibration Syndrome (HAVS)

1. Recommendation: Vibration Exposure Work Restrictions for HAVS

**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.

Indications for Discontinuation – Resolution or desire of the patient to remove limitations. If the exposure(s) are confirmed and the clinical findings are significant, re-exposure is not believed to be indicated.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Moderate

2. Recommendation: Cold Exposure Work Restrictions for HAVS

**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.

Indications for Discontinuation – Resolution or desire of the patient to remove limitations.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Moderate

### Rationale for Recommendations

Limitation of exposure to total vibration dose should be achieved particularly by limiting the duration and frequency to high-amplitude, low-frequency vibration. Reducing transmission of vibration through isolation and damping techniques may also be attempted, although in a patient with established HAVS, avoidance is generally preferable. Avoidance of cold temperatures that provoke symptoms or wearing gloves if sufficient to control symptoms is warranted.(127) Anti-vibration gloves are sometimes utilized. Recognition and reduction of other ergonomic factors including repeated and sustained exertion, forceful exertions, contact stress, and stressful postures may be helpful.

## Laceration Management

There are no quality studies on return to work and restrictions for upper extremity laceration repair. Movement of injured body parts is thought to promote earlier recovery and minimize disability. Most patients should be able to return to work with appropriate task specific restrictions while the wound is healing. Accommodation for prescribed medications, elevation, splinting and modalities such as use of heat or ice may be necessary. While there is no quality evidence for any of these modalities, keeping the wound dry for the first few days, splinting, elevation, and heat or ice are simple techniques that are believed to be helpful. Splinting is generally limited to extensor surface lacerations that cross a joint and involve sufficient tension to pull wound edges apart.(403)

## Human and Animal Bites

Work activities are expected to be minimally impacted except for limitations related to treatment of laceration or infection.

## Hand/Finger Osteoarthritis

Hand osteoarthritis generally requires no work limitations. When the disease progresses to moderate or severe disease, work limitations may be required due to the impairment and or pain.

## Initial Care

Initial treatment should generally be guided by implementing the strongest evidence-based recommendations that are considered first-line interventions. Exceptions include those treatments that are accepted as best practices, but have not been subjected to RCTs or crossover trials (e.g., antibiotics for diabetics with “dirty” lacerations). Careful consideration of the indications and limitations described in the full text for each recommendation is critical to understanding the best application for each intervention. If treatment response is inadequate (i.e., if symptoms and activity limitations continue), second- and third-line recommendations may be considered. Physicians should consider the possibilities of diagnosed and previously undiagnosed medical diseases such as diabetes mellitus, hypothyroidism, and various arthritides. Adverse effects, cost, and provider and patient preferences should be considerations in guiding the choice of recommendations. Part of the initial treatment plan for all disorders should include patient education. For most diagnoses, this is critical to successful treatment.

*Recommendation: Education for Hand, Wrist, or Forearm Disorders*

**Education is recommended for select patients with hand, wrist, or forearm disorders.**

*Frequency* – One or 2 appointments for educational purposes. Additional appointments may be needed if education is combined with occupational or physical therapy treatments. Follow-up educational visit(s) for more severe disorders as part of a progression towards normal functional use is sometimes helpful.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

*Rationale for Recommendation*

There are no quality studies specifically evaluating efficacy of patient education for utility or necessity in treatment of hand, wrist, or forearm disorders. Yet, for many disorders (e.g., criticality of maintaining splinting of mallet finger, cast management, monitoring for signs of infection) education appears essential. Some physicians accomplish this in the course of extended patient visits, while others routinely refer patients to an occupational or physical therapist for education. Regardless of the approach, a few appointments for educational purposes are recommended for select patients. The number of appointments is dependent on the diagnosis, severity of the condition, and co-existing conditions. Although education is usually incorporated as part of the overall treatment plan, an additional 1 or 2 appointments for purely educational purposes may be helpful midway through a treatment course for the more severely affected patient. In addition, education is low cost and thus is recommended.

## Follow-up Visits

Patients with potentially work-related hand, wrist, and forearm symptoms should generally have a follow-up visit approximately every 3 (severe disorders) to 7 days (typical disorder severity) to monitor function, medication use and/or a physical or occupational therapist visit for counseling regarding contributing physical factor avoidance (e.g., reducing force, avoiding static positions), sleep posture, and other concerns. More frequent follow-up is usually required for patients who are not working. Care should be taken to answer questions and make these sessions interactive so that the patient is involved in his or her recovery including identifying potential barriers to recovery and return to normal function and work. More specific guidance for follow-up visits may be included in the discussion of each disorder topic.

## Amputations and Indications for Replantation

The decision for amputation or replantation should be made by a physician who has training and experience in treating amputations and replantations. The key for the initial physician or health care provider is to reduce the warm ischemia time of the amputated part – the time without any preparation of the amputated part. This is best done by washing the amputated part in saline and wrapping it in saline soaked gauze, putting it into a plastic bag if possible, and then placing it onto cardboard that is laid over ice in a cooler or jug. The part of the body where the amputation has occurred should be covered with a compression dressing. Vascular control is important. Attempts to use clamps to control bleeding often damage the neurovascular structures and should not be used. Indicators that are used to suggest replantation success include thumb amputation, multiple digit amputations, amputation at a



metacarpal amputation, almost any body part amputated in a child, wrist or forearm amputation, and individual digit amputated distal to flexor digitorum superficialis (FDS) insertion.

Contraindications may include ring avulsion injuries, severely crushed or mangled parts, amputations at multiple levels, amputations in patients with other serious injuries or diseases, arteriosclerotic vessels, mentally unstable patients, distal amputations (finger tip injuries), individual finger in adult proximal to the FDS insertion and prolonged warm ischemia. Prolonged warm ischemia is defined as more than 6 hours for proximal replantations (wrist), and 12 hours for digits, although some physicians will attempt replantation after 6 hours of warm ischemia, and 24 to 30 hours ischemia time (time from amputation until replant with the digit stored in cool container as described above) for digital replantations.

## Carpal Tunnel Syndrome (CTS)

### Diagnostic Criteria

Patients with a presumptive diagnosis of CTS should have both paresthesias in the median nerve distribution and symptoms that are either nocturnal or provoked. Paresthesias are tingling or numbness in a median nerve distribution, (vibrotactile testing has been utilized to attempt to objectify sensory findings, but appears to not perform particularly well)(404) generally involving at least two median nerve-served digits (they may also have pain – pain is not the primary symptom, there is also some evidence for more non-neurologic pain in workers' compensation patients(405)– or burning in a median nerve distribution, but should have paresthesias); and 2) symptoms that are provoked either nocturnally or with sustained grasp (e.g., holding a tool, steering wheel or newspaper).

Patients with a confirmed diagnosis of CTS should have both symptoms as with a presumptive diagnosis above, and either: 1) a confirmatory electrodiagnostic study (EDS) interpreted as consistent with CTS, or 2) largely or completely resolved symptoms with injection of a glucocorticosteroid.

The differential diagnosis for carpal tunnel syndrome (CTS) particularly includes pronator syndrome; C6 and C7 cervical radiculopathies; and other neurological entrapments located between the spinal cord and median nerve in the carpal canal including thoracic outlet syndrome, diabetic neuropathy, neuropathy from alcohol, other systemic neuropathies, stroke, other cerebrovascular events, and central nervous system tumors. Most other causes may be eliminated or the probability reduced by conducting a careful history, physical exam, or focused testing.

### Special Studies and Diagnostic and Treatment Considerations

#### Electrodiagnostic Studies

Appropriate electrodiagnostic studies (EDS), including nerve conduction studies (NCS), may help differentiate CTS from other conditions such as cervical radiculopathy, other median nerve neuropathies, or ulnar neuropathy at the elbow.(10, 177, 180, 183, 184, 406-448) In select or more difficult cases, especially if cervical radiculopathy is a concern, electromyography (EMG) studies should be incorporated.(406) 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.(171) Thus, EDS testing in a patient with a low pre-test probability of CTS may result in inappropriate diagnosis of CTS. EDS has been purportedly not useful in diagnosing clear-cut CTS cases.(449)

The American Association of Electrodiagnostic Medicine, the American Academy of Neurology, and the American Academy of Physical Medicine and Rehabilitation jointly published a practice parameter for electrodiagnostic studies in CTS.(406) However, the quality of EDS varies widely in practice(450) and this practice guideline is sometimes not adhered to, requiring the treating physician to be familiar with these issues to better interpret the findings in a clinical context. Additionally, cut-off points for abnormal values have yet to be fully standardized and the correlations between symptom severity and EDS severity are not uniformly strong.(11, 167) In patients with suspected CTS where

electrodiagnostic confirmation would alter treatment plans, the following EDS studies are recommended (in the majority of these studies, the hand temperature should be 32°C or warmer):(406)

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 (1741).
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. Needle EMG is optional for some cases. It is primarily used for evaluation of cervical radiculopathy, as well as axonopathies (406).
7. If abnormal in the index limb, then measuring the contralateral limb is helpful for both comparison and for diagnosis of systemic disorders.

1. *Recommendation: EDS for Diagnosis and Pre-operative Assessment of CTS*

**Quality EDS (see above) are recommended to assist in securing a firm diagnosis for those patients without a clear diagnosis of CTS. EDS are also recommended to objectively secure a diagnosis of CTS prior to surgical release.(451) If EDS is elected, needle EMG is important to differentiate between cervical radiculopathy and entrapment, although it is not required in all CTS cases. EDS of the contralateral limb may be necessary in some, if not most cases especially to assess cervical radiculopathy and axonopathies.**

*Frequency* – A repeat study at 3 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.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Moderate

2. *Recommendation: EDS for Initial Evaluation of CTS Patients*

**EDS is not recommended for initial evaluation of most CTS patients with a confirming history and clinical signs as it does not change the management of the condition. EDS is also 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.**

*Strength of Evidence* – **Not Recommended, Insufficient Evidence (I)**

*Level of Confidence* – High

3. *Recommendation: Commercial Products for Performing EDS for CTS Patients*

**There is no recommendation for use of automated devices to accomplish EDS.(452, 453)**

*Strength of Evidence* – **No Recommendation, Insufficient Evidence (I)**

*Level of Confidence* – Low

*Rationale for Recommendations*

EDS are the only unequivocally objective measures of median nerve function.(10, 406, 451, 454-456) However, there are both false-positive and false-negative test results that demand that the physician understand the pre-test

probabilities and be capable of interpreting the results and placing them in an appropriate clinical context. For example, EDS should not be ordered in settings where the clinical history suggests a low likelihood of CTS because the probability of a false-positive test result may be well above 50%. EDS are primarily of assistance in: 1) identifying an anatomic location of nerve conduction slowing; 2) identifying objective evidence for alternate diagnostic considerations (e.g., cervical radiculopathy, axonopathies); and 3) quantifying nerve function to assure the physician that an operative state such as CTS is present. EDS are not invasive or minimally invasive (depending on whether the EMG component is required), have minimal adverse effects, and are high cost. They are recommended for evaluation of select cases, especially if the diagnosis is unclear or surgery is planned.

There are other commercial diagnostic products;(452, 453, 457, 458) and some studies have suggested there may have sufficient accuracy,(445, 452) however, there are relatively few studies available and thus the use of these studies may be currently limited to where there is both no concern about radiculopathy and other disorders and the EDS test is not readily available (e.g., due to distance geographical issues). Thus, there is no recommendation for or against their use.

#### *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.*

## **Ultrasound (Diagnostic)**

Ultrasound and high resolution sonography have been investigated for the evaluation and diagnosis of CTS.(476-487)

#### *Recommendation: Ultrasound for Evaluation and Diagnosis of CTS*

**Ultrasound is not recommended for diagnosing CTS.**

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**

Level of Confidence – Moderate

#### *Rationale for Recommendation*

Multiple moderate-quality comparative studies report that ultrasound does not outperform and often modestly underperforms compared with EDS for the diagnosis of CTS.(465, 482, 484, 488, 489) Thus, ultrasound is not recommended for diagnosing CTS. There are other diagnostic uses of ultrasound at the wrist (e.g., evaluating a cyst).

#### *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.*

## Magnetic Resonance Imaging and Diffusion Tensor Imaging

MRI and especially diffusion tensor imaging (“diffusion MRI) are being investigated for the evaluation and diagnosis of CTS.(493-543)

*Recommendation: MRI and Diffusion Tensor Imaging for Evaluation and Diagnosis of CTS*

**MRI and Diffusion Tensor Imaging is moderately not recommended for diagnosing CTS.**

Strength of Evidence – **Moderately Not Recommended, Evidence (B)**

Level of Confidence – Moderate

### *Rationale for Recommendation*

Multiple moderate-quality comparative studies report that MRI and Diffusion Tensor Imaging do not outperform and often modestly underperform compared with EDS for the diagnosis of CTS.(469, 544-546) Thus, MRI and Diffusion Tensor Imaging are not recommended for diagnosing CTS. There are other diagnostic uses of MRI at the wrist.

### *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.*

## Monitoring Progress

The clinical evaluation and progress of patients is most commonly monitored qualitatively from appointment to appointment. Particularly, physicians seek information regarding the degree to which symptoms are present and whether the patient believes there has been improvement. However, there are several instruments that may be utilized for monitoring the progress of patients with CTS.(553) These include the DASH(554-575) and Boston Carpal Tunnel Questionnaire.(407, 517, 554, 555, 558, 559, 563-565, 567, 569, 570, 572, 575-596) Michigan Hand Outcomes Questionnaire (MHQ) has been used in many studies as a measurement outcome of CTS.(566, 574, 578, 597) The Short Form-36 (SF-36),(561, 567, 576) the Flinn Performance Screening Tool (FPST),(598) the Patient Evaluation Measure questionnaire (PEM),(560, 575) the Amadio questionnaire,(571) the Historical-objective-distribution based scale (Hi-Ob-Db),(579, 591) and the Alderson-McGali hand function questionnaire (AMHFQ)(576) have been used to diagnose CTS. VAS symptoms and pain scores may also be used(561, 565, 576) even though many patients with CTS have no pain. Functional status scores(407, 554, 567, 571, 577, 582, 586, 587, 589, 592, 594, 598-600) and Global Symptom Scores(601) are also used, particularly in some research studies. Grip strength(560, 565, 576, 583, 584, 589, 596, 602-605) and pinch strength measures(560, 565, 576, 581, 583, 584, 588, 596, 602, 604) may be utilized. However, patients who have mild symptoms generally have normal grip strength. All of these questionnaires are subjective and strength measures are effort-dependent, although the strength measures attempt to provide a quantitative measure that may help to gauge improvement over time especially post-operatively.(554, 558, 564, 578, 586, 594, 601, 606-609)

*Recommendation: Instruments for Monitoring the Progress of Patients with CTS*

**There is no recommendation for or against the use of instruments to monitoring the progress of patients with CTS.**

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Level of Confidence – Low

### *Rationale for Recommendation*

There is no quality evidence that any of these instruments meaningfully contribute to improving clinical care. They may be more useful in the post-operative setting.

## Evidence for the Use of Monitoring Progress

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: monitoring progress: disabilities of the arm, shoulder and hand questionnaire, Boston carpal tunnel questionnaire, VAS symptoms score; VAS pain score, functional status scores, global symptom scores, grip strength, pinch strength, carpal tunnel syndrome, median neuropathy, carpal tunnel syndrome/diagnosis, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, median nerve, median neuropathy, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency. We found and reviewed 527 articles in PubMed, 123 in Scopus, 32 in CINAHL, and 23 in Cochrane Library. We considered for inclusion 59 from PubMed, 2 from Scopus, zero from CINAHL, zero from Cochrane Library and zero from other sources. Of the 61 articles considered for inclusion, 59 diagnostic studies and 1 systematic review met the inclusion criteria.

## Specific Treatment Interventions

### Activity Modification and Exercise

#### EXERCISES

Various exercise regimens have been utilized to treat patients with CTS, most commonly tendon-gliding and nerve-gliding exercises.(610-617) These exercises are thought to help prevent adhesion formation.(615, 618-620)

#### 1. Recommendation: Exercises for CTS Patients with Significant Deficits

##### **Exercise is recommended for CTS patients with significant deficits.**

Indications –CTS patients with significant functional deficits, especially more commonly in the post-operative period.

Frequency/Dose/Duration – Appointments scheduled generally weekly for up to 5-6 visits. If there have been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

#### 2. Recommendation: Exercises for Treatment of Acute, Subacute, or Chronic CTS

**There is no recommendation for or against the use of exercises for treatment of CTS in the absence of functional deficits, as quality evidence is lacking.** Exercises and therapy are indicated where there are deficits (see above).

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Level of Confidence – Low

#### Rationale for Recommendations

There are multiple moderate quality studies, but none has clearly found benefit of exercises, including tendon-gliding, for treatment of CTS. One moderate-quality study suggested no statistically significant incremental benefit from adding tendon-gliding exercises to wrist splinting,(610) although modest trends towards benefit appear present. Another moderate-quality study found a combination of tendon-gliding exercise with ultrasound and splinting superior to two other combinations.(611) Thus, it is unclear if there is an independent benefit from tendon-gliding exercises. Additionally, as many believe that physical activity is a risk factor for CTS, the logic of performing exercises for treatment is somewhat dissonant. However, exercise programs are not invasive, have few if any adverse effects, and are low cost if performed independently after receiving initial instructions. Exercise would be advised for those with

functional deficits, such as grip strength (see Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders section for guidance that may be adapted for such patients).

#### *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.*

#### **YOGA**

Yoga has been used to treat CTS,(628) although its main uses have been in treating spine pain and other more widespread MSDs (see Chronic Pain and Low Back Disorders Guidelines).

*Recommendation: Yoga for Treatment of Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against the use of yoga for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There is one moderate-quality RCT that suggested improvements in grip strength; however, the comparative population had an inactive splint for treatment which may have created an artificial difference in grip strength.(628) While yoga appears beneficial for treatment of spine patients,(629) there is no evidence of efficacy for distal upper extremity MSDs. Yoga is not invasive, has low potential for adverse effects, and is low cost. Compliance and adherence are reportedly not good, as patient motivation must be high and there is much self-selection in studies assessing yoga's efficacy.

#### *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.*

## **Medications**

### **NSAIDs/Acetaminophen**

Nonsteroidal anti-inflammatory drugs (NSAIDs) have been widely used to address beliefs in inflammatory mechanisms of CTS or to manage pain associated with CTS(630-635) (see Chronic Pain Guideline for detailed discussion on mechanisms of action, classes of medications, adverse effects, etc.). Acetaminophen and paracetamol are sometimes utilized to treat CTS, although their effects on cyclooxygenase activity are minimal and they are not anti-inflammatory.

1. *Recommendation: NSAIDs or Acetaminophen for Acute, Subacute or Chronic CTS*

**NSAIDs or acetaminophen are not recommended as a primary treatment for acute, subacute or chronic CTS.**(636) NSAID use may be reasonable in cases thought to have an inflammatory component.

*Strength of Evidence – Not Recommended, Evidence (C)*

*Level of Confidence – Low*

*Recommendation: NSAIDs for Post-operative Management of CTS-related Pain*

**NSAIDs are moderately recommended for post-operative management of CTS-related pain.**

*Indication* – Patients having recently undergone carpal tunnel surgical release. Generally, treat 2 weeks up to 6 weeks post-op unless complications occur.

*Frequency/Dose* – See manufacturer’s recommendations.

*Indications for Discontinuation* – Resolution of pain, adverse effects, intolerance.

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – High*

*Recommendation: Acetaminophen for Post-operative Management of CTS-related Pain*

**Acetaminophen is recommended for post-operative management of CTS-related pain.**

*Indication* – Patients having recently undergone carpal tunnel surgical release. Generally treat 2 weeks up to 6 weeks post-op unless complications occur.

*Frequency/Dose* – See manufacturer’s recommendations.

*Indications for Discontinuation* – Resolution of pain, adverse effects, intolerance.

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

*Rationale for Recommendations*

While NSAIDs have been widely used to attempt to address a theoretical inflammatory basis for CTS and/or to treat pain associated with CTS, the one quality study comparing an NSAID to placebo found no benefit from the NSAID.(636) This same study also found no difference between NSAIDs and diuretics which also appear ineffective. There is also no quality evidence that there is a difference among NSAIDs (see Hip and Groin Disorders Guideline). Thus, there is quality evidence that NSAIDs do not have a role in the treatment of typical cases of CTS.(636) Cases of CTS thought to have an inflammatory component (e.g., inflammatory rheumatoid conditions) are reasonable exceptions where NSAID and/or acetaminophen use may be appropriate.

Other studies comparing NSAIDs with manipulation plus ultrasound(637) and lidocaine patch(638) did not find benefits of NSAIDs compared with those treatments. A trial combining splinting (which appears effective) plus NSAID versus glucocorticosteroid injection did not find one arm to be superior.(631) While some patients may benefit from NSAIDs, evidence is lacking that there is any beneficial effect of NSAIDs for treatment of CTS and aggregate analyses of these studies also suggest NSAIDs are ineffective.(636-638) Acetaminophen is thought to also be ineffective.

NSAIDs are not invasive and have low adverse effects profiles, particularly when used for short courses in occupational populations. Generic or over-the-counter formulations are low cost. However, there is quality evidence that other interventions are effective. A short course of an over-the-counter NSAID may be reasonable for select patients; however, routine use of NSAIDs for treatment of CTS is not recommended. Select patients with acute CTS due to unaccustomed forceful use may be potential candidates for treatment with NSAIDs; however, that population has not been studied in quality trials.

There is one high-quality study in post-operative patients indicating that for post-operative pain management, naproxen is superior to acetaminophen, which in turn is superior to placebo.(639) NSAIDs and acetaminophen may also facilitate the rehabilitation process without the impairments associated with opioids. Thus, NSAIDs and acetaminophen are recommended for post-operative pain management.

*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.*

## **Systemic Glucocorticosteroids (AKA “Steroids”)**

### **ORAL**

Glucocorticosteroids are used to treat CTS and other tendinoses through both oral and injection routes (injections for CTS and other tendinoses).(636, 643-648) Although these medications are considered to be anti-inflammatory corticosteroids, absent an inflammatory arthropathy or infection, CTS does not typically evidence inflammation. Thus, the exact mechanism of action is uncertain. Regardless, evidence indicates that carpal tunnel injections are superior to oral steroids for treatment of CTS.(648)

*Recommendation: Oral Glucocorticosteroids for Treatment of Acute, Subacute, or Chronic CTS*

**Oral glucocorticosteroids are moderately recommended for 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.(648) However, for patients declining injection, oral glucocorticosteroids may be warranted. Oral glucocorticosteroids are relatively contraindicated for patients with diabetes mellitus and may worsen glucose intolerance among those who are pregnant.

*Frequency/Dose* – It is unclear what dose and duration of treatment is optimal. Two trials used 10 days of treatment with prednisolone acetate 25mg a day.(646, 648) A third used prednisolone 20mg a day for 2 weeks, then 10mg a day for 2 weeks.(636, 647) Another used prednisone 20mg a day for 1 week, then 10mg a day for 1 week.(644) Another used prednisolone 20mg a day for 2 weeks on one treatment arm.(643) There is evidence that 2 weeks of treatment is as effective as 4 weeks.(643) 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.

*Strength of Evidence* – **Moderately Recommended, Evidence (B)**

*Level of Confidence* – Moderate

(Note: Injections are recommended as superior to oral forms.)

### *Rationale for Recommendation*

There is strong evidence that injected glucocorticosteroids are more effective(648) with longer duration of benefits. Nevertheless, there is consistent evidence that oral glucocorticosteroids are superior to placebo,(636, 643, 644, 646) as well as compared with diuretics and NSAIDs.(636) Unlike glucocorticosteroid injections, long-term follow-up studies have not been reported, thus duration of benefit is unclear. However, oral glucocorticosteroids are not invasive, have relatively few adverse effects for a short course, and are low cost.

### *Evidence for the Use of Oral Glucocorticosteroids*

See Intracarpal Tunnel Glucocorticosteroid Injections (“Steroid Injections”).



## Diuretics

Diuretics have been used to treat CTS, in part due to observations of swelling in some patients. (359, 634, 636, 649-652)

*Recommendation: Diuretics for Treatment of Acute, Subacute, or Chronic CTS*

**Diuretics are moderately not recommended for treatment of acute, subacute, or chronic CTS in the absence of fluid retention states.**

*Strength of Evidence – Moderately Not Recommended, Evidence (B)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There are two quality studies evaluating diuretics for treatment of CTS patients and both failed to find evidence of efficacy compared with placebo. (636, 652) Thus, diuretics are not recommended for routine treatment of CTS patients. Whether they are effective for treatment of patients with CTS accompanied by fluid retention states, such as third trimester pregnancy, has not been determined in quality studies, and thus their use in select cases may be a reasonable intervention.

### *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.*

## Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol)

Opioids have been rarely used to treat pain for patients with CTS, and are generally not indicated. Post-operative use may be reasonable, but use beyond 5 days is associated with worse outcomes (1748). Opioids are addressed in a separate Guideline. The treatment recommendations are summarized below. See Opioids Guideline for all supporting evidence.

### **ACUTE PAIN (UP TO 4 WEEKS)**

1. *Recommendation: Routine Use of Opioids for Treatment of Non-Severe Acute Pain*

**Routine opioid use is strongly not recommended for treatment of non-severe acute pain (e.g., low back pain (LBP), sprains, or minor injury without signs of tissue damage).**

*Harms* – May inadequately treat acute, severe pain.

*Benefits* – Faster recovery, less debility, reduced accidents risks, risks of dependency or addiction.

*Strength of Evidence – Strongly Not Recommended, Evidence (A)*

*Level of Confidence – High*

2. *Recommendation: Opioids for Treatment of Acute, Severe Pain*

**Opioids are recommended for treatment of acute, severe pain (e.g., crush injuries, large burns, severe fractures, injury with significant tissue damage) uncontrolled by other agents and/or with functional deficits caused by pain. They also may be indicated at the initial visit for a brief course for anticipated pain accompanying severe injuries (i.e., failure of other treatment is not mandatory). A Schedule IV<sup>1</sup> opioid may be indicated if there is**

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<sup>1</sup>USA classifies controlled substances that includes a classification system, ranging from Class 1 to Class V corresponding to lower risks of abuse and dependence. Class I includes substances with a high potential for abuse and without a recognized medical use (e.g., heroin, marijuana, LSD). Class II includes most opiates, amphetamines and cocaine. Class III includes buprenorphine, dihydrocodeine, hydrocodone/codeine when compounded with an NSAID, Marinol. Class IV includes tramadol (in some states), carisoprodol, benzodiazepines, and long-acting barbiturates. Class V includes small amounts of codeine (e.g, 30mg, 60mg).

**true allergy to NSAIDs and acetaminophen, other contraindication to an alternative medication, or insufficient pain relief with an alternative. Recommend to taper off opioid use in 1 to 2 weeks.**

*Indications* – Patients should meet all of the following:

- 1) Severe injury with a clear rationale for use (objective functional limitations due to pain resulting from the medical problem, e.g., extensive trauma such as forearm crush injury, large burns, severe radiculopathy).<sup>2</sup>
- 2) Other more efficacious treatments should have been instituted,<sup>3</sup> and either: a) failed; and/or b) have reasonable expectations of the immediate need for an opioid to obtain sleep the evening after the injury.
- 3) Where available, prescription databases (usually referred to as Prescription Drug Monitoring Program (PDMP)) should be checked and not show evidence for conflicting opioid prescriptions from other providers or evidence of misreporting.<sup>4</sup>
- 4) Non-opioid prescriptions (e.g., NSAIDs, acetaminophen) absent contraindication(s) should nearly always be the primary treatment and accompany an opioid prescription.
- 5) Low-dose opioids may be needed in the elderly who have greater susceptibility to the adverse risks of opioids. Those of lower body weight may also require lower opioid doses.
- 6) Dispensing quantities should be only what is needed to treat the pain. Short-acting opioids are recommended for treatment of acute pain. Long-acting opioids are not recommended.
- 7) Due to greater than 10-fold elevated risks of adverse effects and death, considerable caution is warranted among those using other sedating medications and substances including: i) benzodiazepines, ii) anti-histamines (H<sub>1</sub>-blockers), and/or iii) illicit substances.(653-656) Patients should not receive opioids if they use illicit substances unless there is objective evidence of significant trauma or moderate to severe injuries. Considerable caution is also warranted among those who are unemployed as the reported risks of death are also greater than 10-fold.(654, 655) Due to elevated risk of death and adverse effects, caution is also warranted when considering prescribing an opioid for patients with any of the following characteristics: depression, anxiety, personality disorder, untreated sleep disorders, substance abuse history, current alcohol use or current tobacco use, attention deficit hyperactivity disorder (ADHD), post-traumatic stress disorder (PTSD), suicidal risk, impulse control problems, thought disorders, psychotropic medication use, chronic obstructive pulmonary disease (COPD), asthma, or recurrent pneumonia.(654, 657-678) Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis,(679) as well as coronary artery disease, dysrhythmias, cerebrovascular disease, orthostatic hypotension, asthma, recurrent pneumonia, thermoregulatory problems, advanced age (especially with mentation issues, fall risk, debility), osteopenia, osteoporosis, water retention, renal failure, severe obesity, testosterone deficiency, erectile dysfunction, abdominal pain, gastroparesis, constipation, prostatic hypertrophy, oligomenorrhea, pregnancy, human immunodeficiency virus (HIV), ineffective birth control, herpes, allodynia, dementia, cognitive dysfunction and impairment, gait problems, tremor, concentration problems, insomnia, coordination problems, and slow reaction time. There are considerable drug-drug interactions that have been reported (see Appendices 2-3 of Opioids Guideline).

*Frequency/Duration* – Generally, opioids should be prescribed at night or while not working.(680) Lowest effective, short-acting opioid doses are preferable as they tend to have the better safety profiles, less risk of escalation,(681) less risk of lost time from work,(682) and faster return to work.(683) Short-acting opioids are recommended for treatment of acute pain and long-acting opioids are not recommended. Recommend opioid use as required by pain, rather than in regularly scheduled dosing.

If parenteral administration is required, ketorolac has demonstrated superior efficacy compared with opioids for acute severe pain,(684, 685) although ketorolac's risk profile may limit use for some patients. Parenteral opioid administration outside of obvious acute trauma or surgical emergency conditions is almost never required, and requests for such treatment are clinically viewed as red flags for potential substance abuse.

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<sup>2</sup>Other indications beyond the scope of this guideline include acute myocardial infarction or agitation interfering with acute trauma management.

<sup>3</sup>Treatments to have tried generally include NSAIDs and acetaminophen. For LBP patients, additional considerations include muscle relaxants, progressive aerobic exercise, and directional exercise.

<sup>4</sup>Exceptions such as acute, severe trauma should be documented.

Indications for Discontinuation – Resolution of pain, sufficient improvement in pain, intolerance or adverse effects, non-compliance, surreptitious medication use, consumption of medications or substances advised to not take concomitantly (e.g., sedating medications, alcohol, benzodiazepines), or use beyond 2 weeks.

*Harms* – Adverse effects are many (see Opioids Guideline).

*Benefits* – Improved short-term pain control.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – High

### 3. Recommendation: Screening Patients Prior to Initiation of Opioids

**Initial screening of patients is recommended with more detailed screening for: i) requiring continuation of opioids beyond 2 weeks for those with an acute severe injury, and ii) at consideration of initiation for severe pain but no objective evidence.** Screening should include history(ies) of depression, anxiety, personality disorder, other psychiatric disorder, substance abuse, sedating medication use (e.g., anti-histamine/anti-H<sub>1</sub> blocker(654)), benzodiazepine use, opioid dependence, alcohol abuse, current tobacco use, other substance use history, COPD, PTSD, other psychotropic medications, (severe) obesity, cognitive impairment, balance problems/fall risk, osteoporosis, and renal failure (see Appendix 1 of Opioids Guideline). Those who screen positive, especially to multiple criteria, are recommended to: i) undergo greater scrutiny for appropriateness of opioids (may include psychological evaluation), ii) consideration of consultation and examination(s) for complicating conditions and/or appropriateness of opioids, and iii) if opioids are prescribed, more frequent assessments for compliance, achievement of functional gains,(655, 686, 687) adverse effects, and symptoms and signs of aberrancy.

*Harms* – Negligible. If a consultation is needed, there are additional costs that are incurred.

*Benefits* – Improved identification of more appropriate candidates for opioids. Identification of patients at increased risk of adverse effects. In cases where someone has elevated, but potentially acceptable risk, may alert the provider to improve surveillance for complications and aberrant behaviors.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

### 4. Recommendation: Opioid Dose Limits in Acute Pain

**Dispense only that which is required. The maximum daily oral dose recommended for opioid-naïve, acute pain patients based on risk of overdose/death is 50mg morphine equivalent dose (MED)<sup>5</sup>(688).** In rare cases with documented functional improvement (see Appendix 1 of Opioids Guideline), higher doses may be considered, however, risks are substantially higher and greater monitoring is also recommended (see Subacute (1-3 Months) and Chronic Pain (>3 Months) opioid recommendations below). Lower doses should be used for patients at higher risk of dependency, addiction and other adverse effects. Monitoring is also recommended and consultation may be considered for those patients on higher doses.

*Harms* – Theoretical potential to undertreat pain in some patients with increased pain sensitivity.

*Benefits* – Reduced risk for adverse physical and cognitive effects, dependency, addiction and opioid-related overdoses and deaths.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Moderate

### **POST-OPERATIVE PAIN (UP TO 4 WEEKS) (AFTER 4 WEEKS, SEE SUBACUTE PAIN)**

Oral opioids are commonly prescribed after sinus surgery,(689) major noncardiac surgical procedures,(690) mastectomy and immediate breast reconstruction (IBR),(691, 692) coronary artery bypass graft surgery,(693) major abdominal surgery (abdominal laparoscopic, abdominal hysterectomy, bowel resection or radical hysterectomy), (694-697) (694-697) (694-697) (694-697) (694-697) (694-697) (694-697) orthopedic surgery,(698) and molar extraction.(699)

#### 1. Recommendation: Limited Use of Opioids for Post-operative Pain

**Limited use of opioids is recommended for post-operative pain management as adjunctive therapy to more effective treatments.**

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<sup>5</sup>Statistical significance present for acute and chronic pain at and above 50 mg per day of oral morphine equivalent dose.

Indications – For post-operative pain management, a brief prescription of short-acting opioids as adjunct to more efficacious treatments (especially Cox-2 NSAIDs such as celecoxib, non-selective NSAIDs after risk of bleeding is no longer a concern).<sup>6</sup> A brief course of opioids is often needed for minor surgical procedures. However, minor wound laceration repairs often require no opioids. Evidence suggests perioperative pregabalin for 14 days and/or continuous femoral nerve catheter analgesia instead of solely using oral opioids results in superior knee arthroplasty functional outcomes with less venous thromboses.<sup>(700)</sup> Additional considerations include:

- 1) Non-opioid prescriptions (e.g., NSAIDs, acetaminophen) should nearly always be the primary treatment and accompany an opioid prescription. Computerized programs may also assist in optimal management.<sup>(701)</sup>
- 2) The lowest effective dose of a short-acting opioid should be used,<sup>(681)</sup> as well as weaker opioids if possible.<sup>(682, 683)</sup>
- 3) Short-acting opioids are recommended for treatment of acute pain.
- 4) Dispensing should be only what is needed to treat the pain.<sup>7</sup>
- 5) Long-acting opioids are not recommended.
- 6) Low-dose opioids may be needed in the elderly who have greater susceptibility to the adverse risks of opioids. Those of lower body weight may also require lower opioid doses.
- 7) Where available, prescription databases (usually referred to as Prescription Drug Monitoring Program (PDMP)) should be checked for other opioid prescriptions. Due to greater than 10-fold elevated risks of adverse effects and death, considerable caution is warranted among those using other sedating medications and substances including: i) benzodiazepines, ii) anti-histamines (H<sub>1</sub>-blockers), and/or iii) illicit substances.<sup>(653-656)</sup> Patients should not receive opioids if they use illicit substances unless there is objective evidence of significant trauma or moderate to severe injuries. Considerable caution is also warranted among those who are unemployed as the reported risks of death are also greater than 10-fold.<sup>(654, 655)</sup>

Due to elevated risk of death and adverse effects, caution is also warranted when considering prescribing an opioid for patients with any of the following characteristics: depression, anxiety, personality disorder, ADHD, PTSD, suicidal risk, impulse control problems, thought disorders, psychotropic medication use, substance abuse history, current alcohol use or current tobacco use, untreated sleep disorders, COPD, asthma, or recurrent pneumonia.<sup>(654, 657-678)</sup> Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis,<sup>(679)</sup> as well as coronary artery disease, dysrhythmias, cerebrovascular disease, orthostatic hypotension, thermoregulatory problems, advanced age (especially with mentation issues, fall risk, debility), osteopenia, osteoporosis, water retention, renal failure, severe obesity, testosterone deficiency, erectile dysfunction, abdominal pain, gastroparesis, constipation, prostatic hypertrophy, oligomenorrhea, pregnancy, HIV, ineffective birth control, herpes, allodynia, dementia, cognitive dysfunction and impairment, gait problems, tremor, concentration problems, insomnia, coordination problems, and slow reaction time. There are considerable drug-drug interactions that have been reported (see Appendices 2-3 of Opioids Guideline). Inpatient management may moderate these recommendations provided there is careful monitoring, although these same management issues then apply post-discharge.

- 8) For patients taking opioids chronically prior to surgery, consultations with anesthesiology and/or pain management are generally needed as post-operative dosing may be very high and management is often quite challenging.
- 9) Ongoing prescriptions of opioids after the immediate post-operative period should generally be for patients who have undergone a major surgery or have other condition(s) necessitating opioids. Most patients should be making progress towards functional restoration, pain reduction and weaning off the opioids. Patients who have not progressed should be carefully evaluated for physical complications or psychiatric comorbidity, adherence to active treatments, and pending development of addiction or dependency.

*Frequency/Duration* – For moderate and major surgeries, opioids are generally needed on a scheduled basis in the immediate post-operative period. Other post-operative situations may be sufficiently managed with an as needed opioid prescription schedule. Provision of opioids sufficient to participate in therapeutic exercise (e.g., progressive ambulation) and allow sleep may be needed. However, high dose use at night is not recommended due to respiratory

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<sup>6</sup>More efficacious treatments also include therapeutic exercises, e.g., progressive ambulation especially for moderate to extensive procedures (e.g., arthroplasty, fusion).

<sup>7</sup>Generally, this should be sufficient to cover two weeks of treatment. Prescriptions of 90-day supplies in the post-operative setting are not recommended.

depression and disruption of sleep architecture. Weaning should begin as soon as function is recovering and pain is subsiding. Subsequent weaning to as needed opioid use is recommended.

*Indications for Discontinuation* – The physician should discontinue the use of opioids based on sufficient recovery, expected resolution of pain, lack of efficacy, intolerance or adverse effects, non-compliance, surreptitious medication use, self-escalation of dose, or use beyond 3 to 5 days for minor procedures, and 2 to 3 weeks for moderate/less extensive procedures. Use for up to 3 months may occasionally be necessary during recovery from more extensive surgical procedures (e.g., spine fusion surgery). However, with rare exceptions, only nocturnal use is recommended in months 2 to 3 plus institution of management as discussed in the subacute/chronic guidelines below. For those requiring opioid use beyond 1 month, the subacute/chronic opioid use recommendations below apply.

*Harms* – Adverse effects are many (see Opioids Guideline).

*Benefits* – Improved short-term, post-operative pain control. Some studies suggest this may modestly improve functional outcomes in the post-operative population.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – High

### 2. Recommendation: Screening Patients Prior to Continuation of Opioids

**Screening of patients is recommended for patients requiring continuation of opioids beyond the second post-operative week.** Screening should include history(ies) of: depression, anxiety, personality disorder, pain disorder, other psychiatric disorder, substance abuse history, sedating medication use (e.g., anti-histamine/anti-H<sub>1</sub> blocker), benzodiazepine use, opioid dependence, alcohol abuse, current tobacco use, and other substance use history, COPD, PTSD, other psychotropic medications, (severe) obesity, cognitive impairment, balance problems/fall risk, osteoporosis, and renal failure (see Appendix 1 of Opioids Guideline). Those who screen positive, especially to multiple criteria, are recommended to: i) undergo greater scrutiny for appropriateness of opioids (e.g., may include psychological and/or pain evaluation); ii) compliance with active therapies (e.g., ambulation and other exercise after arthroplasty); iii) consider consultation examination(s) for complicating conditions and/or appropriateness of opioids; and iv) if ongoing opioids are prescribed, ensure more frequent assessments for treatment compliance, achievement of functional gains,(655, 686, 687) and symptoms and signs of aberrancy.

*Harms* – Negligible. If a consultation is needed, there are additional costs that are incurred.

*Benefits* – Identification of patients at increased risk of adverse effects. Improved identification of more appropriate and safe candidates for opioids compared with attempting post-operative pain control with non-opioids. This should reduce adverse effects. In cases where someone has elevated, but potentially acceptable risk, this may alert the provider to improve surveillance for complications and aberrant behaviors.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – High

### 3. Recommendation: Opioid Dose Limits in Post-operative Pain

**The maximum daily oral dose recommended for opioid-naïve, acute pain patients based on risk of overdose/death is 50mg morphine equivalent dose (MED)<sup>8</sup>(688).** Post-operative patients particularly require individualization due to factors such as the severity of the operative procedure, response to treatment(s) and variability in response. Higher doses beyond 50mg MED may be particularly needed for major surgeries in the first two post-operative weeks to achieve sufficient pain relief, however, greater caution and monitoring are warranted and reductions below 50mg MED at the earliest opportunity should be sought. Lower doses should be used for patients at higher risk of dependency, addiction and other adverse effects. In rare cases with documented functional improvement, ongoing use of higher doses may be considered, however, risks are substantially higher and greater monitoring is also recommended (see Subacute (1-3 Months) and Chronic Pain (>3 Months) opioid recommendations below).

*Harms* – Theoretical potential to undertreat pain, which could modestly delay functional recovery.

*Benefits* – Reduced risk for adverse effects, dependency, addiction and opioid-related deaths.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

## **SUBACUTE (1-3 MONTHS) AND CHRONIC PAIN (>3 MONTHS)**

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<sup>8</sup>Statistical significance present for acute and chronic pain at and above 50 mg per day of morphine equivalent dose.

1. *Recommendation: Routine Use of Opioids for Subacute and Chronic Non-malignant Pain*

**Opioid use is moderately not recommended for treatment of subacute and chronic non-malignant pain. Opioid prescription should be patient specific and limited to cases in which other treatments are insufficient and criteria for opioid use are met (see below).**

*Harms* – May inadequately treat severe subacute or chronic pain.

*Benefits* – Less debility, fewer adverse effects, reduced accident risks, lower risks of dependency, addiction, overdoses, and deaths.

*Strength of Evidence* – **Moderately Not Recommended, Evidence (B)**

*Level of Confidence* – High

2. *Recommendation: Opioids for Treatment of Subacute or Chronic Severe Pain*

**The use of an opioid trial is recommended if other evidence-based approaches for functional restorative pain therapy have been used with inadequate improvement in function.(702, 703) Opioids are then recommended for treatment of function impaired by subacute or chronic severe pain (e.g., inability to work due to any of the following: chronic severe radiculopathy, chronic severe peripheral neuropathies, complex regional pain syndrome (CRPS), and severe arthroses)(686) (see Appendix 1 of Opioids Guideline).**

*Indications* – Patients should meet all of the following:

- 1) Reduced function is attributable to the pain. Pain or pain scales alone are insufficient reasons.(655, 686, 704-715)
- 2) A severe disorder warranting potential opioid treatment is present [e.g., CRPS, severe radiculopathy, advanced degenerative joint disease (DJD)].(706)
- 3) Other more efficacious treatments have been documented to have failed.(706) Other approaches that should have been first utilized include physical restorative approaches, behavioral interventions, self-applied modalities, non-opioid medications (including NSAIDs, acetaminophen, topical agents, norepinephrine adrenergic reuptake blocking antidepressants or dual reuptake inhibitors; also antiepileptic medications particularly for neuropathic pain) and functional restoration. For LBP patients, this also includes<sup>9</sup> fear avoidant belief training and ongoing progressive aerobic exercise, and strengthening exercises. For CRPS patients, this includes progressive strengthening exercise. For DJD, this includes NSAIDs, weight loss, aerobic and strengthening exercises.
- 4) An ongoing active exercise program is prescribed and complied with.
- 5) Non-opioid prescriptions (e.g., NSAIDs, acetaminophen) absent a contraindication should nearly always be the primary pain medication and accompany an opioid prescription. Other medications to consider include topical agents, norepinephrine adrenergic reuptake blocking antidepressants or dual reuptake inhibitors; also antiepileptic medications particularly for neuropathic pain].
- 6) The lowest effective dose should be used.(681) Weaker opioids should be used whenever possible.(682, 683) Meperidine is not recommended for chronic pain due to bioaccumulation and adverse effects.
- 7) Low-dose opioids may be needed in the elderly who have greater susceptibility to the adverse risks of opioids. Those of lower body weight may also require lower opioid doses.
- 8) Dispensing should be only what is needed to treat the pain.<sup>10</sup>
- 9) Extended-release/long-acting opioids are recommended to be used on a scheduled basis, rather than as needed.(706) As needed opioids should generally be avoided for treatment of chronic pain, although limited use for an acute painful event (e.g., fracture, sprain) is reasonable. Sublingual fentanyl is not recommended for treatment of subacute or chronic pain. Caution is warranted with fentanyl patches due to unpredictable absorption.
- 10) Where available, prescription databases (usually referred to as Prescription Drug Monitoring Program (PDMP)) should be checked for conflicting opioid prescriptions from other providers or evidence of misreporting.
- 11) Due to greater than 10-fold elevated risks of adverse effects and death, considerable caution is warranted among those using other sedating medications and substances including: i) benzodiazepines, ii) anti-histamines (H<sub>1</sub>-blockers), and/or iii) illicit substances.(653-656) Patients should not receive opioids if they use

<sup>9</sup>A previous trial of a muscle relaxant is generally recommended. However, if an opioid trial is contemplated, cessation of all depressant medications including muscle relaxants is advisable.

<sup>10</sup>Generally, this should be sufficient to cover one week of treatment at a time during the trial phase. If a trial is successful at improving function, prescriptions for up to 90-day supplies are recommended.

illicit substances unless there is objective evidence of significant trauma or moderate to severe injuries. Considerable caution is also warranted among those who are unemployed as the reported risks of death are also greater than 10-fold.(654, 655)

Due to elevated risk of death and adverse effects, caution is also warranted when considering prescribing an opioid for patients with any of the following characteristics: depression, anxiety, personality disorder, untreated sleep disorders, substance abuse history, current alcohol use or current tobacco use, ADHD, PTSD, suicidal risk, impulse control problems, thought disorders, psychotropic medication use, COPD, asthma, recurrent pneumonia.(654, 657-678) Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis,(679) as well as coronary artery disease, dysrhythmias, cerebrovascular disease, orthostatic hypotension, asthma, recurrent pneumonia, thermoregulatory problems, advanced age (especially with mentation issues, fall risk, debility), osteopenia, osteoporosis, water retention, renal failure, severe obesity, testosterone deficiency, erectile dysfunction, abdominal pain, gastroparesis, constipation, prostatic hypertrophy, oligomenorrhea, pregnancy, HIV, ineffective birth control, herpes, allodynia, dementia, cognitive dysfunction and impairment, gait problems, tremor, concentration problems, insomnia, coordination problems, and slow reaction time. There are considerable drug-drug interactions that have been reported (see Appendices 2-3 of Opioids Guideline).

Frequency/Duration – Opioids use is generally initiated as a “trial” to ascertain whether the selected opioid produces functional improvement (see Appendix 1 of Opioids Guideline). Opioid use is generally prescribed on a regular basis,(716) at night or when not at work.(680) Only one opioid is recommended to be prescribed in a trial. More than one opioid should rarely be used. Lower opioid doses are preferable as they tend to have the better safety profiles, less risk of dose escalation,(681) less work loss,(682) and faster return to work.(683) Patients should have ongoing visits to monitor efficacy, adverse effects, compliance and surreptitious medication use. Opioid prescriptions should be shorter rather than longer duration.(717)

Indications for Discontinuation – Opioids should be discontinued based on lack of functional benefit(703) (see Appendix 1 of Opioids Guideline), resolution of pain, improvement to the point of not requiring opioids, intolerance or adverse effects, non-compliance, surreptitious medication use, medication misuse (including self-escalation and sharing medication), aberrant drug screening results, diversion, consumption of medications or substances advised to not take concomitantly (e.g., sedating medications, alcohol, benzodiazepines).

*Harms* – Adverse effects are many (see Opioids Guideline). May initiate path to opioid dependency.

*Benefits* – Improved short-term pain ratings. Theoretical potential to improve short-term function impaired by a painful condition.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

### 3. Recommendation: Screening Patients Prior to Initiation of Opioids

**Screening of patients is recommended prior to consideration of initiating a trial of opioids for treatment of subacute or chronic pain.** Screening should include history(ies) of depression, anxiety, personality disorder and personality profile,(683, 718, 719) other psychiatric disorder, substance abuse history, sedating medication use (e.g., anti-histamine/anti-H<sub>1</sub> blocker),(667) benzodiazepine use, opioid dependence, alcohol abuse, current tobacco use, and other substance use history, COPD, PTSD, other psychotropic medications, (severe) obesity, cognitive impairment, balance problems/fall risk, osteoporosis, and renal failure (see Appendix 1 of Opioids Guideline). Those who screen positive, especially to multiple criteria, are recommended to: i) undergo greater scrutiny for appropriateness of opioids (may include psychological and/or psychiatric evaluation(s) to help assure opioids are not being used instead of appropriate mental health care); ii) consideration of consultation and examination(s) for complicating conditions and/or appropriateness of opioids; and iii) if opioids are prescribed, more frequent assessments for compliance, achievement of functional gains and symptoms and signs of aberrant use.

*Harms* – Negligible. If a consultation is needed, there are additional costs that are incurred.

*Benefits* – Identification of patients at increased risk of adverse effects. Improved identification of more appropriate and safe candidates for treatment with opioids. This should reduce adverse effects. In cases where someone has elevated, but potentially acceptable risk, this may alert the provider to improve surveillance for complications and aberrant behaviors.

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – High*

*4. Recommendation: Opioid Dose Limits in Subacute and Chronic Pain*

**The maximum daily oral dose recommended for subacute or chronic pain patients based on risk of overdose/death is 50mg Morphine Equivalent Dose (MED).**(657, 688) In rare cases with documented functional improvements occurring with use above 50mg MED, subsequent doses up to 100mg may be considered, however, risks of death are much greater and more intensive monitoring is then also recommended. Lower doses should be considered in high-risk patients. Caution appears warranted in all patients as there is evidence the risk of dose escalation is present even among patients enrolled in a “hold the line (stable dose) prescribing strategy” treatment arm.(720)

For those whose daily consumption is more than 50mg MED, greater monitoring is recommended to include: i) at least monthly to not more than quarterly appointments with greater frequencies during trial, dose adjustments and with greater co-morbid risk factors and conditions; ii) at least semiannual attempts to wean below 50mg MED if not off the opioid; iii) at least semiannual documentation of persistence of functional benefit; iv) at least quarterly urine drug screening (see 6. *Recommendation: Urine Drug Screening*); and v) at least semiannual review of medications, particularly to assure no sedating medication use (e.g., benzodiazepine, sedating anti-histamines).

*Harms* – None in a short-term trial. For chronic pain patients, theoretical potential to undertreat pain and thus impair function. However, there is no quality literature currently available to support that position.

*Benefits* – Reduced risk for adverse effects, dependency, addiction, and opioid-related deaths.

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – High*

*5. Recommendation: Use of an Opioid Treatment Agreement (Opioid Contract, Doctor/Patient Agreement, Informed Consent)*

**The use of an opioid treatment agreement (opioid contract, doctor/patient agreement, or informed consent) is recommended to document patient understanding, acknowledgement of potential adverse effects, and agreement with the expectations of opioid use (see Appendix 1 of Opioids Guideline).**(702, 721-725, 726{Burchman, 1995 #3097, 727-732) **If consent obtained, it is recommended appropriate family members be involved in this agreement.**

*Harms* – Negligible.

*Benefits* – Educates the patient and significant others that these medications are high risk, with numerous adverse effects. It allows for a more informed choice. It provides a framework for initiation of a trial, monitoring, treatment goals, compliance requirement, treatment expectations, and conditions for opioid cessation. It should reduce risk of adverse events and opioid-related deaths, although that remains unproven to date.

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

*6. Recommendation: Urine Drug Screening*

**Baseline and random urine drug screening, qualitative and quantitative, is recommended for patients prescribed opioids for the treatment of subacute or chronic pain to evaluate presence or absence of the drug, its metabolites, and other substance(s) use. In certain situations, other screenings (e.g., hair particularly for information regarding remote use(733-738) or blood (for acute toxicity) may be appropriate.**

*Indications* – All patients on opioids for subacute or chronic pain.

*Frequency* – Screening is recommended at baseline, randomly at least twice, and up to 4 times a year and at termination. More intensive screening is recommended for those consuming more than 50mg MED (see above). Federal guidelines recommend at least 8 tests a year among those utilizing opioid treatment programs.(739) Screening should also be performed “for cause” (e.g., provider suspicion of substance misuse including over-sedating, drug intoxication, motor vehicle crash, other accidents and injuries, driving while intoxicated, premature prescription renewals, self-directed dose changes, lost or stolen prescriptions, using more than one provider for prescriptions, non-pain use of medication, using alcohol for pain treatment or excessive alcohol use, missed appointments, hoarding of medications, and selling medications). Standard urine drug/toxicology screening processes should be followed (consult a qualified medical review officer).(740-742) If there is an aberrant drug screen result (either positive for unexpected drugs or unexpected metabolites or unexpectedly negative results), there should be a careful evaluation of whether there is a plausible



explanation (e.g., drug not tested, drug metabolite not tested, laboratory cutpoint and dosing interval would not capture the drug/metabolite, laboratory error). In the absence of a plausible explanation, those patients with aberrant test results should have the opioid discontinued or weaned.(703)

*Harms* – No adverse clinical effects if properly interpreted.

*Benefits* – Identifies aberrant medication(s) and substance(s) use. Such uses are high-risk for opioid events including fatalities (see tables below). It provides objective evidence to cease an opioid trial or ongoing treatment. Identifies patients who may be diverting medication (those screening negative for prescribed medication).

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – High

*Evidence for the Use of Opioids*

See Opioids Guideline.

## **Vitamins (Including Pyridoxine)**

Treatment of CTS with pyridoxine (Vitamin B<sub>6</sub>) has been attempted(634, 650, 743-746) as there has been some association between pyridoxine deficiencies and peripheral neuropathies, as well as some reports of associations of deficiencies with CTS in some,(747) but not all studies.(748) Vitamin B<sub>12</sub> has also been reported as a successful treatment for stroke patients with CTS.(749)

1. *Recommendation: Pyridoxine for Treatment of Acute, Subacute, or Chronic CTS*

**Pyridoxine is not recommended for routine treatment of acute, subacute, or chronic CTS in patients without vitamin deficiencies.**

*Strength of Evidence* – **Not Recommended, Evidence (C)**

*Level of Confidence* – Low

2. *Recommendation: Other Vitamins for Treatment of Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against the use of other vitamins for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence* – **No Recommendation, Insufficient Evidence (I)**

*Level of Confidence* – Low

### *Rationale for Recommendations*

There are two quality studies that reviewed pyridoxine to treat CTS patients. However, benefits have not been shown in the highest quality study.(745) The moderate-quality crossover trial reported improvements in symptoms in 7 patients; however, 3 patients did not receive the placebo although their symptoms scores on pyridoxine were lower than in a control period.(743) While vitamin B-6 is relatively low risk and patients may use it without prescription, available evidence does not support its use for the routine treatment of CTS, thus it is not recommended. However, it may be a reasonable treatment option among patients with presumptive pyridoxine deficiency (e.g., malnutrition, alcoholism, malabsorption, especially jejunal disorders such as sprue, etc.).

### *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.*

## Topical Medications: Lidocaine Patches

Topical lidocaine patches have been increasingly used to treat numerous pain conditions through transdermal application of topical anesthetic.(638, 750, 751)

*Recommendation: Lidocaine Patches for Treatment of Acute, Subacute, or Chronic CTS*

**Lidocaine patches are recommended for treatment of select cases of acute, subacute, or chronic CTS with pain.**

*Indications* – Moderate to severe CTS with pain as a central complaint 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.

*Frequency/Duration* – Usually 3 patches per day. Duration of use for chronic, localized pain may be as long as indefinitely, although most patients do not require indefinite treatment, as symptoms usually resolve, improve, or require surgery. Caution is warranted regarding widespread use of topical anesthetics for potential systemic effects from widespread administration.(752) For the hand this may require both patches and other applications or use in other body locations.

*Indications for Discontinuation* – Resolution, intolerance, adverse effects, lack of benefits, or failure to progress over a trial of at least 2 weeks.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

### *Rationale for Recommendation*

Topical lidocaine has been suggested to improve pain associated with CTS although the case diagnoses do not appear well substantiated in the available study as pain complaints as an overriding symptom among CTS patients raise concerns about alternate explanations for the symptoms.(751) In one moderate-quality study, lidocaine patches were suggested to be somewhat more effective than naproxen;(638) however, naproxen does not appear particularly effective and the study had a number of weaknesses. In the other study, injection was comparable to the patch, yet injections are likely a more effective strategy than naproxen, thus this body of evidence somewhat conflicts. Lidocaine patches are not invasive and have low adverse effects although some patients may experience local reactions such as skin irritation, redness, pain, or sores. These patches are also moderately or even high cost over time. While there are other lower cost topical treatments that provide analgesia (including heat, ice, and capsaicin), lidocaine patches may be a reasonable treatment option for pain related to CTS. Patients should be monitored to ensure that they are receiving benefit and to ascertain if there are any untoward local skin changes as a result of use.

### *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, 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. 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.*

## Gabapentin

Gabapentin has been used to treat carpal tunnel syndrome.(755)

*Recommendation: Gabapentin for treatment of Carpal Tunnel Syndrome*

**Gabapentin is moderately not recommended for treatment of carpal tunnel syndrome.**

*Strength of Evidence* – **Moderately Not Recommended, Evidence (B)**

*Level of Confidence* – Moderate

### *Rationale for Recommendation*

There is one high-quality, placebo-controlled study evaluating the use of gabapentin for treatment of CTS and finding it ineffective, thus gabapentin is moderately not recommended.

#### *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.*

## Physical Methods/Rehabilitation

### Devices

#### **MAGNETS**

Treatment of CTS and other hand, wrist, and forearm MSDs with magnets(756-758) and pulsed magnetic field therapy(759-761) has been attempted to manage pain.(612, 651, 762)

*1. Recommendation: Magnets for Management of Pain from of Acute, Subacute, or Chronic CTS*

**Magnets are moderately not recommended for management of pain from acute, subacute, or chronic CTS.**

*Strength of Evidence – Moderately Not Recommended, Evidence (B)*

*Level of Confidence – High*

*2. Recommendation: Pulsed Magnetic Field Therapy for Management of Pain from of Acute, Subacute, or Chronic CTS*

**Pulsed magnetic field therapy is not recommended for management of pain from acute, subacute, or chronic CTS.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

Quality evidence suggests magnets(756, 757) are ineffective for treatment of CTS. Low-quality evidence suggests pulsed magnetic field therapy(759, 761) is not effective for treating CTS.(756) Magnets are not invasive, have no adverse effects, and are low cost, but other interventions have been shown effective. Thus, magnets are not recommended for treatment of CTS.

#### *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.*

## **WRIST SPLINTING**

Wrist splinting has been utilized to treat CTS.(387, 611, 628, 634, 647, 762-766, 767{Baysal, 2006 #208, 768-771) A precise mechanism of action is unclear, although it is believed to prevent hyperflexed postures, particularly while sleeping, that provoke symptoms.(766, 768) Placement of the wrist in functional neutral posture (approximately 15° of extension) is most typically performed;(634) however, most studies do not specify the posture and at least one study utilized a neutral posture of 0°(614) which actually is a modest degree of flexion. Whether those differences in postures are clinically meaningful is unknown.

*Recommendation: Nocturnal Wrist Splinting for Acute, Subacute, or Chronic CTS*

**Nocturnal wrist splinting is moderately recommended for treatment of acute, subacute, or chronic CTS.(772)**

*Indications* – Symptoms consistent with carpal tunnel syndrome.

*Frequency/Dose* – Wrist splints are recommended to be worn while sleeping.(387, 763-766) There is no recommendation for or against the use of splints during the daytime; however, splints theoretically increase force requirements needed to perform some jobs and have demonstrated alterations in other upper extremity postures;(773) thus, they may have a relative contraindication to daytime use. However, one study testing nocturnal versus full-time use suggested modestly better results in electrodiagnostic parameters, but not symptoms, with full-time use.(765) There are numerous models and trials using different types of splints with all trials showing benefits and head-to-head trials, suggest there is, as yet, no identified optimal type of splint.(622, 774, 775)

*Discontinuation* – Splints should be re-adjusted 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 there is only partial improvement and symptoms are sufficient for additional treatment, consideration of glucocorticosteroid injection and/or electrodiagnostic testing is indicated. If there is no improvement, splints should be discontinued and the accuracy of the diagnosis re-evaluated.

*Strength of Evidence* – **Moderately Recommended, Evidence (B)**

*Level of Confidence* – High

### *Rationale for Recommendation*

Wrist splints have been shown to be effective compared to not splinting(764, 766) or to ergonomic education.(387) Splinting is also comparable to and in some measures superior to oral steroids.(647) One trial found splinting combined with NSAIDs comparable to glucocorticosteroid injection.(631) Both trials evaluating exercises and splinting used splinting for all subjects, precluding a comparison between those interventions. One trial suggested no superiority of a combination of tendon-gliding exercises combined with splinting combined with splinting alone.(610) Another trial suggested modest superiority of surgery over 18 months of follow-up; however, there may have been a slight bias in favor of surgery due to a baseline trend towards longer duration of symptoms in the splint group,(763) particularly in light of a subsequent report that those with shorter duration of symptoms had superior results with splinting.(776) Another trial compared splinting versus injection versus surgery and found few differences except for a modest trend favoring surgery over the long term.(777) A trial conducted in the Netherlands comparing splinting with surgery found little clinical difference, but concluded surgery was more cost-effective.(778) A recent report suggests splinting is more likely to be effective in those with milder symptoms of less than 1-year duration.(776) Wrist splints are not invasive, have no significant adverse effects, and are not costly. They are moderately recommended for treatment of CTS.

### *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.

## Allied Health Therapies

### ACUPUNCTURE

Acupuncture has been used to treat CTS and other hand, wrist, and forearm MSDs.(790, 791) There is evidence of its efficacy for treatment of chronic spine disorders, although the evidence suggests traditional acupuncture is not superior to other acupuncture methods (see Chronic Pain and Low Back Disorders Guidelines).

*Recommendation: Acupuncture for Acute, Subacute, or Chronic CTS*

**Acupuncture is not recommended for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – Not Recommended, Evidence (C)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are quality trials of acupuncture compared with placebo or sham acupuncture and they have failed to show benefit of acupuncture for treatment of CTS.(792) One trial found no differences between acupuncture and oral steroid.(793, 794) Another trial susceptible to contact time bias found minimal differences between acupuncture and nocturnal wrist splinting.(781) Thus, the highest quality evidence suggests acupuncture is ineffective for treatment of CTS and acupuncture is not recommended.

#### *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.*

### BIOFEEDBACK

Biofeedback is a behavioral medicine method of providing automated information and training to improve control of certain physiologic processes which are normally inaccessible to a subject's perception. Audible electromyographic (EMB) biofeedback has been used to treat CTS.(798)

*Recommendation: Biofeedback for Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against the use of biofeedback for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies regarding the utilization of biofeedback for treating CTS patients. Biofeedback is not invasive, has no adverse effects, and is moderate cost. However, in the absence of quality evidence, there is no recommendation for or against its use.

#### *Evidence for the Use of Biofeedback*

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: Biofeedback or psychology; 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 14 articles in PubMed, 92 in Scopus, 3 in CINAHL, and 1 in Cochrane Library. We considered for inclusion 3 from PubMed, 0 from Scopus, CINAHL, Cochrane Library or other sources. Of the 3 articles considered for inclusion, 0 randomized trials and 0 systematic studies met the inclusion criteria.

#### **LOW LEVEL LASER THERAPY**

Low level laser treatment (LLLT) has been used to treat MSDs including CTS.(790, 799, 800) It usually involves laser energy that does not induce significant heating (the theory is that the mechanism of action is through photoactivation of the oxidative chain).(801)

*Recommendation: Low Level Laser Therapy for Acute, Subacute, or Chronic CTS*

**Low level laser therapy is not recommended for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – Not Recommended, Evidence (C)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are multiple moderate-quality studies evaluating LLLT with all of the higher quality studies demonstrating lack of efficacy. There are 5 trials comparing LLLT with sham/placebo laser and the 3 highest quality studies found lack of benefit.(802-804) One trial found no differences when compared with ultrasound(805) and a second trial found ultrasound superior.(806) Another study found no additive benefits of LLLT over splinting.(807) Thus, higher quality evidence indicates LLLT is not effective for treatment of CTS. Low-level laser is not invasive, has low adverse effects, but is costly. It is not recommended for the treatment of CTS.

#### *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.

#### **MANIPULATION AND MOBILIZATION**

Manipulation and mobilization are two types of manual therapy which have been used for treatment of CTS.(613, 627, 813-818) These include wide arrays of different techniques and schools of thought. Some consider these two interventions to be on a spectrum of velocity and applied force. In general, mobilization involves assisted, low-force, low-velocity movement. Manipulation involves high-force, high-velocity, and low-amplitude action with a focus on moving a target joint (see Chronic Pain and Low Back Disorders Guidelines for more details).

*1. Recommendation: Manipulation of the Wrist Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against the use of manipulation of the wrist for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

*2. Recommendation: Manipulation of the Spine for Acute, Subacute, or Chronic CTS*

## **Manipulation of the spine is not recommended for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

### *Rationale for Recommendations*

There are two moderate-quality studies that evaluate manipulation for treatment of CTS. However, both have considerable methodological problems. One study compared manipulation plus ultrasound versus ibuprofen. Exclusion criteria did not exclude prior ibuprofen use, which is may well have been widespread, resulting in a comparison analogous to no treatment, which biases towards the other treatment arm, ibuprofen use was PRN after 2 weeks, subject contact time differed between groups, all biasing in favor of manipulation plus ultrasound. That study failed to find improvements compared with ibuprofen(637) which as noted previously appear ineffective. The other moderate-quality study had two active-treatment arms.(819) Thus, there is no quality study showing manipulation is effective as a treatment for CTS. Manipulation is not invasive, is moderately costly, but does have rare adverse effects from cervical manipulation. Cervical manipulation is not recommended for treatment of CTS. There is no recommendation for or against manipulation of the wrist as there is an absence of quality evidence.

### *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.*

### **MESSAGE AND SOFT TISSUE MESSAGE**

Massage has been used to treat patients with CTS, particularly when combined with other forearm symptoms.(361)

#### **1. Recommendation: Massage for Acute, Subacute, or Chronic CTS**

**Massage is not recommended for most patients for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### **2. Recommendation: Massage for Acute, Subacute, or Chronic CTS with Forearm Myofascial Pain**

**Massage is 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 4 appointments. Objective evidence of improvement should be followed. Additional 3 or 4 treatments should be based on incremental improvement in objective measures.

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

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendations*

There is no quality evidence of efficacy for massage as a treatment for CTS. There is one moderate-quality trial that suggested Madenci hand massage (author same as the named massage technique) was effective as a combined therapy, however, the study design includes significant contact time biases and multiple unquantified co-interventions.(822) Regardless, massage is not thought to be helpful for typical CTS patients. However, some patients with forearm

myofascial pain are thought to potentially derive some benefits. Objective measures should be followed documenting improvement in order for additional treatments to be added. Massage is not invasive, has few adverse effects, but is moderately costly over time.

#### *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.*

#### **Therapeutic Touch**

Therapeutic touch, considered an alternative healing technique, involves the use of the practitioner's hands to focus and facilitate healing.(825)

*Recommendation: Therapeutic Touch for Acute, Subacute, or Chronic CTS*

**Therapeutic touch is not recommended for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – Not Recommended, Evidence (C)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies suggesting therapeutic touch is effective for treatment of CTS.(825) Therapeutic touch is not invasive, has no adverse effects, and is low cost. However, it has not been shown to be efficacious and other treatments have documented benefit, thus therapeutic touch is not recommended for the treatment of CTS.

#### *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.*

#### **ICE/SELF-APPLIED ICE**

Ice has been rarely used to treat CTS.

*Recommendation: Ice for Treatment of Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against use of ice for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*



There are no quality studies suggesting ice is effective for treatment of CTS. Ice is not invasive, has no adverse effects, and is low cost when self-applied. However, it has not been shown to be efficacious and other treatments have documented benefit, thus it is suggested other treatments should be used in preference.

#### *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.*

#### **HEAT/SELF-APPLIED HEAT**

Various forms of heat treatment have sometimes been used to treat CTS.(626)

*Recommendation: Heat for Treatment of Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against use of heat for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies suggesting heat is effective for treatment of CTS. There is one trial with paraffin as a cointervention.(626) Heat is not invasive, has no adverse effects, and is low cost when self-applied. However, it has not been shown to be efficacious and other treatments have documented benefit, thus it is suggested other treatments should be used in preference.

#### *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.*

#### **DIATHERMY**

Diathermy is a type of heat treatment that has been used clinically to heat tissue.(826, 827) There are two forms of diathermy – short wave and microwave. High-dose diathermy is also used to coagulate tissue. Proponents of diathermy utilize it to treat a wide range of conditions, believing it penetrates deeper than hot packs or heating pads and stimulates healing. (827, 828)

*Recommendation: Diathermy for Treatment of Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against use of diathermy for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies clearly demonstrating that diathermy is effective for treatment of CTS. The two available trials have considerable methodological flaws (e.g., represented as double blinded). Diathermy is not invasive, has no adverse effects, but becomes moderately costly with repeated applications. It has not been clearly shown to be efficacious and other treatments have documented benefit, thus it is suggested other treatments should be used in preference.

#### *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.*

#### **ULTRASOUND (THERAPEUTIC)**

Ultrasound has been used to treat many MSDs including CTS.(805, 831-834)

*Recommendation: Ultrasound for Acute, Subacute, or Chronic CTS in Select Patients Who Fail Splint Use or Decline Injection*

**There is no recommendation for or against ultrasound for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

The highest quality trial found ultrasound to be ineffective compared with sham ultrasound where both groups were treated with splinting.(640) One moderate-quality study found modest efficacy comparing ultrasound with placebo.(831) Another study had no placebo control and found ultrasound superior to low level laser therapy.(805) One trial found ultrasound comparable to glucocorticosteroid injection.(835) The remaining quality studies included co-interventions(611, 637) or had a lower quality rating and mostly suggested lack of efficacy.(832)

Ultrasound is not invasive, has few adverse effects, and is moderate to high cost depending on the number of treatments (which were numerous in the quality studies). As the available studies substantially conflict, there is no recommendation for or against therapeutic ultrasound. Ultrasound may be a reasonable option for highly select patients with mild to moderate CTS who decline glucocorticoid injection, have received insufficient response to splinting, and are not thought to be surgical release candidates; in such cases, a set of 4-6 treatments may be reasonable with a successive set of 4-6 appointments based on incremental functional gain. However, some evidence suggests possible efficacy of phonophoresis (see Phonophoresis).

#### *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.*

## Electrical Therapies

### Phonophoresis

Phonophoresis involves the use of ultrasound to deliver topically applied drugs and has been used to treat patients with CTS.(839)

*Recommendation: Phonophoresis for Acute, Subacute, or Chronic CTS*

**Phonophoresis is 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* – The regimen in the highest quality study consisted of 5-15 sessions per week for 4-8 weeks with ketoprofen phonophoresis (PH),(840) US pulse mode (1:4) with 2.5% ketoprofen gel at 1 MHz frequency and 1 W/cm<sup>2</sup> intensity.(640) Dexamethasone has also been successfully used,(783, 840) with one trial suggesting the steroid is superior to NSAID (diclofenac).(783) Other NSAIDs and glucocorticoids are presumably equally efficacious.(640)

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

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Low

#### *Rationale for Recommendation*

One high-quality comparative trial found ketoprofen phonophoresis plus splinting superior to ultrasound plus splinting.(640) One moderate quality comparative trial found dexamethasone administered by phonophoresis superior to iontophoresis.(840) One moderate quality comparative trial found phonophoresis with glucocorticoid superior to phonophoresis with diclofenac or splinting.(783) Phonophoresis is not invasive, has low adverse effects, and is moderately costly. However, phonophoresis with either NSAID or dexamethasone is recommended particularly where splinting is insufficiently controlling symptoms and an injection is declined.

#### *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.*

### Iontophoresis

Iontophoresis, a drug-delivery system that utilizes electrical current to transdermally deliver either glucocorticosteroids or NSAIDs, has been used to treat distal upper extremity MSDs including CTS.(839, 841, 842) It is believed to be more efficacious in situations where the dermis and adipose tissue overlying the target tissue is thin which facilitates penetration of the pharmaceutical to the target tissue and may be somewhat of an obstacle for treatment of CTS.

*Recommendation: Iontophoresis for Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against the use of iontophoresis for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence* – **No Recommendation, Insufficient Evidence (I)**

### Rationale for Recommendation

Iontophoresis has been studied for the treatment of CTS. There is one moderate-quality study comparing iontophoresis with dexamethasone versus distilled water which reported no benefit.(841) However, it was small in size (n = 20) and appears underpowered. The other moderate-quality study found injection to be superior.(842) There is no quality study of sufficient size comparing iontophoresis with placebo, precluding an assessment of quality evidence of efficacy. Iontophoresis with glucocorticosteroid may be a reasonable option for treating patients who decline injection; however, oral glucocorticosteroids have quality evidence of efficacy and may be recommended preferentially as iontophoresis is believed to be less effective than glucocorticosteroid injections.(842) Iontophoresis is not invasive, has low adverse effects, and is of moderate cost. However, other treatments have documented efficacy and should be used preferentially.

### 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.*

## Injection Therapies

Four major types of injections have been utilized to treat patients with CTS. These include: 1) carpal tunnel injections with glucocorticosteroids (discussed previously); 2) carpal tunnel injections with insulin among diabetics; 3) intramuscular glucocorticosteroid injections; and 4) botulinum injections.

### Intracarpal Tunnel Glucocorticosteroid Injections (“Steroid Injections”)

Steroid injections of the carpal canal are frequently performed to treat CTS patients,(631, 650, 777, 789, 839, 842-855) including those with acute cases (i.e., those that typically occur with fractures, trauma, or unaccustomed high-force use and present primarily with acute flexor wrist pain).(856-858) While various injection techniques have been utilized (including distal to proximal), the most common technical injection approach utilizes a fine gauge needle (e.g., 27- or 25-gauge) entering the skin near the distal wrist crease to the medial (ulnar) side of palmaris longus, and angled approximately 45 degrees distally. While it has been suggested that these injections are underutilized,(859) steroid injections should be done by those experienced with administering these injections.

#### 1. Recommendation: Carpal Tunnel Injections for Treatment of Subacute or Chronic CTS

##### **Carpal tunnel injections are strongly recommended for the treatment of subacute or chronic CTS.**

*Indications* – CTS unresponsive to nocturnal wrist splinting, generally with symptoms lasting at least 3 weeks. It is not believed to be necessary to perform EDX prior to injections.

*Dose* –One high-quality study found lower 1-year surgery rates with methylprednisolone 80mg vs. 40 mg of 73% vs. 81%, which were also superior to placebo.(860) Generally, at least 40mg of methylprednisolone or equivalent is recommended as the minimum initial dose. Although optimum dose remains unclear, evidence in total includes evaluations with methylprednisolone acetate (12, 15, 20, 40, 60mg, 80mg), betamethasone (6.0, 6.4mg), triamcinolone hexacetonide (20, 40, 80mg), and hydrocortisone (25, 100mg) in quality studies. Some physicians increase the dose in proportion to perceived symptom severity. However, there is no quality evidence to support this practice. The type of steroid to inject and whether to use a depot preparation, are also unclear as there are no quality studies comparing the various preparations commonly utilized. Most physicians include at least 1mL of an injectable anesthetic (e.g., 1% lidocaine). Lidocaine allows for rapid assessment immediately after the injection. The limitation of using an anesthetic

as an adjuvant is that the numbness that ensues afterwards may limit a patient's activities. Thus, a shorter-duration anesthetic such as lidocaine is recommended.

*Frequency/Duration* – A single injection and the results carefully evaluated to document improvement, even if short-term as it is believed to have considerable prognostic significance. There is no evidence that a series of injections is efficacious, although it has been argued that two injections are ideal.(861) There is no evidence that there is a limit to the number of injections to treat an episode or in a lifetime. 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. A second injection, typically utilizing a moderately higher dose, may be indicated if there has been insufficient but partial relief, or if the first injection was thought to have not entered the carpal canal.

*Indications for Discontinuation* – No partial response to carpal tunnel injection(s), then no recommendation for additional injection(s). Patients who fail to even partially respond to injections are *a priori* suspected to not have CTS and a thorough search for an alternate diagnosis should ensue. Patients who respond to carpal tunnel injections, but redevelop symptoms are believed to be ideal candidates for surgical release.

*Strength of Evidence* – **Strongly Recommended, Evidence (A)**

*Level of Confidence* – High

## 2. *Recommendation: Carpal Tunnel Injections for Treatment of Acute CTS without Fracture*

**Carpal tunnel injections are recommended for treatment of acute CTS without fractures. (Acute CTS with fractures should be referred for potential emergent surgical release.)**

*Indications/Dose/Frequency* – See above Recommendation #1.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

### *Rationale for Recommendations*

There is strong consistent evidence that carpal tunnel injections are efficacious with superiority to placebo.(631, 777, 839, 842, 843, 845, 849, 851, 854, 860) There also is evidence that injections are superior to oral glucocorticosteroids(648) and iontophoresis with glucocorticosteroids.(842) Most data suggest superiority of ultrasound guidance compared with blind injections, although cost-effectiveness of ultrasound guidance has not been reported. As evidence somewhat conflicts, use of ultrasound for guidance should be for those with training and experience in its use and with nominal (if any) added cost for imaging (1742-1747). Duration of improvements after injection is controversial and may differ by CTS severity. Nearly all quality studies required electrodiagnostic confirmation and many had patients with symptoms lasting years, suggesting more severely affected patients benefited. In such patients, injections may be somewhat less efficacious than in patients with more recent or mild symptoms that are seen initially in primary care settings.

Aside from local tenderness among 50% of patients lasting a mean 1.2 days,(862) long-term complications are rare. Long-term outcomes are somewhat controversial. One study of 30 patients found 11.4% remained asymptomatic over an 80-week observation period with more undergoing surgery if treatment had been via an oral steroid than via an injection. Other studies reported only 22% of injected patients were subsequently referred for surgery during 1 year of follow-up.(845)

Steroid injections into the carpal tunnel are minimally invasive, have minimal adverse effects, and are moderately costly. These injections provide lasting relief of at least intermediate-term durations in a majority of CTS patients. They are strongly recommended for treatment of subacute or chronic CTS.

Carpal tunnel injections are also recommended by consensus of the Evidence-based Practice Hand, Wrist, and Forearm Panel for treatment of acute CTS in cases where there are no fractures. There are no quality studies of these clinical cases; however, these injections are thought to be the best treatment for acute CTS presentations.

### *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.

## Intramuscular Injections

Intramuscular injections have been used to treat CTS.(854)

*Recommendation: Intramuscular Injections for Acute, Subacute, or Chronic CTS*

**Intramuscular injections are not recommended for treatment of acute, subacute, or chronic CTS.**

*Strength of Evidence – Not Recommended, Evidence (C) – Chronic CTS*

**Not Recommended, Insufficient Evidence (I) – Acute, subacute CTS**

*Levels of Confidence – Moderate*

### *Rationale for Recommendation*

Intramuscular injections for CTS are not recommended as they have been found to be inferior to carpal tunnel injections.(854)

### *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.

## Insulin Injections

Treatment of CTS with carpal tunnel insulin injections has been attempted.(634, 872)

*Recommendation: Insulin Injections for Acute, Subacute, or Chronic CTS*

**There is no recommendation for or against use of insulin injections for treatment of acute, subacute, or chronic CTS.**

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Level of Confidence – Low

### *Rationale for Recommendation*

There is one quality study which included CTS patients that suggests benefit from 7 weekly injections of insulin.(872) A second moderate quality trial found a lack of benefits compared with physiotherapy.(873) The consensus of the Evidence-based Practice Hand, Wrist, and Forearm Panel is that these results require replication. Applicability of these results, even if confirmed, are suggested to be relatively limited to a narrow subset of diabetic patients with CTS who fail to improve with other therapies and either decline surgery or have significant symptoms of focal intracarpal nerve dysfunction after surgery. These injections are invasive, may have adverse effects that also require ascertainment, and are moderate to high cost. There is no recommendation for or against insulin injections for treatment of diabetic patients with CTS.

### *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.*

## Botulinum Injections

Botulinum injections have been used to treat CTS.(874, 875)

*Recommendation: Botulinum Injections for Acute, Subacute, or Chronic CTS*

**Botulinum injections are not recommended for treatment of acute, subacute, or chronic CTS.**

Strength of Evidence – **Not Recommended, Evidence (C) – Chronic CTS**

**Not Recommended, Insufficient Evidence (I) – Acute or subacute**

Level of Confidence – Low

### *Rationale for Recommendation*

There is one quality study that included CTS patients that does not show clear benefit from botulinum injections, but did show weakness in two patients lasting a few weeks.(874) There are no other quality studies identified for management of other distal upper extremity disorders, including tendinoses. Botulinum injections are invasive, have adverse effects when the effects of the toxin are beyond the site where they were injected that include fatalities,(752, 876) and are costly. They are not recommended for management of CTS.

## *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.*

## **Surgery**

### **Carpal Tunnel Surgical Release**

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. If there is no clear indication for surgery, referring the patient to a provider experienced in non-operative treatment of CTS may aid in formulating a treatment plan.

Treatment of CTS with surgical release of the carpal flexor retinaculum has been utilized for many decades with surgical case series suggesting significant benefits.(762, 877-903) In the late 1980s, endoscopic releases were reported, gained prominence, utilized various equipment,(894, 895, 904-913) and were initially reported as superior to open releases.(907, 911, 914-918) However, the endoscopic technique reportedly has a higher incidence of injuries to the nerve, particularly in inexperienced surgical hands, as well as higher rates of incomplete surgical releases.(919) A large endoscopically treated case series of 2,402 cases involving 1,698 patients reported an overall success rate of 95% and recurrence rate of 0.5% in experienced hands.(920) More recently, the open technique has been revised towards a minimal incisional technique(921) and continues to be successfully performed with little apparent difference in outcome versus endoscopic releases.(922-925) Currently, there is a trend towards performing these minor surgical releases in uncomplicated patients in clinics as opposed to in hospitals or ambulatory surgical centers that is facilitating return to work on the same day as surgery.

Many adjunctive procedures and modifications of surgical release have been attempted in order to obtain better clinical results. These include neurolysis, epineurotomy, epineurectomy, tenosynovectomy, excision of the carpal ligament, cutaneous nerve sparing, two small open incisions, use of a Knifelight, hypothenar fat pad and other flaps, and concomitant release of the ulnar nerve in Guyon's canal.(926-941)

Most, but not all surgical studies required patients to have preoperative confirmation with electrodiagnostic studies (EDS), although the EDS criteria are usually not specified. How results compare among those without EDS confirmation



is unclear. Risks of surgical decompression include complications of anesthesia (addressed separately in this document), wound infection, complex regional pain syndrome, and damage to the median nerve.(894, 895, 942, 943) Incomplete decompression or recurrence of symptoms can lead to the need for further surgery. Early return to work is the main cost driver regardless of the type of carpal tunnel surgical approach utilized. Early return to work appears more dependent on the attitude of the employer and patient than on the surgical technique,(944) with self-employed patients incurring less lost work time.(944) The durations of lost time have been shown to vary from days to weeks, further suggesting that surgical approaches are not the primary determinants of return-to-work status.

1. *Recommendation: Surgical Release for Treatment of Subacute or Chronic CTS*

**Surgical release is strongly recommended for patients who fail non-operative treatment for subacute or chronic CTS.(911, 914-918, 922-925, 945, 946) It is also recommended for patients who have emergent or urgent indications (e.g., acute compression due to fracture, arthritides, or compartment syndrome with unrelenting symptoms of nerve impairment).**

*Indications* – Failure of non-operative treatment or severe symptoms such as continuous tingling and numbness. Many surgeons will not operate on a patient without a positive EDS. Most patients should have had at least 1 glucocorticosteroid injection with documentation of at least partial or complete relief followed by a return of symptoms. Patients should have an electrodiagnostic study (EDS) consistent with CTS (see Electrodiagnostic Studies). The decision to undergo surgery is typically driven by nocturnal symptoms.(947) 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: (i) there is recurrence of symptoms after surgical release, (ii) electrodiagnostic findings are supportive at 8–12 weeks after surgical release, or (iii) re-exposure to work factors are not explanatory and remediable. Patients not improving after an initial surgery should undergo a thorough diagnostic evaluation.

*Strength of Evidence* – **Strongly Recommended, Evidence (A)**

*Level of Confidence* – High

2. *Recommendation: Open or Endoscopic Release for Subacute or Chronic CTS*

**Either open or endoscopic release is moderately recommended for treatment of subacute or chronic CTS. With either open or endoscopic, the effectiveness results from complete division of the flexor retinaculum. The procedure that the surgeon is most comfortable performing is recommended.(922, 923, 925, 945, 946)**

*Indications* – See indications above for Recommendation #1.

*Strength of Evidence* – **Moderately Recommended, Evidence (B)**

*Level of Confidence* – Moderate

3. *Recommendation: Knifelight for Subacute or Chronic CTS*

**The use of a Knifelight is recommended for treatment of subacute or chronic CTS.**

*Indications* – See indications above for Recommendation #1.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Low

4. *Recommendation: Other Adjunctive Procedures or Techniques for Subacute or Chronic CTS*

**While there may be limited indications for the following procedures or techniques, their routine use is not recommended for treatment of subacute or chronic CTS.**

**Epineurotomy is moderately not recommended.**

*Strength of Evidence* – **Moderately Not Recommended, Evidence (B)**

*Level of Confidence* – Moderate

**Internal neurolysis is strongly not recommended.**

*Strength of Evidence* – **Strongly Not Recommended, Evidence (A)**

*Level of Confidence* – High

**Flexor retinacular lengthening is moderately not recommended.**

*Strength of Evidence – Moderately Not Recommended, Evidence (B)*  
*Level of Confidence – Moderate*

**Ulnar bursal preservation is moderately not recommended.**

*Strength of Evidence – Moderately Not Recommended, Evidence (B)*  
*Level of Confidence – Moderate*

**The mini palmar incision using the ring finger as a guide does not require any special changes in the location of the incision.(940) Therefore, altering the location of the incision to “superficial nerve-sparing incision” is not recommended.**

*Strength of Evidence – Not Recommended, Evidence (C)*  
*Level of Confidence – Low*

**As discussed above, an incision that is placed too far ulnarly may result in damage to the ulnar nerve or artery; therefore, an ulnar incisional approach is not recommended.**

*Strength of Evidence – Not Recommended, Evidence (C)*  
*Level of Confidence – Low*

**Flexor tenosynovectomy is not recommended.**

*Strength of Evidence – Not Recommended, Evidence (C)*  
*Level of Confidence – Moderate*

5. *Recommendation: Biopsy of Abnormal Tenosynovium for Subacute or Chronic CTS*

**Biopsy of abnormal tenosynovium is recommended for treatment of subacute or chronic CTS.**

*Indications – Abnormal appearing tenosynovium, including potential amyloidosis, infectious agents, or evidence for inflammatory conditions.*

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Moderate*

*Rationale for Recommendations*

Evidence that surgery is effective is strong. Six quality studies have compared carpal tunnel release with other interventions. Three quality studies document superiority compared with splinting.(763, 777, 778) Two of three studies suggest superiority of surgical release compared with injection(777, 851-853) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy.(641) These appear to indicate a slight superiority of surgery to injection over 1 year and a modestly stronger benefit compared with nocturnal splinting. Longer-term outcomes are believed to further favor surgery.

Seventeen quality trials have compared open versus endoscopic techniques.(907, 911, 914-918, 922-925, 945, 946, 948-952) Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases,(922, 923, 925, 945, 946, 948-952) which appears to be due to the successful use of minimal incisional techniques that utilize incisions as small as 2cm. These small incisions appear to have removed the primary advantage of endoscopic releases. Quality evidence of superiority of endoscopic versus minimal incisional releases is now lacking and one study has reported no differences at 5-year follow-up, also importantly documenting no differences in reoperation rates.(945) Differences in recovery time between the endoscopic or minimally invasive techniques reported mostly in the 1990s appear to have largely or completely disappeared in the 2000s with 4,(922, 923, 925, 945, 946) of 6 studies(917, 918) showing a lack of superiority of the endoscopic release.(922-925, 945, 946) However, it is the surgeon’s experience and comfort that are the determining factors in the selection of the procedure performed.

Overall, the available evidence suggests either the open or endoscopic procedures are successful surgical procedures. Thus, the Evidence-based Practice Hand, Wrist, and Forearm Panel agreed regarding the overall recommendation for surgery. The mini-procedures continue to improve outcomes,(921) while most early studies compared endoscopic to the traditional open procedure. Outcome measures vary with each study making a direct comparison difficult. Studies have shown that with well-motivated individuals and a mini-palm technique, return to modified work the next day is possible.(398)

Recently, a Knifelight has been utilized for carpal tunnel releases.(928, 932) This technique involves use of an instrument through a small palmar incision to perform a blinded division of the flexor retinaculum. While there is sufficient quality evidence to document efficacy and recommend the procedure,(928, 932) further studies are needed comparing the Knifelight with a standardized, minimal incisional technique and using larger sample sizes.

There have been many alterations on standard operative techniques(953) and/or adjunct surgical procedures performed to attempt to derive superior outcomes for patients who have been subjected to quality studies. Without exception, none of the following were found beneficial – epineurotomy,(929, 930, 935, 954, 955) neurolysis,(937, 938) flexor tenosynovectomy,(939) flexor retinacular lengthening,(956) nerve sparing incisions,(940) double-limited incisions,(941) ulnar incisions,(957) and ulnar bursal preservation.(931) Evidence indicates that even in the presence of synovial hypertrophy and histological changes, tenosynovectomy has not been shown to be beneficial in a moderate-quality study.(939) However, biopsy of abnormal tissue is indicated for diagnostic and therapeutic purposes. Examples of potential findings to be sought include amyloidosis, infectious agents, and evidence for inflammatory conditions.

The primary cost driver for CTS claims is lost work time.(778) CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation.(914, 925) In quality studies, lost time ranged from 12 days for open releases in the Netherlands(778) to 88 days for endoscopically treated patients in Sweden,(922) with most trials reporting these data between 12 and 40 days.(778, 907, 914, 916-918, 923, 924, 928, 932, 958) There is no clear pattern by country or procedure, other than a propensity for greater lost time in the 1990s in the open release groups compared with the endoscopic releases, prior to the dissemination of limited incisional techniques.

#### *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.*

#### **PERIOPERATIVE ANTIBIOTICS**

Perioperative antibiotics have been administered to patients undergoing carpal tunnel release, most commonly as pre-incisional antibiotics rather than post-operative antibiotic courses. Some surgeons use antibiotics in all patients. Also, some institutions have implemented policies mandating use in all cases.

##### **1. Recommendation: Perioperative Antibiotics for Patients Undergoing Carpal Tunnel Release**

**Pre-incisional antibiotics are recommended for consideration for patients with risk factors undergoing carpal tunnel release. Thresholds for use in other patients should be generally low.**

*Indications* – Patients with risk factors (e.g., diabetes mellitus, susceptibility to infections) who are undergoing carpal tunnel release surgery. Institutions may also mandate use through policies.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

2. *Recommendation: Routine Use of Antibiotics for Patients Undergoing Carpal Tunnel Release*

**Routine use of antibiotics for all patients undergoing carpal tunnel release is not recommended.**

Strength of Evidence – **Not Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

*Rationale for Recommendations*

There are no quality studies regarding the administering of peri-operative antibiotics to patients undergoing carpal tunnel release. Infections among these patients are quite uncommon. Antibiotics are invasive when administered intravenously, have low adverse effects, and are moderate to high cost depending on frequency and route of administration. Risk factors among patients, such as diabetics or those who are susceptible to infections, should be considered. As noted, some institutions mandate the use of these antibiotics, and there is no quality evidence to overturn those policies. However, routine use is not generally recommended.

*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.*

**ANESTHETIC ISSUES FOR CARPAL TUNNEL SURGICAL RELEASES**

Anesthetic techniques for carpal tunnel release and other hand surgery have ranged from general anesthesia to axillary/regional blocks to local infiltration.(888, 970) Tourniquets have also been used.(971)

*Recommendation: Anesthesia during Carpal Tunnel Release*

**Anesthesia, either local or regional, is recommended during carpal tunnel release.**

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – High

*Rationale for Recommendation*

There are no head-to-head comparative trials for most of these anesthetic techniques, thus evidence-based recommendations are not supportable. Ketorolac has been found useful as an adjunct to bier blocks for hand surgery.(972)

### *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.*

#### **FOLLOW-UP VISITS**

Carpal tunnel surgical patients usually have a good recovery, although it can be variable and determined by many factors, including severity of the condition, surgical results, complications, coexisting medical conditions, motivation, pain tolerance, compliance with post-operative instructions, speed of returning to activities of daily living, and speed of returning to work. Carpal tunnel release patients have undergone numerous formal rehabilitation programs. However, as the surgical procedure has become less invasive, the overall trend is towards less formal rehabilitation or courses with fewer appointments. In an increasing number of cases this now includes home exercises and graded increased use. Rehabilitation has included range-of-motion exercises, strengthening exercises, splinting, and a virtual reality system.(989) Home exercise programs appear to be the most effective for regaining function.(990)

Most patients require one or two follow-up clinical appointments for wound care and instructions. Patients with less optimal outcomes may require additional appointments to monitor and facilitate recovery. Patients with physically demanding jobs whose initial restrictions are not accommodated may require a greater number of appointments to monitor their recovery and help facilitate their return to work at appropriate intervals.

While most recovery occurs within the first 3 months after surgery, a full functional recovery from carpal tunnel release including attaining a maximum grip strength is estimated to minimally occur at 6 months and for some patients as long as 1 year. For more information regarding post-operative rehabilitation, see Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders.

## **Triangular Fibrocartilage Complex (TFCC) Tears**

### **Diagnostic Criteria**

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. Imaging studies should be consistent with a triangular fibrocartilage complex (TFCC) tear of sufficient magnitude to explain the symptoms. Other TFCC tears do not have all these features, yet are found in the course of imaging for wrist abnormalities.(14, 220, 221) These other tears generally represent asymptomatic prevalent tears discovered through imaging. Treatment of those tears is usually not indicated. TFCC tears are most commonly classified by the Palmer classification system(223) which has been utilized to

develop treatment recommendations (see Table 5. Palmer Classification of TFCC Tears and Treatment Recommendations. Type I are acute, traumatic injuries and Type II are degenerative.\*). However, overlap may be present between the types in particular due to concomitant degenerative and traumatic issues.

**Table 5. Palmer Classification of TFCC Tears and Treatment Recommendations. Type I are acute, traumatic injuries and Type II are degenerative.\***

Type	Anatomy	Treatment
IA	Avascular articular disc tear	Immobilization. Arthroscopic debridement if immobilization unsuccessful.
IB	Base of the styloid tear	Immobilization. Arthroscopic or open surgery if immobilization fails.**
IC	Carpal detachment	Immobilization. Arthroscopic or open surgery if immobilization fails.
ID	Detachment off the radius	Immobilization. Arthroscopic or open surgery if immobilization fails.
IIA	Thinning of the articular disc without tear	Address degenerative joint disease risks.*** Surgery rarely indicated. Possible ulna shortening in select cases.
IIB	Thinning of articular disc accompanied by chondromalacia of the lunate or ulna	Address degenerative joint disease risks. Surgery rarely indicated. Possible ulna shortening in select cases.
IIC	Central disc tear with chondromalacia	Address degenerative joint disease risks. Surgery for residual symptoms, including ulna shortening and wafer procedure.
IID	Central tear, chondromalacia and lunotriquetral ligament disruption	Address degenerative joint disease risks. Surgery for residual symptoms including ulna shortening and wafer procedures. Possible arthrodesis.
IIE	Central tear, chondromalacia and lunotriquetral ligament disruption and ulnocarpal arthritis	Address degenerative joint disease risks. Surgery for residual symptoms

\*Adapted from Ahn 2006, Bednar 1994, and Palmer 1990.

\*\*Surgery of these is felt to be rarely necessary due to vascular supply.

\*\*\*Degenerative joint disease risks include body mass index, gout, rheumatoid arthritis, other inflammatory arthropathies, and repeated forceful wrist use.

## Special Studies and Diagnostic and Treatment Considerations

### X-Rays

*Recommendation: X-rays to Diagnose Triangular Fibrocartilage Complex (TFCC) Tears*

**X-rays are 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.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendation*

There are no quality studies evaluating x-rays for the diagnosis of triangular fibrocartilage complex (TFCC) tears. Some patients do not require initial x-rays and can be managed clinically. However, x-rays may assist particularly in ruling out other potential sources of wrist pain. They are also indicated for those who fail to improve or have other symptoms suggesting consideration of other potential diagnoses. X-rays also assist with analysis for evidence of other conditions such as osteoarthritis. Positive ulnar variance (an ulna that extends more distally than the radius) is thought to increase risk.

### MR Arthrography and MRI

*Recommendation: MR Arthrography or MRI to Diagnose Triangular Fibrocartilage Complex (TFCC) Tears*

**MR arthrography or MRI is recommended to diagnose triangular fibrocartilage complex (TFCC) tears.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

### *Rationale for Recommendations*

There are no quality studies evaluating MR arthrography or MRI for the diagnosis of triangular fibrocartilage complex (TFCC) tears. MR arthrography is thought to be superior. Traditional arthrography without MRI has mostly been replaced by MR arthrography and MRI.(991-996) Virtual MR arthroscopy is in development, but its utility is not yet demonstrated.(997)

## **Arthroscopy**

Diagnostic arthroscopy is often combined with surgical repair (see Surgery section).

## **Initial Care**

Splinting has been used for treatment of TFCC tears(998) as have ice, heat and rest.

1. *Recommendation: Relative Rest for Acute, Subacute, or Chronic Triangular Fibrocartilage Complex (TFCC) Tears*  
**Relative rest is recommended for treatment of acute, subacute, or chronic triangular fibrocartilage complex (TFCC) tears.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

2. *Recommendation: Splinting for Moderate or Severe Acute or Subacute Triangular Fibrocartilage Complex (TFCC) Tears*

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

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

3. *Recommendation: Self-application of Ice for Acute, Subacute, or Chronic Triangular Fibrocartilage Complex (TFCC) Tears*

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

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

4. *Recommendation: Self-application of Heat for Acute, Subacute, or Chronic Triangular Fibrocartilage Complex (TFCC) Tears*

**Self-application of heat is recommended for treatment of acute, subacute, or chronic triangular fibrocartilage complex (TFCC) tears.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendations*

There is no evidence of the efficacy of wrist splints to treat acute, subacute, or chronic TFCC tears (knee menisci which are structurally similar, appear to heal with use). Yet, there may be cases where a wrist splint seems helpful and others have recommended immobilization (see Table 5. Palmer Classification of TFCC Tears and Treatment Recommendations. Type I are acute, traumatic injuries and Type II are degenerative.\*). Splints may help with avoiding aggravating activities or actions that provoke symptoms and therefore, may be more appropriate for acute or moderate to severe injuries. There are also no quality studies evaluating relative rest, rest, ice, or heat for TFCC tears. However, limitations are often needed for more symptomatic cases. Though not invasive, limitations can be moderate to high cost over time; however, 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, are not invasive, have no adverse effects, and are not costly and are recommended.

### *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.

## Follow-up Visits

Patients generally require from 1 to 6 appointments, depending on severity and need for workplace limitations. Greater numbers of appointments may be required for evaluating and treatment pain and monitoring function and work status over time. Severe TFCC tears, especially those that either are immobilized for many weeks or undergo surgery may require occupational or physical therapy typically for teaching mobilization exercises and strengthening exercises.

## Medications

Over-the-counter medications are generally helpful. Prescription medications may be needed in moderate to severe cases.

## NSAIDs/Acetaminophen

*Recommendation: NSAIDs or Acetaminophen for Acute, Subacute, or Chronic Triangular Fibrocartilage Complex (TFCC) Tears*

**NSAIDs or acetaminophen are recommended to control pain associated with acute, subacute, or chronic TFCC tears particularly for patients with significant pain.**



*Indications* – Pain due to acute, subacute, or chronic TFCC tears.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendation*

There are no quality studies evaluating NSAIDs or acetaminophen for controlling pain associated with TFCC tears. However, NSAIDs may help particularly with more acute symptoms. These medications are not invasive, have low adverse effects for short-term use in employed populations, and are not costly. Thus, NSAIDs or acetaminophen are recommended for treatment of pain from acute, subacute, or chronic TFCC tears.

#### *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 and Cochrane Library without date limits using the following terms: Acetaminophen, anti-inflammatory agents, non-steroidal, NSAIDs, 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, 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.

## Physical Methods/Rehabilitation

### Exercise

Exercise is generally not indicated acutely; however, exercise may be needed in the recovery or post-operative phases. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

#### *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.

## Surgery

1. *Recommendation: Arthroscopic or Open Surgical Repair for Subacute or Chronic Triangular Fibrocartilage Complex (TFCC) Tears*

**Surgical repair (arthroscopic or open) is recommended for 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.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

There are no quality studies evaluating surgical repair for TFCC tears. Location of the TFCC tear is thought to be related to prognosis with peripheral tears having a better probability of success with non-surgical treatment due to vascular supply; however, central tears also may become asymptomatic.(999) Arthroscopic repair is most typically used with excellent or good results reported in 74% of a case series of 35 patients(1000) with other estimates of success up to 93%,(220, 1001-1004) although open repairs may be performed.(1005)

#### 2. *Recommendation: Ulna Shortening and Wafer Procedures for Chronic Triangular Fibrocartilage Complex (TFCC) Tears*

**Ulna shortening(1006) and wafer procedures are recommended for select cases of chronic Types IIC and IID (Table 5) TFCC tears for which non-surgical treatment is unsuccessful and there is a demonstrable ulna positive variance.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies evaluating ulna shortening and wafer procedures for TFCC tears. However, in select cases with ulna positive variance and without resolution of considerable or incapacitating symptoms or lacking trending towards resolution, this procedure is recommended. This procedure is invasive, has adverse effects, may not be effective, but also may provide either cure or relief of symptoms and thus is recommended for select cases.

#### *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.*

## **Crush Injuries and Compartment Syndrome**

### **Special Studies and Diagnostic and Treatment Considerations**

#### **X-Rays**

*Recommendation: X-rays for Evaluating Crush Injuries or Compartment Syndrome*

## **X-rays are recommended for evaluating patients with crush injuries or compartment syndrome.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

### *Rationale for Recommendation*

There are no quality studies evaluating the use of x-rays for crush injuries or compartment syndrome. However, x-rays are essential for evaluating the extent of injuries and identification of fractures.

### *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, crush injury, upper extremity; 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, 2 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 1580 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

## **MRI/CT**

*Recommendation: MRI or CT for Crush Injuries or Compartment Syndrome*

**MRI or CT is recommended for follow-up of select patients with crush injuries or compartment syndrome.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *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.

### *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.

## **Initial Care**

Compartment pressure measurements are helpful and assist in guiding need of emergent surgery.

### *1. Recommendation: Elevation and Relative Rest for Acute Crush Injuries or Compartment Syndrome*

**Elevation and relative rest are recommended for treatment of acute crush injuries or compartment syndrome.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *2. Recommendation: Splinting for Subacute Crush Injuries or Compartment Syndrome*

**Splinting is recommended after initial treatment for moderate or severe acute and subacute crush injuries or compartment syndrome.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *3. Recommendation: Self-application of Ice for Acute Crush Injuries or Compartment Syndrome*

**Self-application of ice is recommended for treatment of acute crush injuries or compartment syndrome. Other cryotherapies may be required in hospital settings for more severe cases.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

4. *Recommendation: Self-application of Heat for Acute Crush Injuries or Compartment Syndrome*  
**Self-application of heat is not recommended for treatment of acute crush injuries or compartment syndrome.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendations*

There are no quality studies evaluating rest/elevation, splinting, or self-application of ice or heat to treat crush injuries or compartment syndrome. However, elevation, rest, and ice are believed to be helpful for treatment of these conditions and in milder cases may be the principal treatments administered. These interventions are not invasive, have no adverse effects, and are not costly (other than repeated administrations of cryotherapies in hospital settings where monitoring is required); thus, they are recommended. Splints may assist in symptomatic relief, are not invasive, have few adverse effects, and are low to moderate cost. The type of splint required depends on the type of injury and subsequent debility. Splints are frequently custom made for patients with these injuries. Splints are recommended particularly for patients with moderate to severe injuries.

#### *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.

## Follow-up Visits

Patients generally require multiple follow-up appointments with the number dependent on the severity of the injury. The mildest cases of crush injuries may require 1 to 3 follow-up appointments. Severe cases of compartment syndrome or crush injuries that have major medical complications and activity limitations may require dozens of appointments to evaluate, treat, advance activity limitations and otherwise monitor and actively facilitate clinical progress. Moderate and severe crush injuries and compartment syndrome usually require occupational or physical therapy for teaching mobilization and strengthening exercises. Therapy needs can be extensive (see below).

## Medications

Over-the-counter medications may be helpful, but most patients require prescription medications for pain, particularly for moderate to severe injuries. (Jones 15) Mannitol has been reported as a treatment.(1007)

### NSAIDs/Acetaminophen

*Recommendation: NSAIDs or Acetaminophen for Acute or Subacute Crush Injuries or Compartment Syndrome*

**NSAIDs or acetaminophen are recommended to control pain associated with acute or subacute crush injuries or compartment syndrome.**

*Indications* – Pain due to acute or subacute crush injuries or compartment syndrome.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects, particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendation*

There are no quality studies evaluating NSAIDs or acetaminophen for patients with crush injuries or compartment syndrome. There is one trial with non-specific limb injury suggesting efficacy of diclofenac (Woo 05). These medications are helpful for numerous other musculoskeletal disorders and are believed helpful for these injuries. As NSAIDs and acetaminophen are non-invasive, have low adverse effects, and are low cost, they are recommended for treatment of pain associated with acute or subacute crush injuries or compartment syndrome.

#### *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.

## Opioids

See Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol) in Carpal Tunnel Syndrome section.

## Physical Methods/Rehabilitation

### Exercise

Exercise is generally not indicated acutely; however, exercise may be needed in the recovery or post-operative phases. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of

5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

#### *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.

## Hyperbaric Oxygen

*Recommendation: Hyperbaric Oxygen for Acute or Subacute Crush Injuries or Compartment Syndrome*

**Hyperbaric oxygen is 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.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There is one quality study of hyperbaric oxygen (HBO) for treatment of crush injuries with considerable benefits demonstrated including improved healing and reduced need for additional surgeries.(1009) HBO is non-invasive and generally safe,{Garcia-Covarrubias, 2005 #694;Dougherty, 2013 #3485;Eskes, 2013 #3483;Eskes, 2011 #3484;Greensmith, 2004 #3486} (Eskes 13, Eskes 11, Dougherty 13, Garcia-Covarrubias 05, Greensmith 04) although it is high cost. However, HBO is recommended for treatment of patients with moderate to severe crush injuries or compartment syndrome as risks are outweighed by benefits.

#### *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.

## Surgery

*Recommendation: Surgery for Acute or Subacute Crush Injuries or Compartment Syndrome*

**Surgery is 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. Compartment pressure measurements are helpful and assist in guiding need of emergent surgery.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – High*

*Rationale for Recommendation*

There are no quality studies evaluating surgeries for crush injuries or compartment syndrome of the hand or forearm and the clinical variability between patients is large. However, fasciotomies are particularly essential for treatment of significant neurovascular compromise from compartment syndrome and is a surgical emergency.(19, 227, 1010-1019) (Kalyani 11, Hayakawa 09, Wall 10, Gourgiotis 07) Other procedures may be required based on remediable defects such as fractures, ligament tears, or other injuries.

*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.*

## **Kienböck Disease**

### **Diagnostic Criteria**

Patient has non-radiating wrist compartment pain, limited range of motion, and developed x-ray evidence of radiological collapse of the lunate.

## Special Studies and Diagnostic and Treatment Considerations

### X-Rays

*Recommendation: X-rays to Diagnose Kienböck Disease*

**X-rays are recommended to diagnose Kienböck disease.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

#### *Rationale for Recommendation*

There are no quality studies evaluating the use of x-rays to diagnose Kienböck disease. However, x-rays are used to confirm the diagnosis and are moderately costly, thus they are recommended. X-rays generally should be taken of both hands.

#### *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.

### CT

*Recommendation: CT to Diagnose Kienböck Disease*

**CT is recommended to diagnose Kienböck disease when xrays are negative or unclear.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

There is one quality study evaluating the use of CT scans that included patients with Kienböck disease suggesting 3-D CT may provide more information than xray or plain CT (Nakamura 89). CTs are used to assist with diagnosis and management, thus they are recommended where xrays are negative or unclear.

#### *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.

### MRI

*Recommendation: MRI to Diagnose Kienböck Disease*

**MRI is recommended to diagnose Kienböck disease.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*



There are 2 moderate-quality articles evaluating the use of MRIs to diagnose Kienböck disease. However, MRI was not shown to have superior performance for diagnostic purposes. MRIs are used to assist with diagnosis and management, thus they are recommended.

#### *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.

## Screening for Systemic Disorders

*Recommendation: Screening for Systemic Disorders for Kienböck Disease*

**Screening for systemic disorders is recommended for patients with Kienböck disease.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

There are multiple disorders that are thought to predispose to Kienböck disease. These disorders may be otherwise asymptomatic, there may be potential to develop other manifestations of these diseases including in the other hand, and it may be possible to slow the rate of progression of this condition through active clinical management. Thus, 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 or prevent the disease in the other hand.

#### *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.

## Initial Care

Initial care of patients with Kienböck disease involves identification and elimination or control of potential systemic contributing factors. Patient's limitations should be based on their capabilities.

1. *Recommendation: Self-application of Ice for Acute, Subacute, or Chronic Kienböck Disease*

**Self-application of ice is recommended for treatment of acute, subacute, or chronic Kienböck disease.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

2. *Recommendation: Self-application of Heat for Acute, Subacute, or Chronic Kienböck Disease*

**Self-application of heat is recommended for treatment of acute, subacute, or chronic Kienböck disease.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

3. *Recommendation: Splints for Acute, Subacute, or Chronic Kienböck Disease*

**Splints are recommended for treatment of select patients with acute, subacute, or chronic Kienböck disease.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

*Rationale for Recommendations*

There are no quality studies evaluating the use of ice or heat for treatment of Kienböck disease. However, these treatments may help with symptomatic relief. These interventions are not invasive, have no adverse effects, and are not costly, thus they are recommended. There are no quality studies evaluating splinting for Kienböck disease. A trial may be helpful to assess whether splinting provides symptomatic relief. Splints are not invasive and have few adverse effects over the short term although over the long term there are concerns regarding the potential for accelerated debility, disuse and weakness of the wrist. Splints are also low cost. Thus, they are recommended for select patients.

*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.

**Follow-up Visits**

Patients with Kienböck disease generally require periodic appointments to follow the clinical course. Frequencies of appointments may be greater where workplace limitations are required. Post-operative rehabilitation can be considerable, with a requirement for occupational or physical therapy on a prolonged basis in order for the patient to recover as much function as possible.

**Medications**

Over-the-counter medications are generally helpful for pain associated with Kienböck disease. Prescription medications may be needed for moderate to severe cases. Patients with Kienböck disease often develop chronic pain (see Chronic Pain Guideline for a comprehensive approach to managing chronic pain). An abbreviated approach is noted below.

## NSAIDs/Acetaminophen

*Recommendation: NSAIDs and Acetaminophen for Acute, Subacute, or Chronic Kienböck Disease*

**NSAIDs and acetaminophen are recommended to control pain associated with acute, subacute, or chronic Kienböck disease.**

*Indications* – Pain due to acute, subacute, or chronic Kienböck disease.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

### *Rationale for Recommendation*

There are no quality studies evaluating NSAIDs and acetaminophen for Kienböck disease. However, these medications may relieve pain and increase function. They are not invasive, have few adverse effects in employed populations, and are low cost, thus they are recommended.

### *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.

## Topical Medications

*Recommendation: Topical Medications for Treatment of Acute, Subacute, or Chronic Kienböck Disease*

**Topical medications including topical creams, ointments, and lidocaine patches are recommended for treatment of pain associated with acute, subacute, or chronic Kienböck disease.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

### *Rationale for Recommendation*

There are no quality studies evaluating the use of topical medications for treatment of Kienböck disease. However, these treatments may provide symptom relief. They are not invasive, have few adverse effects in employed populations, and are low cost, thus they are recommended. Caution is warranted if there is use of anesthetic agents over large areas of the body, as adverse effects from systemic absorption have been reported.

### *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, Kienböck 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.

## Opioids

See Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol) in Carpal Tunnel Syndrome section.

## Physical Methods/Rehabilitation

### Exercise

Exercise is generally not utilized during acute presentations of Kienböck disease. However, exercise is nearly always necessary for post-operative patients and is frequently used for patients in the subacute and chronic phases. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

#### *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

### Surgery

#### *Recommendation: Surgical Repair for Chronic Kienböck Disease*

**Surgical treatment is recommended as an option for patients with moderate to marked impairment if not improved 8 weeks post-injury or after 6 weeks of non-operative treatment due to Kienböck disease.**

**Strength of Evidence – Recommended, Insufficient Evidence (I)**

**Level of Confidence – Low**

#### *Rationale for Recommendation*

There are no quality studies evaluating surgical repair for Kienböck disease. There are many different surgical procedures and no quality comparative studies that have been reported. Surgical procedures utilized have included: lunate excision with silicone implants(1022-1024) (no longer recommended), excision with autogenous soft tissue implants including coiled palmaris longus tendon,(1022, 1025-1030) external fixation,(1029, 1031) arthrodesis,(1032, 1033) radial shortening,(1034, 1035) (Takahara 09) scaphoid-trapezium-trapezoid fusion,(1030, 1036, 1037) in advanced cases, proximal row carpectomy,(1038-1040), lunate core decompression,(1041, 1042) (Mehrpour 11, Rodrigues-Pinto 12) and vascularized bone transfers.(1043) (Lu 06) A comparative clinical trial found superior clinical results and better preservation of carpal height ratio using palmaris longus tendon ball with a bone core compared with no bone core.(1028) In the absence of quality studies, the main determinant of surgical technique is the experience and comfort of the surgeon with specific treatment approaches.

#### *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.

## Wrist Sprains

### Diagnostic Criteria

A history of an acute traumatic event with forceful loading of the wrist, combined with a negative examination other than ligamentous tenderness and negative x-rays.

### Special Studies and Diagnostic and Treatment Considerations

#### X-Rays

X-rays are traditionally the first diagnostic imaging study to evaluate wrist sprains and potential fractures.(1044)

*Recommendation: X-rays for Wrist Sprains*

**X-rays are recommended to determine whether a fracture is present, particularly for patients with scaphoid pain or scaphoid tubercle tenderness.**(1045)

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

*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.

#### CT Scans

*Recommendation: CT scans for Wrist Sprains*

**CT scans are recommended to determine whether a fracture is present, particularly for patients with scaphoid pain or scaphoid tubercle tenderness with negative x-rays.**(1045)

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

*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.

## MR Arthrography

*Recommendation: MR Arthrography for Wrist Sprains*

**MR arthrography is recommended for patients without improvement in wrist sprains after approximately 6 weeks of treatment.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendations*

There are no quality studies evaluating x-rays for wrist sprains. Mild wrist sprain may not necessitate x-rays. There is no evidence other studies are helpful in the acute setting (see discussion of scaphoid fractures for other studies in the presence of ongoing, non-resolving pain.) However, x-rays may assist in diagnosing and treating the condition and thus are recommended. There also are no quality studies evaluating MR arthrography. However, MR arthrograms are helpful to particularly 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.

### *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.

## Initial Care

### 1. *Recommendation: Relative Rest for Acute Wrist Sprains*

**Relative rest is recommended for treatment of acute wrist sprains.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### 2. *Recommendation: Splinting for Moderate or Severe Acute or Subacute Wrist Sprains*

**Splinting is recommended for treatment of moderate or severe acute or subacute wrist sprains.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### 3. *Recommendation: Self-application of Ice for Acute Wrist Sprain*

**Self-application of ice is recommended for treatment of acute wrist sprain.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### 4. *Recommendation: Self-application of Heat for Acute Wrist Sprain*

**Self-application of heat is recommended for treatment of acute wrist sprain.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

### *Rationale for Recommendations*

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)

## **Follow-up Visits**

Patients generally require 1 to 3 appointments, depending on severity of the sprain and the need for workplace limitations. Severe wrist sprains may require occupational or physical therapy mostly for teaching mobilization exercises. Wrist sprains that do not resolve or trends towards resolution by 6 weeks should have either further diagnostic evaluation or referral for consideration of other diagnostic testing and treatment options.

## **Medications**

Over-the-counter medications are generally helpful for pain associated with wrist sprain. Prescription medications may be needed for moderate to severe cases.

## NSAIDs/Acetaminophen

*Recommendation: NSAIDs and Acetaminophen for Acute or Subacute Wrist Sprain*

**NSAIDs and acetaminophen are recommended to control pain associated with acute or subacute wrist sprain.**

*Indications* – Pain due to acute or subacute wrist sprain.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Evidence (C) – NSAIDs**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I) – Acetaminophen**

*Level of Confidence* – Moderate

### *Rationale for Recommendations*

There are no quality studies directly evaluating the use of NSAIDs and acetaminophen for pain associated with wrist sprain; however, there are moderate-quality studies of lower extremity sprains(1047, 1048) and these injuries are believed to be analogous (see Ankle and Foot Disorders Guideline). These medications may relieve pain and increase function. They are not invasive, have few adverse effects in employed populations, and are low cost, thus they are recommended for pain associated with acute or subacute wrist sprain.

### *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.

## Opioids

See Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol) in Carpal Tunnel Syndrome section.

## Physical Methods/Rehabilitation

### Exercise

Exercise is generally not indicated acutely. Patients with deficits may require a home exercise program during recovery phases. Some patients require a formal exercise program. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

### *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.

## Surgery

*Recommendation: Surgery for Treatment of Acute or Subacute Wrist Sprain*

**Surgery is not recommended for treatment of acute or subacute wrist sprain in the absence of a remediable defect.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

### *Rationale for Recommendation*

There are no quality studies evaluating the use of surgery for wrist sprain. Other than among patients with other trauma necessitating surgery, wrist sprains are not believed to respond to surgery. Ongoing symptoms that do not resolve should be evaluated for other diagnoses.

### *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 articles met the inclusion criteria.*

## Mallet Finger

### Diagnostic Criteria

Mallet finger is a clinical diagnosis with a characteristic presentation of inability to extend the distal segment when the extensor tendon is damaged.

### Special Studies and Diagnostic and Treatment Considerations

#### X-Rays

*Recommendation: X-rays for Mallet Finger*

**X-rays are recommended in most cases of mallet finger to determine if a fracture is present and to what extent.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There are no quality studies evaluating the use of x-rays for mallet finger. X-rays may assist in identifying fractures and the magnitude of the involvement of the joint surface, which if large enough, alters management to surgery. It is reasonable to omit x-rays if there is no swelling or tenderness.

### *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.

## Ultrasound

*Recommendation: Ultrasound to Diagnose Mallet Finger*

**Ultrasound is not recommended to diagnose mallet finger.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There are no quality studies evaluating the use of ultrasound to diagnose mallet finger. While ultrasound has been used for imaging,(1049, 1050) (Bianchi 08) there is no evidence it alters treatment or prognosis and x-ray studies appear sufficient for diagnostic purposes. Thus, ultrasound is not recommended to diagnose mallet finger.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: ultrasonography, ultrasound, ultrasound scanning, sonography, mallet finger, baseball, hammer; 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, 10 in Scopus, 0 in CINAHL, 0 in Cochrane Library, and 178 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. Zero articles met the inclusion criteria.

## Initial Care

Care usually involves a splint and follow-up visits. Large fracture fragments are rare(264, 1051-1054) and necessitate surgery.

## Splints

1. *Recommendation: Splints for Acute or Subacute Mallet Finger*

**Extension splinting with the joint in a neutral or hyperextended position is moderately recommended for treatment of acute or subacute mallet finger.**(264, 1054)

*Indications – Acute or subacute mallet finger.*

*Frequency/Duration – Splinting for 6 to 8 weeks, possible nocturnal use for an additional 2 to 4 weeks.*

*Indications for Discontinuation – Skin complications, non-compliance.*

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – High*

### *Rationale for Recommendation*

There are 5 moderate-quality RCTs incorporated in this analysis. Splints must hold the finger in continuous, full extension for a minimum duration of 6 weeks.(1055, 1056) (Smit 10) Some protocols involve 8 weeks, while some involve nocturnal use for an additional 2 to 4 weeks.(264, 1053-1055, 1057-1059) (Valdes 15) There are many different types of(264, 1053, 1054, 1057, 1058) and no quality evidence of the unequivocal superiority of one versus another.(1060-1062) A padded aluminum splint was reportedly superior compared to a Stack (pre-fabricated plastic) splint due to easier fit and fewer skin complications.(264) Another trial found the Stack splint superior to the Abouna splint.(1054) Extension *must* be maintained even if the splint is removed for skin hygiene, which is often one of the times non-compliance occurs and is believed to cause many of the treatment failures.(1060) One quality study suggested better outcomes with fixation for patients presenting with delayed treatment.(1051)

### *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.

### 2. *Recommendation: Instructions for Splint Wear*

**It is recommended that careful instructions on splint wear be provided to patients.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – High

### *Rationale for Recommendation*

There are no quality studies evaluating the use of instructions for splint wear for mallet finger. However, instructions appear critical for preventing treatment failures and are thus recommended.

### *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.

## **Follow-up Visits**

Patients require a few appointments to reinforce importance of splinting and of not removing the splint unsupported. Multiple appointments are generally not required.

## **Medications**

Nonprescription medications are usually not required as mallet finger is generally not painful. Prescription medications are rarely required as mallet finger is generally not painful.

### *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.

## Physical Methods/Rehabilitation

### Exercise

Exercise is not indicated acutely and most patients with mallet finger do not require participation in an exercise program. However, patients usually require careful education about splinting. For patients with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders.

#### *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.

### Surgery

#### 1. *Recommendation: Surgical Interventions for Mallet Finger with Displaced Fractures*

**Surgical treatment with a fixation wire is recommended for patients with displaced fractures involving more than one third to one half of the articular surface of the DIP joint.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### 2. *Recommendation: Surgical Interventions for Failed Splinting Cases of Mallet Finger*

**Surgery is recommended for those cases that fail splinting yet have sufficient symptoms or concerns that an attempt at fixation is desired.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

Quality studies to determine which patients with mallet finger would be optimal for surgical interventions are not currently available.(1060) One study reported a non-statistically significant trend suggesting preference for fixation among those presenting late for treatment;(1051) however, the dropout rate was high. A low-quality study also suggested no difference in splinting outcomes among those presenting late.(1052) Surgery is invasive, has relatively few adverse effects for this disorder, and is high cost; however, surgery is recommended for these select patients.

#### *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.

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.

## Flexor Tendon Entrapment (Tenosynovitis and Trigger Digit)

### Diagnostic Criteria

The diagnosis of flexor tendon entrapment is clinical. Patients without triggering will typically have only focal A1 pulley tenderness with or without a tendon nodule. Patients with triggering can usually demonstrate the triggering for the examiner.(36, 40)

### Special Studies and Diagnostic and Treatment Considerations

There are no special tests that are typically performed.(36, 40) 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.(36, 40)

#### *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.

### Initial Care

The initial care for this condition is not well defined. As quality evidence for efficacy of other interventions is lacking and success of injections is strong, arguably, the initial management should be glucocorticosteroid injection(39) in contrast with most other potentially occupational MSDs where non-invasive treatments are initially indicated.

### Splints

*Recommendation: Splints for Select Cases of Acute, Subacute, or Chronic Flexor Tendon Entrapment*

**Splints are recommended for treatment of select cases (i.e., patients who decline injection) of acute, subacute, or chronic flexor tendon entrapment.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There is one moderate-quality RCT evaluating the use of two different splints for flexor tendon entrapment with no apparent differences in outcomes between the types of splints.(1066) Historically splints were widely used for treatment of trigger digits;(27, 36, 40, 1067, 1068) (Colbourn 08) however, prior to the advent of glucocorticosteroid injection, the lack of successful treatments often resulted in surgery. Splints have been used to treat trigger digits(27, 36) and they may be reasonable intervention for patients who decline injection, although it is recommended that patients be educated that the use of splints appears substantially less successful than injections (or surgery).

### *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.

## **Follow-up Visits**

Follow-up visits are generally limited unless complications arise. Success of injections is usually high, thus 1 or 2 follow-up appointments are typical. Post-surgical outcomes for minimally invasive approaches are similarly excellent and necessitate few, if any follow-up appointments beyond 1 or 2. Additional appointments are required for complicated courses.

## **Medications**

There are no quality studies on use of medications for this condition, although some have recommended NSAIDs.(36) Medications are generally not required as the condition is generally not substantially painful. NSAIDs may be a reasonable option to control pain; however, injections appear to be superior interventions. NSAIDs may be a more appropriate intervention for those who decline initial injection.

### *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: 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.

## **Physical Methods/Rehabilitation**

### **Exercise**

Exercise is not generally indicated acutely and most patients with flexor tendon entrapment do not require an exercise program. For patients with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional

improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

#### *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, 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.

## Injections

### Glucocorticosteroid Injections

*Recommendation: Glucocorticosteroid Injections for Acute, Subacute, or Chronic Flexor Tendon Entrapment*

**Glucocorticosteroid injections are strongly 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 at the first appointment may be the most appropriate initial intervention.(39)

*Dose* – Optimal dose is unknown. Quality studies have included betamethasone 6mg,(38, 1069) depot preparation of methylprednisolone 20mg;(1070) and triamcinolone 1mL(1071) most of which were generally combined with an anesthetic. However, there are no quality comparisons of doses and the need for topical anesthetic is untested in quality studies. Subcutaneous injection over the A-1 pulley appears as efficacious as attempted intrasheath injection.(1072)

*Frequency/Duration* – A single injection and results evaluated to document improvement. Ultrasound-guidance is not shown to be helpful (Cecen 15).

*Indications for Discontinuation* – If a partial response, consideration should be given to repeating the injection, typically at a modestly higher dose.

*Strength of Evidence* – **Strongly Recommended, Evidence (A)**

*Level of Confidence* – High

#### *Rationale for Recommendation*

There are 2 high-quality and 2 moderate-quality studies incorporated into this analysis.(38, 1069-1071)

Glucocorticosteroid injection(s) are the most commonly used intervention for trigger digits.(39, 40) Quality studies have reviewed attempts to inject along the tendon, although a moderate-quality study failed to find superior results among the group with an attempt to inject within the sheath(1072) and a low-quality study performed subcutaneous injections that were efficacious.(1073) Further, ultrasound guidance has not been found to improve the results (Cecen 15). It has been suggested that many injections are performed along, rather than within the sheaths(1074) and thus it may not matter how precisely these injections approximate the target tissue. Multiple studies have consistently demonstrated efficacy of these injections compared with placebo with estimates of success typically exceeding 80%.(31, 38, 1069-1071, 1075-1083) Two studies compared injection with surgery, but the recurrence rates while lower with surgery still showed strong efficacy of injection (0% vs. 11% recurrence(1083) and 0% vs. 14%.(1082) They are less effective in diabetics, although still are effective(38) and there is weak evidence that patients failing other medical treatments may respond at lower rates of approximately 60%.(280) These injections are minimally invasive, have low adverse effects, and are moderate cost. Some caution is warranted regarding repeated administrations with adverse effects including atrophy that generally recovers over time. Nevertheless, quality studies have documented their efficacy and thus, they are strongly recommended.

### *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.*

## **Surgery**

*Recommendation: Surgery for Persistent or Chronic Flexor Tendon Entrapment*

**Open release for persistent or chronic flexor tendon entrapment is moderately recommended. Percutaneous release is also a reasonable option.**(1091)

*Indications* – Triggering digit or symptoms of stenosing tenosynovitis that has been unresponsive to at least 1 glucocorticosteroid injection, or with an inadequate response. Those without any response should be evaluated carefully for possible alternate conditions. Adjunctive surgical treatment with glucocorticosteroid injection could be considered, although that evidence relies on a single moderate-quality study.(1092)

*Strength of Evidence* – **Moderately Recommended, Evidence (B)**

*Level of Confidence* – High

### *Rationale for Recommendation*

Both open (with a scalpel) and percutaneous (with a needle through the skin) releases are performed with evidence both are effective.(1093) Evidence is strong that percutaneous release is as effective, if not more effective than open release,(271, 1082, 1083, 1091, 1094-1098 Gilberts 01) is faster to perform, requires fewer resources,(1091, 1098) involves less pain, and results in faster recovery.(1091) Failures are believed to be due to incomplete release of the A-1 pulley.(1099) There are concerns, however, that particularly in inexperienced hands, lacerations of digital nerves, arteries, and other structures and other complications have been reported with the percutaneous technique. The thumb appears more prone to these complications. A moderate-quality study attempted to identify which third of the pulley was responsible for triggering; however, failures occurred in all surgical groups regardless of which third of the pulley was released.(1099) A low-quality case series suggested repeat percutaneous release was reasonable for treatment of incomplete releases,(1100) although open release has been favored for percutaneous failures. One moderate-quality study compared injections with percutaneous release combined with glucocorticosteroid injection and reported surgical release was superior,(1092) although the success rates were both lower than other reports. Surgical release is invasive (though less invasive with percutaneous release),(1101) has low adverse effects, but is costly. For those patients failing glucocorticosteroid injection(s), surgery is recommended.

### *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.*

## Extensor Compartment Tenosynovitis (Including de Quervain's Stenosing Tenosynovitis and Intersection Syndrome)

### Diagnostic Criteria

These diagnoses are clinical. Patients without triggering will typically have tenderness that is focal over the affected tendon(s) or compartment. Finkelstein's maneuver should be positive.

### Special Studies and Diagnostic and Treatment Considerations

There are no special tests that are typically performed for extensor compartment tenosynovitis. X-rays are usually not helpful, although one study suggested minor xray changes may be present (Chien 01). The threshold for testing for confounding conditions such as diabetes mellitus and hypothyroidism should be low, particularly to prevent other morbidity. There are reports of MRI findings;(1104-1106) however, the utility of MRI has not been demonstrated in quality studies. Distinguish from de Quervain's.

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.

*Recommendation: MRI to Diagnose Extensor Compartment Tenosynovitis*

**MRI is selectively recommended to diagnose extensor compartment tenosynovitis.**

*Strength of Evidence – Recommended*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are 2 moderate-quality articles evaluating the use of MRIs to diagnose extensor compartment tenosynovitis. However, the vast majority of cases are readily diagnosed clinically, obviating the need for imaging. MRI may be reasonable 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*

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.

## Initial Care

Initial care usually involves limitation of the physical factors thought to be contributing.(42) Thumb spica splints for de Quervain's and wrist braces for the other compartment tendinoses are generally believed to be helpful.(42) 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.(42, 43, 45, 349, 1111) NSAIDs are often prescribed for initial treatment.(42) Perhaps the largest question in the management of these conditions is how soon to inject, including whether patients might not be most effectively treated by injection at initial clinical presentation, however, there are no quality studies to address that question.

## Splints

*Recommendation: Thumb Spica and Wrist Splints for Acute and Subacute Thumb Extensor Compartment Tenosynovitis*  
**Thumb spica splints for treatment of acute and subacute thumb extensor compartment tendinoses, and non-spica wrist splints for treatment of other extensor compartment tendinoses(42) are recommended.**

*Indications* – Patients with extensor compartment tendinoses.

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

*Indications for Discontinuation* – Failure to respond or resolution.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

### *Rationale for Recommendation*

There is one moderate-quality RCT evaluating wrist splints for extensor compartment tenosynovitis with full-time compared with PRN use and found no differences.(1112) Wrist splints are not invasive, have few adverse effects, and are not costly; thus, they are recommended.

### *Evidence for the Use of Splints*

There are 3 moderate-quality RCT incorporated into this analysis.(1112-1114) (Mardani-Kivi 14; Mehdiinasab 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.

## Follow-up Visits

Follow-up visits are generally required every 1 or 2 weeks to evaluate efficacy of interventions until resolution of the condition.

## Medications

There are few quality studies on use of medications for this condition, although they are frequently prescribed. Medications are more frequently needed compared with trigger digits, as these conditions are typically more painful.

### NSAIDs

*Recommendation: NSAIDs for Acute, Subacute, or Chronic Extensor Compartment Tenosynovitis*

**NSAIDs (oral or topical) are recommended to control pain associated with acute, subacute, or chronic extensor compartment tenosynovitides.**

*Indications* – Patients with wrist compartment tendinoses.

*Dose* – Optimal dose is unknown and there are no quality studies comparing different NSAIDs. Regularly scheduled dosing is recommended for acute, significantly symptomatic presentations.

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

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Low

#### *Rationale for Recommendation*

NSAIDs are often used to treat pain associated with wrist compartment tendinoses.(42, 43, 45, 349, 1111, 1115, 1116) There is one quality study demonstrating efficacy of a ketoprofen patch versus placebo.(1116) However, another study failed to demonstrate efficacy of injectable nimesulide as an adjuvant treatment to triamcinolone acetonide 10mg injection(1115) and another study of diclofenac gel for treating marathon kayakers prior to racing also was negative,(1117) although applicability to occupational populations is questionable. As an NSAID patch has been demonstrated to be efficacious compared to placebo, it is assumed that other topical forms are also efficacious. NSAIDs are not invasive, have low adverse effects in employed populations, and are low cost, thus they are recommended.

#### *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.

## Physical Methods/Rehabilitation

### Exercise

Exercise is not generally indicated acutely and most patients with extensor tendon entrapment do not require an exercise program. For those with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

### *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 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.

## **Iontophoresis**

*Recommendation: Iontophoresis for Acute and Subacute Extensor Compartment Tenosynovitis*

**Iontophoresis treatments using glucocorticosteroids and sometimes NSAIDs are recommended for extensor compartment tenosynovitis.**

*Indications* – Patients with wrist compartment tendinoses. Generally those who either fail to respond adequately to NSAIDs, splints, and activity modifications or decline injection.

*Dose* – Glucocorticosteroid is generally used; however, quality studies have documented successful treatment of lateral epicondylalgia with NSAIDs administered via iontophoresis (see Elbow Disorders Guideline), thus they appear reasonable for this indication as well.

*Frequency/Duration* – Generally 2 or 3 appointments to ascertain efficacy; an additional 4 to 6 appointments may be scheduled if efficacious. If improvements continue at 6 appointments, additional 4 to 6 appointments are reasonable.

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

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

### *Rationale for Recommendation*

There are no quality studies evaluating iontophoresis for extensor compartment tenosynovitis. Iontophoresis is not invasive, has low adverse effects, but is moderate to high cost depending on the number of treatments. Iontophoresis with either a glucocorticoid or NSAID is recommended for select patients who fail to respond to other treatments or who decline injection.

### *Evidence for the Use of Iontophoresis*

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.

## **Other Non-Operative Interventions**

*Recommendation: Other Non-operative Interventions Including Manipulation and Mobilization, Massage, Deep Friction Massage, or Acupuncture for Acute, Subacute, or Chronic Extensor Compartment Tenosynovitis*

**There is no recommendation for or against the use of other non-operative interventions (i.e., manipulation and mobilization, massage, deep friction massage, or acupuncture) for the treatment of acute, subacute, or chronic extensor compartment tenosynovitis as other interventions have proven efficacy and are preferentially indicated for initial and subsequent treatment options.**

*Strength of Evidence* – **No Recommendation, Insufficient Evidence (I)**

*Level of Confidence* – Low

### *Rationale for Recommendation*

There are no quality studies evaluating other non-operative interventions for extensor compartment tenosynovitis. Manual therapy has been attempted;(1118) however, there are no quality studies available to assess its efficacy. Deep friction massage has been used and does not appear successful.(1119)

### *Evidence for the Use of Acupuncture*

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.

## **Injections**

### **Glucocorticosteroid Injections**

Glucocorticosteroid injections are frequently used for the wrist compartment tendinoses.(43, 45, 280, 349, 1111{Anderson, 1991 #710, 1115, 1121-1127) Techniques vary slightly(1124, 1128) and have included attempted selective injection of the extensor pollicis brevis tendon,(1129) although there are no quality studies to compare techniques. Estimates of efficacy in case series and active treatment arms of trials range from 54-100%.(1123, 1124, 1128-1133)

*Recommendation: Glucocorticosteroid Injections for Acute, Subacute, or Chronic de Quervain's or Other Wrist Compartment Tendinosis*

**Glucocorticosteroid injections are recommended for treatment of acute, subacute, or chronic de Quervain's or other wrist compartment tendinosis.**

*Indications* – Wrist compartment symptoms of pain over a compartment. Generally at least 1 week of non-invasive treatment to determine if condition will resolve without invasive treatment. It is reasonable to treat cases with an initial injection although there is no quality evidence to support that approach. Failure or suboptimal results with an initial

injection result in a need for additional injection(s) in a minority of patients that is (are) usually successful.(1126, 1128, 1129)

*Dose* – Optimal dose is unknown. Studies have utilized methylprednisolone acetate 40mg,(1079, 1128, 1132) and triamcinolone acetonide 10mg.(1126, 1129) An adjuvant injectable anesthetic is typically used.(1115, 1128, 1129) Some providers splint the wrist afterwards, however, there is no quality evidence this improves efficacy or duration of benefits. Two low-quality studies suggest no greater efficacy with splinting; however, greater costs and lost time were incurred.(1122, 1134)

*Frequency/Duration* – It is recommended that a single injection be scheduled and the results evaluated to document improvement.(1126) Failure of a response within 1 or 2 weeks should result in reanalysis of the diagnosis and consideration of repeat injection.(1126) Recurrence of symptoms months later should result in consideration of re-injection.(1124, 1128) There is no maximum number of injections to treat an episode or over a lifetime demonstrated in quality studies. Therapeutic injection failures are reportedly strongly associated with the presence of a separate compartment for the extensor pollicis brevis tendon in 73% of cases.(1132)

*Indications for Discontinuation* – If a partial response, consideration should be given to repeating the injection, typically at a modestly higher dose.

**Strength of Evidence – Recommended, Evidence (C)**

*Level of Confidence* – High

#### *Rationale for Recommendation*

There is 1 moderate-quality study comparing glucocorticosteroid injections with placebo for treatment of de Quervain's stenosing tenosynovitis.(1126) The trial showed considerable benefits from active treatment that persisted for 12 months and allows for an evidence-based recommendation. One trial found steroid injection superior to acupuncture.(1120) Ultrasound-guidance has been suggested to be moderately superior.(1135) Two trials have found inconclusive evidence regarding whether splint use is required in addition to steroid injection(1113, 1114) A high-quality trial found the steroid flare was unrelated to pH;(1079) however, there was no placebo control group. Another high-quality trial found no additive benefit of NSAID in addition to injection to prevent recurrence but did not assess reductions in pain immediately after injection thus appears to have no bearing on use of NSAIDs for those purposes.(1115) A low-quality trial found glucocorticosteroid injection superior to splinting in pregnant and lactating females.(1121) These injections are minimally invasive, have low adverse effects, and are moderately costly; thus, they are recommended to treat de Quervain's or other wrist compartment tendinosis.

#### *Evidence for the Use of Glucocorticosteroid Injections for Wrist Compartment Tendinosis*

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.*

## Surgery

*Recommendation: Surgical Release for Subacute or Chronic Extensor Compartment Tenosynovitis*

**Surgical release is recommended for patients with subacute or chronic extensor compartment tenosynovitis who fail to respond to injection.**(1124)

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

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

### *Rationale for Recommendation*

There are no quality studies evaluating the use of surgical release for extensor compartment tenosynovitis.(346, 1137) While surgery release is invasive, has moderate adverse effects, and is costly, it is usually clinically effective and recommended for patients who have failed glucocorticosteroid injection(s) and other non-invasive treatments.

### *Evidence for the Use of Surgery*

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.*

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

### Diagnostic Criteria

There is no quality evidence comparing diagnostic testing for this disorder. Most case series report electrodiagnostic testing assisted in making a diagnosis. The characteristic finding is a prolonged distal motor latency. One report opined that idiopathic or “cumulative stress” cases have no characteristic pattern.(50) Electrodiagnostic calculations are complicated by the curvilinear course of the deep motor nerve. Witmer described a technique reducing the complexity that may be useful to the electromyographer.(1138)

### Special Studies and Diagnostic and Treatment Considerations

#### Electrodiagnostic Studies

*Recommendation: Electrodiagnostic Testing for Ulnar Nerve Entrapment at the Wrist*

## **Electrodiagnostic testing is recommended to confirm clinical suspicion of ulnar nerve entrapment at the wrist.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There are 3 moderate studies supporting the use of electrodiagnostic testing.(1139-1141) However, 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*

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.

## **MRI/Ultrasound**

*Recommendation: MRI or Ultrasound to Diagnose Ulnar Nerve Entrapment at the Wrist*

**There is no recommendation for or against the use of MRI or ultrasound to diagnose ulnar nerve entrapment at the wrist.** Use of MRI for a suspected soft-tissue mass may be reasonable.

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Evidence for the Use of MRI and Ultrasound*

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.



## CT

*Recommendation: CT to Diagnose Ulnar Nerve Entrapment at the Wrist*

**CT is 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.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendations*

There are no quality studies evaluating the use of ultrasound or MRI for ulnar nerve entrapment at the wrist and therefore, there is no recommendation for or against the use of these tests. The use of ultrasound, MRI, or CT has also been reported useful in identifying suspected hamate fractures or mass lesions such as a ganglion cyst.(50, 57, 1138) MRI is generally preferable for soft tissue masses and CT is preferable for boney masses. These tests are moderate to high cost, but are recommended for evaluation of select patients suspected of having occult fractures of the hamate or mass lesions.

### *Evidence for the Use of 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: 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.

## Initial Care

Ulnar neuropathy at the wrist that is not related to trauma, such as from the use of wheelchair, crutches, or other equipment may benefit initially from non-invasive therapies and activity adjustments including elimination or mitigation of significant pressure points (e.g., using padding, etc.) and splinting.

## Activity Modification

*Recommendation: Activity Modification for Ulnar Nerve Compression at the Wrist*

**Activity modification, 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.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Evidence for the Use of Activity Modification*

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.

## Splints

*Recommendation: Neutral Wrist Splinting for Acute, Subacute, or Chronic Ulnar Nerve Compression at the Wrist*  
**Neutral wrist splinting is recommended as a first-line treatment for acute, subacute, or chronic ulnar nerve compression at the wrist.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Evidence for the Use of Splints*

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.

## Follow-up Visits

Follow-up visits are generally required every 2 to 4 weeks to evaluate efficacy of interventions until resolution of the condition.

## Medications

### NSAIDs

*Recommendation: NSAIDs for Acute, Subacute, or Chronic Ulnar Nerve Compression at the Wrist*

**There is no recommendation for or against the use of NSAIDs to control pain associated with acute, subacute, or chronic ulnar nerve compression at the wrist.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There is no recommendation for or against the use of NSAIDs for acute or subacute ulnar nerve compression at the wrist as evidence of efficacy is lacking. NSAIDs do not work particularly well for other neuropathies (see Chronic Pain Guideline and CTS section), thus other options are generally preferable.

### *Evidence for the Use of NSAIDs*

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.

### Glucocorticosteroids

*Recommendation: Glucocorticosteroids for Acute, Subacute, or Chronic Ulnar Nerve Compression at the Wrist*

**There is no recommendation for or against the use of oral and injected glucocorticosteroids for treatment of acute, subacute, or chronic ulnar nerve compression at the wrist.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendations*

There are no quality studies evaluating these treatments for ulnar nerve compression at the wrist. Activity modification to avoid focal mechanical compression and the use of the hypothenar area as a hammer are thought to be important and are recommended. NSAIDs have been utilized. However, evidence of efficacy for treatment of CTS and other neuropathic pain (see Chronic Pain guideline) is lacking, thus other options are generally preferable. The mechanism(s) of efficacy of glucocorticosteroids for treatment of CTS and other disorders is unclear. If the mechanism involves tendon sheaths and related structures, then these medications would be predicted to be ineffective for ulnar neuropathy at the wrist. However, if through another mechanism of action directly involving the nerve sheath, then these injections could be effective. These treatments are not invasive to low invasive, have few adverse effects and are low to moderate cost. They are recommended with the exceptions of NSAIDs and injections for which there is no evidence of efficacy and concerns that the available literature does not support those treatments as efficacious.

#### *Evidence for the Use of Glucocorticosteroids*

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.*

## **Physical Methods/Rehabilitation**

*Recommendation: Physical Methods/Rehabilitation for Acute, Subacute, or Chronic Ulnar Neuropathy at the Wrist*

**There is no recommendation for or against the use of physical methods/rehabilitation (i.e., iontophoresis, self-application of ice or heat, manipulation, mobilization, massage, friction massage, or acupuncture) for treatment of acute, subacute, or chronic ulnar neuropathy at the wrist.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies evaluating the efficacy of physical methods/rehabilitation (i.e., iontophoresis, ice, heat, manipulation, mobilization, massage, friction massage, and acupuncture) for ulnar neuropathy at the wrist and therefore, there is no recommendation for or against the use of these treatments.

#### *Evidence for the Use of Physical Methods/Rehabilitation*

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.

## Exercise

Exercise is not generally indicated acutely. Many patients with chronic findings and functional deficits and post-operative patients require some appointments to at minimum help institute a home exercise program. For patients with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

### *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, 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.

## Surgery

Space occupying lesions with significant motor or sensory deficits generally have been reported in the literature as requiring surgical decompression (or needle aspiration of ganglia) with excellent results and rapid recovery of deficits. In addition to lesion type, consideration may be influenced by the presence of diabetes mellitus. Although there are not quality studies, there may be a stronger indication for decompression of peripheral nerve entrapment syndromes in diabetic patients. In a case series of diabetics with peripheral neuropathy, decompression surgery improved sensory function in 88% of upper extremities and 69% of lower extremities compared with 32% of patients that were treated non-operatively.(1143) Another case series demonstrated similar results, also favoring recovered function in the upper extremities.(1144)

*Recommendation: Surgical Decompression for Subacute or Chronic Ulnar Nerve Compression at the Wrist*

**Surgical decompression is recommended for subacute or chronic ulnar nerve compression at the wrist after failure of non-operative treatment or if space-occupying lesions are present.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There are no quality studies evaluating the efficacy of surgical intervention for ulnar nerve compression at the wrist. However, clinically many patients respond well to surgery. Surgery is invasive, has adverse effects and is costly. 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*

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.*

## **Radial Nerve Entrapment**

### **Special Studies and Diagnostic and Treatment Considerations**

#### **Electrodiagnostic Studies**

Electrodiagnostic studies can confirm the diagnosis of a radial nerve motor neuropathy.(58)

*Recommendation: Electrodiagnostic Testing for Radial Nerve Motor Neuropathy*

**Electrodiagnostic testing is recommended to confirm clinical suspicion of a radial nerve motor neuropathy.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There is no quality evidence available for the use of electrodiagnostic testing; however, it is recommended as an objective test to evaluate radial nerve motor neuropathy.(58, 59, 1145)

However, 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*

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.

**Ultrasound (Diagnostic)**

Ultrasound has been used as an adjunct to electrophysiological studies for evaluation of radial nerve neuropathy.(446)

*Recommendation: Diagnostic Ultrasound for Radial Nerve Neuropathy*

**There is no recommendation for or against ultrasound to confirm clinical suspicion of a radial nerve neuropathy.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

*Rationale for Recommendation*

There is no quality evidence available that diagnostic ultrasound materially alters the ability to diagnose radial nerve entrapments and thus there is no recommendation for or against diagnostic ultrasound.

*Evidence for the Use of Ultrasound*

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.

## Initial Care

Overall, the literature suggests patients most often appear to respond to non-operative treatments including no treatment; avoidance of exposures thought to be contributing (if present); avoidance of wearing a watch, tight jewelry or shirt sleeves on the affected side; corticosteroid injection;(1148) and temporary thumb spica splinting.(66, 1149)

## Splints

*Recommendation: Wrist Extension or Thumb Spica Splint for Acute, Subacute, or Chronic Radial Nerve Compression Neuropathy*

**The use of a wrist extension or thumb spica splint is recommended for treatment of acute, subacute, or chronic radial nerve compression neuropathy.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

Splints appear to be helpful for many cases and thus are recommended, particularly wrist extension splints.

### *Evidence for the Use of Splints*

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.

## Follow-up Visits

Follow-up visits are generally required every 2 to 4 weeks to evaluate efficacy of interventions until resolution of the condition.

## Medications

### NSAIDs

*Recommendation: NSAIDS for Acute, Subacute, or Chronic Radial Nerve Compression Neuropathy*

**There is no recommendation for or against the use of NSAIDs to control pain associated with acute, subacute, or chronic radial nerve compression neuropathy.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Evidence for the Use of NSAIDs*

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.

## Glucocorticosteroids

*Recommendation: Glucocorticosteroids for Acute, Subacute, or Chronic Radial Nerve Compression at the Wrist*

**There is no recommendation for or against the use of oral and injected glucocorticosteroids for treatment of acute, subacute, or chronic radial nerve compression at the wrist.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendations*

Although there are no quality studies on which to rely for the treatment of distal radial neuropathies, non-invasive options are available and have few adverse effects and are low cost. NSAIDs are not unreasonable and are recommended by some;(60) however, evidence of efficacy is lacking, NSAIDs do not work particularly well for other neuropathies (see Chronic Pain guideline); thus, other options are generally preferable. The mechanism(s) of efficacy of glucocorticosteroids is unclear.(1150) (Rinkel 13) If the mechanism involves tendon sheaths and related structures, then these medications would be predicted to be ineffective for distal radial neuropathies. However, if through another mechanism of action directly involving the nerve sheath, then these injections could be effective. These treatments are not invasive to low invasive, have few adverse effects, and are low to moderate cost. They are recommended, with the exception of NSAIDs and injections for which there is no evidence of efficacy and concerns that the available literature does not support those treatments as efficacious.

*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, glucocorticoid injections, 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 0 articles. Zero articles met the inclusion criteria.*

### *Evidence for the Use of MRI and Ultrasound*

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.

## Physical Methods/Rehabilitation

*Recommendation: Physical Methods (Iontophoresis, Self-application of Ice or Heat, Manipulation and Mobilization, Massage, Friction Massage, or Acupuncture) for Acute, Subacute, or Chronic Radial Neuropathy at the Wrist*

**There is no recommendation for or against the use of physical methods for treatment of acute, subacute, or chronic radial neuropathy at the wrist including iontophoresis, self-application of ice or heat, manipulation and mobilization, massage, friction massage, or acupuncture.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There are no quality studies evaluating the use of iontophoresis, self-application of ice and heat, manipulation and mobilization, friction massage, or acupuncture for radial neuropathy at the wrist and therefore, there is no recommendation for or against these treatments. There are reports of benefits from massage, but no quality studies, thus there is no recommendation for massage.

#### *Evidence for the Use of Physical Methods/Rehabilitation*

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.

### **EXERCISE**

Exercise is not generally indicated acutely. Many patients with chronic findings, functional deficits and post-operative patients require some appointments to at minimum help institute a home exercise program. For patients with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

#### *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, 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.

## **Surgery**

*Recommendation: Surgical Release for Subacute or Chronic Radial Nerve Compression Neuropathy*

**Surgical release is recommended for subacute or chronic cases of radial nerve compression neuropathy that persist despite other interventions.(60)**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

There are no quality studies available on the efficacy of surgical intervention. There are no quality studies evaluating the efficacy of surgical intervention for distal radial neuropathies. However, clinically many patients respond well to surgery. Surgery is invasive, has adverse effects and is costly. It is recommended for select patients who failed trials of other non-operative treatments or if space occupying lesions are present.

#### *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: 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.*

## Non-Specific Hand, Wrist, and Forearm Pain

### Diagnostic Criteria

Non-specific pain is not a discrete diagnosis, per se, but the absence of a discrete diagnosis.

### Special Studies and Diagnostic and Treatment Considerations

#### Rheumatological Studies and Joint Aspiration

1. *Recommendation: Rheumatological Studies for Arthralgias*

**Rheumatological studies are recommended for evaluation of 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.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – High

2. *Recommendation: Arthrocentesis for Joint Effusions*

**Arthrocentesis (joint aspiration) of inexplicable joint effusions, particularly for evaluation of infections and crystalline arthropathies is recommended.**

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

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – High

#### *Rationale for Recommendations*

There are no quality studies evaluating rheumatological studies for evaluation of arthralgias; however, these studies have been helpful in diagnosing numerous rheumatological disorders. Arthrocentesis is also helpful for securing important diagnoses, such as septic arthritis and crystalline arthropathies.

#### *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.

## Electrodiagnostic Studies

*Recommendation: Electrodiagnostic Studies to Evaluate Non-specific Hand, Wrist, or Forearm Pain in Patients with Paresthesias or Other Neurological Symptoms*

**Electrodiagnostic studies are 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 (see CTS section above) and interpretations of abnormal findings should be cautious.

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

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

### *Rationale for Recommendation*

There is 1 low-quality study evaluating electrodiagnostic studies for non-specific pain. However, electrodiagnostic studies may assist in diagnosing and treating the condition and thus are recommended.

### *Evidence for the Use of Electrodiagnostic Studies*

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, 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 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.

## X-Rays

*Recommendation: X-rays for Evaluation of Non-specific Hand, Wrist, or Forearm Pain*

**X-rays are recommended for evaluation of cases in which non-specific hand, wrist, or forearm pain persists.**

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

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – High

### *Rationale for Recommendation*

There is 1 moderate-quality study evaluating x-ray studies for non-specific pain. X-rays may assist in diagnosing and treating the condition and thus are recommended.

### *Evidence for the Use of X-rays*

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.

## Initial Care

### Relative Rest

*Recommendation: Relative Rest for Acute Non-specific Hand, Wrist, or Forearm Pain*

**Relative rest is a recommended treatment 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).**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies and treatment is empiric. For patients with high ergonomic exposures, relative rest may be helpful. This intervention is not invasive, has low adverse effects, and for short periods is low to moderate cost, thus it is recommended.

#### *Evidence for the Use of Relative Rest*

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.

### Splints

*Recommendation: Splinting for Acute or Subacute Non-specific Hand, Wrist, or Forearm Pain*

**There is no recommendation for or against the use of splinting for treatment of acute or subacute non-specific hand, wrist, or forearm pain.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies and treatment is empiric. Splinting may at times be helpful, but enforces debility, thus there is no recommendation for or against its use. It is generally not recommended for chronic use.

#### *Evidence for the Use of Splints*

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.

### Ice/Heat

*Recommendation: Self-application of Ice or Heat for Acute or Subacute Non-specific Hand, Wrist, or Forearm Pain*

**Self-application of ice or heat is recommended for treatment of acute or subacute non-specific hand, wrist, or forearm pain.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There are no quality studies and treatment is empiric. Self-applications of heat or ice are sometimes helpful. These interventions are not invasive, have low adverse effects, and are low cost, and thus are recommended.

### *Evidence for the Use of Ice/Heat*

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.

## Follow-up Visits

Patients may require 1 to 3 appointments depending on the severity or the pain and need for workplace limitations.

## Medications

### NSAIDs/Acetaminophen

*Recommendation: NSAIDs or Acetaminophen for Acute or Subacute Non-specific Hand, Wrist, or Forearm Pain*

**NSAIDs or acetaminophen are recommended for control of pain associated with acute or subacute non-specific hand, wrist, or forearm pain.**

*Indications* – Acute or subacute non-specific hand, wrist, or forearm pain.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Evidence (C) – NSAIDs**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I) – Acetaminophen**

*Level of Confidence* – Low

### *Rationale for Recommendation*

There are two moderate-quality studies evaluating the use of NSAIDs or acetaminophen for treatment of non-specific lower extremity pain(1047, 1048) which is presumably analogous to upper extremity pain and showed benefits (see Ankle and Foot Disorders Guideline). These medications may relieve pain and increase function. They are not invasive, have few adverse effects in employed populations, and are low cost. Thus, they are recommended.

### *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, 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.

## Opioids

See Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol) in Carpal Tunnel Syndrome section.

## Physical Methods

*Recommendation: Physical or Occupational Therapy for Acute, Subacute, or Chronic Non-specific Hand, Wrist, or Forearm Pain*

**There is no recommendation for or against the use of physical or occupational therapy for treatment of acute, subacute, or chronic non-specific hand, wrist, or forearm pain.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There are no quality studies evaluating any of the physical or occupational therapy modalities for treatment of non-specific hand, wrist, or forearm pain. (A case series of hand rehabilitation with occupational therapy services suggested benefits of occupational therapy for patients with heterogenous disorders.) Thus, treatments administered are empiric. These treatments are not invasive, have few adverse effects, but are moderate to high cost depending on number of treatments. They are generally not indicated for initial treatment. They may be more reasonable for more persistent cases. Trials of these modalities may be helpful in cases that do not resolve with initial treatment methods outlined above. However, these treatments are empiric and thus the success may be limited. Thus, there is no recommendation for or against these modalities.

### *Evidence for the Use of Physical or Occupational Therapy*

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.

## Exercise

Exercise is not generally indicated acutely. One moderate quality study of mostly chronic patients found no differences between two types of exercise programs, but had no control group.(1153) Many patients with chronic findings, functional deficits and post-operative patients require some appointments to at minimum help institute a home exercise program. For those with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

### *Evidence for the Use of Exercise*



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.

## Surgery

Not applicable.

## Scaphoid Fracture

### Diagnostic Criteria

A clinical impression is made upon history of appropriate injury mechanism, physical examination findings of substantial tenderness particularly over the scaphoid tubercle. Findings of snuffbox tenderness, positive axial compression of thumb test, and effusion in the wrist (possibly echymosis) should be sought. A fracture identified on imaging that includes a “scaphoid view” confirms that diagnostic impression. Fracture is not always confirmed on initial standard wrist x-rays, although those fractures identified later are by definition non-displaced and have good clinical outcomes with subsequent non-operative treatment. The differential diagnosis includes wrist sprain, undisplaced epiphyseal fractures of the distal portion of the radius in children, fracture of the hook of the hamate, avulsion fracture of the triquetrum, carpal instability, distal ulna subluxation, de Quervain’s tenosynovitis, radioscaphoid arthrosis, scapholunate dislocation, and tri-scaphoid arthrosis.

### Special Studies and Diagnostic and Treatment Considerations

#### X-Rays

X-rays have been widely used as the first diagnostic test for scaphoid fractures.(285, 290, 1044, 1155) (Tiel-van Buul 93)

1. *Recommendation: X-rays for Diagnosing Scaphoid Fractures*

**X-rays are recommended for diagnostic purposes that include at least 3 to 4 views including a “scaphoid view.”**(71)

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

2. *Recommendation: Follow-up X-rays for Scaphoid Fractures*

**Follow-up x-rays in 2 weeks are recommended for evaluation of potential scaphoid fractures,(1156) particularly for patients with a high clinical suspicion of fracture, but negative initial x-rays.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

#### *Rationale for Recommendations*

There are no quality studies evaluating x-rays for scaphoid fractures. However, x-rays have been used for decades to evaluate these fractures, identify those requiring surgical treatment, and to evaluate healing; thus, they are recommended to diagnose scaphoid fracture.

#### *Evidence for the Use of X-rays*

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

## MRI

MRI has been used for the diagnosis of scaphoid fractures.(1164-1167) (Carpenter 14)

*Recommendation: MRI for Diagnosing Scaphoid Fractures*

**MRI is moderately recommended for diagnosis of occult scaphoid fractures when clinical suspicion remains high despite negative x-rays.**(1155, 1158, 1168-1171)

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

*Strength of Evidence* – **Moderately Recommended, Evidence (B)**

*Level of Confidence* – Low

- Acute  Subacute  Chronic
- Preoperative  Perioperative  Postoperative
- Mild  Moderate  Severe

*Rationale for Recommendation*

MRI is not required for the majority of scaphoid fractures. However, for patients with a clinical suspicion of scaphoid fracture, but negative x-rays, current treatment recommendations are generally to splint the hand, thus often necessitating prolonged lack of use and lost productivity. A moderate-quality study has reported cost effectiveness of MRI to diagnose occult scaphoid fractures and reduce lost productivity for those without x-ray imaging evidence of fractures.(1172) Two moderate quality studies have suggested comparable results between CT and MRI,(1158, 1162) although two other studies suggested CT was better to evaluate cortical involvement.(1157, 1159) Thus, as there is evidence to support its use among these select patients, MRI is recommended.

*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.

## High-Spatial Resolution Sonography

High-spatial resolution sonography has been used to diagnose scaphoid fractures.(1200, 1201) (Hauger 02; Fusetti 05)

*Recommendation: High-spatial Resolution Sonography for Diagnosing Scaphoid Fractures*

**High-spatial resolution sonography is recommended to diagnose occult scaphoid fractures when clinical suspicion remains high despite negative x-rays.**

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Moderate

### *Rationale for Recommendation*

There are a few quality studies regarding the use of high-spatial resolution sonography to diagnose scaphoid fractures, with data suggesting reasonable reliability.(1200)

### *Evidence for the Use of High-Spatial Resolution Sonography*

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.

## **CT Imaging**

CT has been used to diagnose scaphoid fractures.(1202)

### *Recommendation: CT Imaging for Diagnosing Scaphoid Fractures*

**CT imaging is moderately recommended to diagnose occult scaphoid fractures when clinical suspicion remains high despite negative x-rays.**(1200, 1203, 1204) Quality studies include multiplanar reconstructive CT.(1204)

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There are some quality studies regarding the use of CT to diagnose scaphoid fractures, although false positives occur.(1203) One comparative trial was unable to confirm CT as superior to bone scan.(1205) A retrospective case series study reported that 22% (n = 118) of patients with negative x-rays, but with clinical suspicion of scaphoid fracture, were confirmed positive by CT imaging.(1206) There are no studies comparing MRI with CT with bone scanning and no recommendation is made for one over the other. Two moderate quality studies have suggested comparable results between CT and MRI,(1158, 1162) although two other studies suggested CT was better to evaluate cortical involvement.(1157, 1159) For patients with continuing symptoms suggestive of scaphoid fracture, but absence of findings on repeat x-ray, CT scan has been reported to be an effective imaging technique.(1207, 1208) Therefore, CT imaging for those with clinical impression of fracture but negative x-rays is recommended.

### *Evidence for the Use of CT Imaging*

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.

## **Bone Scan**

Bone scans have been utilized for years to diagnose occult fractures.(1212)

### *Recommendation: Bone Scanning for Diagnosing Scaphoid Fractures*

**Bone scanning is recommended to diagnose occult scaphoid fractures when clinical suspicion remains high despite negative x-rays.**(1155, 1168-1171, 1187, 1213)

*Indications* – At least 48 hours after the injury with continuing clinic suspicion of scaphoid fracture.(1214)

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendation*

There are few quality studies on bone scanning for scaphoid fracture and suggesting utility.(1213-1216) 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*

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.

## Initial Care

### Splints

*Recommendation: Wrist Splinting for Scaphoid Tubercle Fractures*

**Wrist splinting is recommended for treatment of scaphoid tubercle fractures.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – High

#### *Rationale for Recommendation*

There are no quality studies evaluating wrist splinting for treatment of scaphoid tubercle fractures. However, clinical experience suggests splinting may suffice, as these fractures heal well due to adequate blood supply.(1221) (Symes 11) Splinting is not invasive, has few adverse effects, is low cost, and thus is recommended.

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Splint, splinting, scaphoid fracture, Scaphoid 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 and reviewed 8 articles in PubMed, 68 in Scopus, 3 in CINAHL, 1 in Cochrane Library, 95 in Google Scholar, and 0 from other sources. We considered for inclusion 3 from PubMed, 1 from Scopus, 0 from CINAHL, 1 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 6 articles considered for inclusion, 0 randomized trials and 1 systematic studies met the inclusion criteria.

### Cast Immobilization

Casting has been long been traditionally used as a primary intervention, with successful union being achieved 88 to 95% of the time.(1222, 1223) (Alshryda 12) Typically, a Colles' cast is recommended with the wrist in approximately 20° anatomic extension (functionally neutral posture), although many practitioners prefer a thumb spica cast.(402, 1224, 1225) 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.

1. *Recommendation: Wrist Casting for Stable Scaphoid Fractures*

**Immobilization of the wrist with casting is moderately recommended for treatment of documented stable scaphoid fractures which are displaced less than 1mm, are non-oblique, and do not include the proximal 1/3 of the scaphoid.**

*Indications* – Stable documented scaphoid fractures that include fractures with any of these properties:

- Fragments displaced less than 1mm;
- Fragments are non-oblique;
- Fragment does not include the proximal 1/3 of the scaphoid.

*Frequency/Duration* – Casting should be performed for 6 to 8 weeks, and then with the cast removed, imaging taken to assess healing.(402, 1156)

*Strength of Evidence* – **Moderately Recommended, Evidence (B)**

*Level of Confidence* – High

*Rationale for Recommendation*

There is no quality evidence comparing casting to no immobilization for scaphoid fractures. However, in cadaveric studies there is a significant difference in angulation and rotation when comparing casting with no-casting. There are 6 moderate-quality studies that include casting as a treatment with effective results in achieving successful union reported.(401, 402, 1222, 1226-1228) Casting is not invasive, has some associated stiffness, decreased grip strength, and atrophy due to disuse, and is of moderate cost; however, it is believed to be essential to healing. It also has been associated with lower rates of subsequent development of osteoarthritis than operative fixation.(1229) Thus, casting is recommended for treatment of stable scaphoid fractures.

2. *Recommendation: Use of Thumb Immobilization with Casting for Scaphoid Fractures*

**There is no recommendation for or against concurrent immobilization of the thumb with the wrist for treatment of scaphoid fractures.**

*Strength of Evidence* – **No Recommendation, Insufficient Evidence (I)**

*Level of Confidence* – Low

*Rationale for Recommendation*

There is significant debate whether or not the thumb should be immobilized along with the wrist. There is one moderate-quality study that found no advantage to using a thumb spica compared with a Colles' cast in 392 patients.(1226) Another study included thumb immobilization in both groups when comparing long and short arm casts to evaluate the effect of pronation and supination.(1227) The authors concluded inhibition of pronation and supination during the first 6 weeks was beneficial. However, in a cadaveric model study, short arm casting was found to be just as effective as a thumb spica,(1230) in eliminating displacement and rotation of the fracture. Thus, there is no evidence of improved healing rates or reduced rates of non-union between the two types of cast, although thumb immobilization markedly reduces function.(1172, 1226, 1231, 1232)

3. *Recommendation: Colles' Casting or Supportive Bandaging for Suspected but Radiographically Negative Scaphoid Fracture*

**Colles' casting or supportive bandaging is recommended for patients with suspicion of scaphoid fracture, but with negative x-rays.(1233)**

*Duration* – 2 weeks, followed by cast removal, clinical examination, and re-x-ray.(1156, 1234) (Leslie 81; Gumucio 89)

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

*Rationale for Recommendation*

The prognosis of occult fractures is thought to be very good as the fragments are by definition, well approximated.(288, 1156, 1235) For patients with suspicion of fractures, but negative x-rays, either Colles' casting or supportive bandaging(1233) is recommended for 2 weeks, followed by cast removal, clinical examination, and repeat x-ray.(1156, 1234) Reassessment in 2 weeks allows sufficient time for the fracture plane to be identifiable on repeat x-rays. Casting or splinting in 2 weeks is generally sufficient to prevent significant range of motion during the initial time the fracture

would be healing and is recommended. If x-rays are again negative and symptoms persist, it is unlikely that there is a fracture and other diagnoses should be sought.

#### 4. *Recommendation: Casting for High-risk Scaphoid Fractures*

**Long-arm casting at 90° of elbow flexion is recommended for high-risk scaphoid fractures that are displaced 1mm or more,(1236, 1237) or fractures of the proximal 1/3 of the scaphoid and oblique fractures.(1156, 1234) It is recommended that high-risk scaphoid fractures be evaluated and treated by a specialist experienced in the management of these fractures.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

Scaphoid fractures are at a high risk for non-unions. High-risk scaphoid fractures have been treated surgically for many years as they tend to not heal well, thus fixation is believed to facilitate healing. While there are no quality studies supporting this belief, clinical experiences indicate superior results with this approach. Surgical intervention is invasive, has significant adverse effects including risk of non-union, and is costly. However, the risks of not operating appear higher and surgery is recommended. For non-displaced fractures, non-operative treatment is likely preferable, particularly as the long-term risk of osteoarthritis is lower.

#### *Evidence for Casting with Thumb Immobilization for Scaphoid Fractures*

There are 7 moderate-quality RCTs incorporated into this analysis.(1224, 1226-1228, 1231, 1238, 1239)

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: cast immobilization, scaphoid fracture, Scaphoid 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 and reviewed 29 articles in PubMed, 110 in Scopus, 11 in CINAHL, 15 in Cochrane Library, 6 in Google Scholar, and 0 from other sources. We considered for inclusion 29 from PubMed, 1 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 31 articles considered for inclusion, 7 randomized trials and 1 systematic studies met the inclusion criteria.

## Follow-up Visits

Duration of immobilization is typically 6 to 8 weeks to develop resolution of tenderness and for imaging evidence of healing.(402, 1156) After 6 to 8 weeks, the cast should be removed, imaging repeated, and casts reapplied for an additional 3 to 6 weeks, with a repeating process until evidence of fracture healing is documented. The average casting time for non-displaced fractures is 10 weeks,(402) with all expected to heal in 6 months.(401)

## Medications

### NSAIDs/Acetaminophen

*Recommendation: NSAIDs or Acetaminophen for Scaphoid Fractures*

**NSAIDs or acetaminophen are recommended to control pain associated with scaphoid fractures.**

*Indications – Pain due to a scaphoid fracture.*

*Frequency/Duration – Scheduled dosage rather than as needed is generally preferable.*

*Indications for Discontinuation – Resolution of pain, lack of efficacy, development of adverse effects, particularly gastrointestinal.*

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

There is no quality evidence for or against the use of NSAIDs or acetaminophen for scaphoid fractures. These medications have been found useful in other musculoskeletal injuries and by inference may be efficacious for control of

swelling and pain in the initial stages of injury, although some concerns about healing of bones have been raised. Other studies have suggested no delayed bone healing (see Distal Forearm Fractures).

#### *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, 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.

## Physical Methods/Rehabilitation

### 1. Recommendation: Education after Cast Removal for Scaphoid Fractures

**Referral of select patients needing education after cast removal for scaphoid fractures is recommended.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

### 2. Recommendation: Physical or Occupational Therapy after Cast Removal for Scaphoid Fractures for Patients with Functional Debilities

**Referral of patients with functional debilities or those unable to return to work for physical or occupational therapy after cast removal for scaphoid fractures is recommended.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

### 3. Recommendation: Physical or Occupational Therapy after Cast Removal for Scaphoid Fractures for All Other Patients

**Routine referral for physical or occupational therapy after cast removal for scaphoid fractures of otherwise healthy patients who are able to return to work is not recommended.**

*Strength of Evidence* – **Not Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

#### *Rationale for Recommendations*

There are no quality studies evaluating education or occupational or physical therapy for scaphoid fracture. (However, there are several studies showing this for various MSD outcomes when comparing formal therapy with a self-administered home exercise program – see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders.) These therapies are generally unnecessary for most patients. However, some patients may need formal therapy with exercises if there are considerable impairments or a failure to progress after removal of the cast or splint. A few appointments for educational purposes for select patients are recommended. The number of appointments is dependent on the degree of debility, with one or two educational appointments appropriate for mildly affected patients. Patients with severe debility or those unable to return to work may necessitate 8 to 12 appointments that particularly include progressive strengthening exercises. Additionally, while routine use may be of limited benefit, those patients who have muscle weakness or other debilities may also derive benefit from therapy including self-training exercises, particularly if unable to return to work. Therefore, occupational or physical therapy is recommended for select patients.

#### *Evidence for the Use of Physical Methods/Rehabilitation*

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.

## Surgery

Displaced fractures are believed to require surgical treatment with fixation, but there are no quality studies of displaced fractures. Surgical treatment of non-displaced scaphoid fractures has been evaluated in quality studies and there is no quality evidence of improved long-term outcomes with surgery.(402, 1223, 1228, 1240-1244) These studies generally indicate earlier, short-term functional recovery is achieved by surgery compared with prolonged casting.(401, 1228, 1240-1242) A Swedish study also found higher costs among manual workers treated with casts due to longer periods of lost time.(1244) However, two quality studies, one with 10-year follow-up, demonstrated an 11-fold increased risk of scaphotrapezial osteoarthritis in those surgically treated with internal fixation compared with those casted.(402, 1228) Another study noted a significant potential for overtreatment of these patients with surgery.(1242)

Indications to surgically fix a scaphoid fracture are not well defined, and there is a suggestion that some patients are better candidates than others (e.g., widely displaced fragments, or requirement for earlier recovery such as in professional athletes). Quality evidence indicates operative treatment of non-displaced or minimally displaced scaphoid fractures provide no long-term benefit in functional outcomes, and results in significantly higher incidence of scaphotrapezial joint osteoarthritis. Until better quality evidence becomes available, 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.

1. *Recommendation: Surgical Fixation of Displaced Scaphoid Fractures*  
**Surgical fixation of displaced scaphoid fractures is recommended.**  
*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – High*

*Rationale for Recommendation*  
See above.

2. *Recommendation: Surgical Intervention of Non-displaced or Minimally Displaced Scaphoid Fractures for Patients Requiring Early Recovery*  
**Surgical intervention of treatment of non-displaced or minimally displaced scaphoid fractures is recommended for patients requiring earlier functional recovery.**

*Indications* – 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, thus electing to forego attempted non-operative management and its attended lower risk of later osteoarthritis but longer course of immobilization in exchange for earlier return to work. There is no significant evidence that one technique, including bone grafting is superior to another.(1245-1249)

*Strength of Evidence – Recommended, Evidence (C)*  
*Level of Confidence – Low*



3. *Recommendation: Surgical Intervention of Non-displaced or Minimally Displaced Scaphoid Fractures for All Other Patients*

**Surgical intervention for treatment of non-displaced or minimally displaced scaphoid fractures is not recommended for all other patients.**

*Strength of Evidence – Not Recommended, Evidence (C)*

*Level of Confidence – Low*

*Rationale for Recommendation*

See above.

*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.*

## **Ultrasound/Osteogenic Protein Adjuvant**

1. *Recommendation: Ultrasound with Bone Graft for Scaphoid Fractures*

**There is no recommendation for or against the use ultrasound to accelerate bone graft healing for scaphoid fractures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

*Rationale for Recommendation*

Low intensity pulsed ultrasound has been evaluated for the treatment of fractures.(1252-1257) (Rubin 01, Riboh 12, Siska 08, Virk 12, Pounder 08, Barry 15, Nelson 03, Parvizi 05, Smoljanovic 07, Griffin 02) There is one moderate-quality RCT that reported earlier healing of muscle-pediculated bone graft after low intensity ultrasound treatment for 21 patients with scaphoid non-union with healing of a mean 38 days earlier.(1258) While the results are promising, they need replication with a larger sample size prior to recommendation.

*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.*

## 2. Recommendation: Osteogenic Protein Adjuvant for Scaphoid Fractures

**There is no recommendation for or against the use of osteogenic protein-1 for adjuvant treatment with bone grafting for scaphoid fractures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There is a small trial of osteogenic protein-1 (BMP-7) for treatment of 17 patients with scaphoid non-union at the proximal pole included 3 arms comparing: 1) autologous iliac bone graft; 2) autologous iliac bone graft plus osteogenic protein-1; versus 3) allogenic iliac bone graft plus osteogenic protein-1.(1259) The study reported the following healing rates: sclerotic area at 3 months 138.3±15.1 versus 74.0±14.1 versus 103.6±13.2mm<sup>2</sup> respectively. However, the results need repeating in a larger sample size prior to a recommendation.

### *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)

## Distal Phalanx Fractures and Subungual Hematoma

### Diagnostic Criteria

Diagnosis is evident from clinical suspicion, physical examination findings, and x-ray confirmation.

### Special Studies and Diagnostic and Treatment Considerations

#### X-Rays

*Recommendation: X-rays for Diagnosing Tuft Fractures*

**X-rays are recommended to diagnose tuft fractures.**

*Indication* – Clinical tuft fractures that do not involve the DIP joint do not require x-rays as they do not alter treatment. Still, the threshold for obtaining x-rays for those fractures is low in the event they may involve the joint.

*Frequency/Duration* – Obtaining x-rays once is generally sufficient. Follow-up x-rays are rarely indicated aside from complicated healing.

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There are no quality studies evaluating the use of x-rays for distal phalangeal/tuft fractures. X-rays may assist in identifying fractures and the magnitude of the involvement of the DIP joint surface, which if large enough may alter management in favor of surgery (see below). As this section of the digit is readily accessible for physical examination, patients may be treatable without x-rays as x-rays will not change the management of tuft fractures that do not involve the joint. X-rays are recommended for assessment of fractures thought to involve the DIP joint.

### *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, 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.

## **MRI/CT/Ultrasound/Bone Scan Imaging**

*Recommendation: MRI, CT, Ultrasound, or Bone Scanning for Diagnosing Tuft Fractures*

**MRI, CT, ultrasound, or bone scanning is not recommended for diagnosing tuft fractures.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

### *Rationale for Recommendation*

There are no quality studies regarding the use of MRIs, CTs, ultrasound, or bone scanning for diagnosing tuft fractures. As x-rays are sufficient for diagnostic purposes, neither MRI, CT, diagnostic ultrasound, nor bone scanning is recommended.

### *Evidence for the Use of MRI/CT/Ultrasound/Bone Scan Imaging*

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.

## **Initial Care**

Tuft fractures are initially treated by caring for accompanying soft tissue injury and splinting of the finger to prevent further discomfort or injury. Reduction of the relatively uncommon significantly displaced fractures should be attempted with dorsal traction followed by immobilization in a volar splint. In the small percentage of patients, reduction cannot be achieved and referral to an orthopedic surgeon for consideration of pinning may be indicated.(77)

Management of subungual hematoma associated with a tuft fracture varies widely. There are no quality RCTs investigating the treatment ramifications of no treatment, trephination, nail plate removal, nail bed laceration repair, or conversion of closed fracture into open fracture.(75, 76, 1260-1270) As subungual hematoma is often associated with nail bed laceration, many practitioners promote removing the nail and repairing the nail bed to avoid future cosmetic defects.(76) The primary concern for this procedure is the potential to convert an underlying fracture into an open fracture.(75, 76, 1260-1270)

Tuft fractures associated with nail avulsion may require reduction of the nail plate under the eponychium, or removal if reduction cannot be performed. As with the removal of the nail for other conditions, the eponychial space should be preserved by packing with petroleum gauze cut in the shape of the nail to prevent scarring of the nail bed and stunted nail growth.(1270) The nail or gauze should remain in place for 2 to 3 weeks to allow initial formation of a new nail plate. Full growth of the new nail takes approximately 4 to 5 months. Open fractures other than from subungual hematoma trephination of the distal phalanx require cleansing, debridement, and inspection for foreign bodies. 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.

1. *Recommendation: Trephination for Management of Subungual Hematoma*

**Trephination is recommended for management of subungual hematoma.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

2. *Recommendation: Nail Removal or Laceration Repair for Management of Subungual Hematoma*

**Nail removal or laceration repair is not recommended for the management of subungual hematoma.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

*Rationale for Recommendations*

There are no quality studies regarding trephination or nail removal/laceration repair to manage subungual hematoma. (75, 76, 1260-1272) (Ciocon 06; Dean 12) In a prospective study of 47 patients with subungual hematoma involving 50% or more surface area of the nail, a nail bed laceration was associated with fracture in 80% of patients. Thus, tuft fractures with subungual hematoma have a high likelihood of an associated laceration.(76) However, another prospective study of 48 patients with subungual hematoma, 42% of which had an underlying tuft fracture, were treated exclusively with electrocautery trephination. At 10-months follow-up post-trephination, there were no infectious or cosmetic complications despite not repairing the laceration or by converting a closed fracture into an open fracture. Another prospective study conducted in children with subungual hematoma compared nail removal and laceration repair to trephination over a 2-year follow-up and concluded that there was no justification based on absence of adverse clinical outcomes from trephination to perform nail removal and exploration.(1268) Each participant had a short course of antibiotics. There were no case reports found of osteomyelitis from trephination over hand tuft fracture, nor any reports of adverse cosmetic outcomes (nail scarring, permanent depression) in patients with finger nail bed laceration that were managed without suturing. Thus, the practice of avoiding trephination over distal phalangeal fracture to avoid creating an open fracture, or the practice of exploring and repairing nail bed lacerations associated with subungual hematoma appears unsupported by the available literature.

Trephination is most commonly accomplished with a hot cautery unit. Successful trephining with 29-gauge needle inserted below the nail plate reported,(1273) as well as fine point scalpel blade, surgical drill and laser have also been reported.(1261) Trephining gives good cosmetic and functional results.(1260)

*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.

## **NSAIDs/Acetaminophen**

*Recommendation: NSAIDs or Acetaminophen for Tuft Fractures*

**NSAIDs or acetaminophen are recommended to control pain associated with tuft fractures.**

*Indications – Pain due to tuft fracture.*

*Frequency/Duration – Scheduled dosage rather than as needed is generally preferable.*

*Indications for Discontinuation – Resolution of pain, lack of efficacy, development of adverse effects, particularly gastrointestinal.*

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*

#### *Rationale for Recommendation*

There is no quality evidence regarding the use of NSAIDs or acetaminophen to control pain associated with tuft fractures. However, these medications are thought to be effective for control of swelling and pain in the initial stages of injury, are not invasive, have low adverse effects, are low cost, thus they are recommended.

#### *Evidence for the Use of NSAIDs or 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, 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.

### **Antibiotic Prophylaxis**

*Recommendation: Post-trephination Antibiotic Prophylaxis for Open Fractures*

**There is no recommendation for or against the use of post-trephination antibiotic prophylaxis for open fractures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*  
*Level of Confidence – Low*

#### *Rationale for Recommendation*

Antibiotic prophylaxis for open fractures is widely used. However, they may not be necessary for open phalangeal fractures as a quality study did not show evidence of improvements upon infection rates compared with aggressive irrigation and debridement as there were equal numbers of soft tissue infections and no cases of osteomyelitis in either group.(1274) However, the study appears underpowered to detect these relatively infrequent events. Use of antibiotics may be more strongly indicated for those with risks for infection, such as patients with diabetes mellitus. Thus, there is no recommendation for or against use of antibiotics and the threshold for use of antibiotics for prophylaxis is suggested to be low.

#### *Evidence for the Use of Antibiotic Prophylaxis*

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.

### **Tetanus Immunization**

*Recommendation: Tetanus Immunization Status for Open Fractures*

**For open fractures, it is 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.(1277)*

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

#### *Rationale for Recommendation*

There are no quality studies of tetanus immunization updating for open fractures. However, these immunizations are widely used and believed to have been successful on a population basis in reducing risk of tetanus over many decades. Tetanus immunizations are minimally invasive, have low adverse effects, and are low cost. As the adverse effects of not immunizing may be fatal, tetanus immunization updating for open wounds is recommended. Wounds that are not clean or burns should require immunization if over 5 years since last immunization, rather than 10 years.(1277) Patients without a completed immunization series of 3 injections should receive tetanus immune globulin along with immunization.

#### *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.*

## **Immobilization**

### 1. *Recommendation: Protective Splinting of Distal Phalanx for Fractures*

**Protective splinting of the distal phalanx to the PIP is recommended for fractures.**(77, 78, 1278)

*Duration – Approximately 3 weeks.*

*Strength of Evidence – **Recommended, Insufficient Evidence (I)***

*Level of Confidence – Moderate*

### 2. *Recommendation: Tight Circumferential Taping for Tuft Fractures*

**Tight circumferential taping around the fingertip is not recommended for tuft fractures.**

*Strength of Evidence – **Not Recommended, Insufficient Evidence (I)***

*Level of Confidence – Low*

#### *Rationale for Recommendations*

There are no quality studies evaluating immobilization for fractures. In the closed crush fracture of the distal phalanx, the L-shaped Alumafoam splint placed on the volar aspect to protect the soft tissues has been considered the best treatment, although quality comparative trials are lacking. Splinting generally is maintained for approximately 3 weeks.(88, 1279) (Chalmer 13, Leggit 06) Tight circumferential taping is not recommended due to potential to impair circulation. Volar splinting is not invasive, has few adverse effects, is low cost and is recommended.

#### *Evidence for the Use of Immobilization*

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.

## Follow-up Visits

Uncomplicated closed tuft fractures do not require follow-up, particularly if there is not a need for work and activity limitations. Two or three appointments may be required for gradual reduction in limitations. Patients should be advised that residual tenderness and hypersensitivity to cold temperatures may persist for 6 months in a more than half of all patients with this injury.(1280)

## Prescription Medications

There are no quality studies of the use of other prescription medications in tuft fracture than already addressed in the Initial Care section. However, some patients may require pain medication, especially nocturnally, for the first few days.

## Physical Methods/Rehabilitation

### Exercise

Exercise is not indicated acutely. Few patients require exercise after recovery. For those with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

*Recommendation: Routine Use of Physical or Occupational Therapy for Tuft Fractures*

**There is no recommendation for or against the routine use of physical or occupational therapy for treatment of tuft fractures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There are no quality studies of the use of physical or occupational therapy or other methods for tuft fractures, and these injuries rarely require therapy. Joint mobilization therapy may be useful for complicated injuries or post surgical fixation. A few appointments for purposes of teaching range of motion exercises for recovery of full motion may be rarely indicated, particularly for those with more severe injuries or those with a lack of improvement after removal of splints. However, the vast majority of patients with tuft fractures require no further treatment.

### *Evidence for the Use of Physical or Occupational Therapy*

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.

## Surgery

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.(87, 1167, 1281) (Carpenter 13)

### *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: 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.*

## Middle and Proximal Phalangeal and Metacarpal Fractures

### Diagnostic Criteria

Diagnosis is determined by clinical suspicion evident from history, physical examination findings and x-ray confirmation.

### Special Studies and Diagnostic and Treatment Considerations

#### X-Rays

*Recommendation: X-rays for Diagnosing Phalangeal or Metacarpal Fractures*

**X-rays are 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.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

#### *Rationale for Recommendation*

There are no quality studies evaluating the use of x-rays for phalangeal and metacarpal fractures. However, x-rays assist in identifying fractures, orientation of fracture plane(s), magnitude of the involvement of the interphalangeal and metacarpal phalangeal joints, which if large enough may alter management in favor of surgery (see below). X-rays are recommended for assessment of fractures of the phalanges and metacarpals.

### *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 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.

## MRI/CT/Ultrasound/Bone Scan Imaging

*Recommendation: MRI, CT, Ultrasound, or Bone Scanning for Diagnosing Phalangeal or Metacarpal Fractures*

**MRI, CT, ultrasound, or bone scanning is not recommended for diagnosing phalangeal or metacarpal fractures.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There are no quality studies evaluating MRIs, CTs, ultrasound, or bone scanning for diagnosing phalangeal or metacarpal fractures. As fracture displacement and rotation are of primary concern, most fractures are readily diagnosed and treatment planned with radiographs. Discovering occult non-displaced fractures on CT would be unlikely to change the management except for delineation of articular impaction injuries.(78) Therefore, MRI, CT, diagnostic ultrasound, or bone scanning is not recommended for diagnosing phalangeal or metacarpal fractures.

### *Evidence for the Use of MRI/CT/Ultrasound/Bone Scan Imaging*

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

## Initial Care

Initial management should include treatment of soft tissue injuries(1282) and pain control following completion of physical examination. Regional anesthesia should be administered 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.

Regional anesthesia is typically performed through injection of local anesthetic as a digital block through one of many described techniques including digital ring block, palmar subcutaneous block, metacarpal block, and volar thecal block. The traditional digital block technique, also known as dorsal subcutaneous block, and occasionally referred to as metacarpal block, includes instilling local anesthetic from a dorsal approach into the webspace lateral to each side of the injured finger. A true metacarpal block is similar to ring block, but at the metacarpal head. A volar thecal block, also referred to as transthecal block, is the instillation of local anesthetic into the potential space of the tendon sheath at the distal palmar crease (A-1 pulley) proximal to the injured digit. The palmar subcutaneous block is performed at the same location as the thecal block, but subcutaneously. Other block techniques include ulnar or radial block injuries that are proximal to the phalanx, such as for metacarpal injuries, and hematoma block which is the direct injection of local anesthetic into the fracture hematoma.

## Digital Block

*Recommendation: Digital Block – Traditional (Ring) Block Technique, Palmar Subcutaneous Block*

**The ring block technique, followed by volar subcutaneous block, is moderately recommended for digital anesthesia, as it provides more effective coverage of dorsal phalangeal injuries than the other techniques.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

For phalangeal fractures, there is clear evidence that the three most common digital blocks are similarly effective in onset and depth of anesthesia, although each has advantages and drawbacks particular to the specific technique. However, although it requires two punctures, the traditional digit or ring block has been found to be as effective or more effective than the other two block types as it provides better anesthetic results for the dorsal finger as compared to palmar (subcutaneous) block(1283-1285) and transthecal block.(1286-1288) There is no clear difference in the primary anesthesia outcomes between transthecal and palmar techniques(99, 1289, 1290) although patients preferred the subcutaneous technique and many reported residual pain at the block site 24 hours after injection in the transthecal block group. Subjects in the ring block were also satisfied with the technique compared to transthecal blocks, and were rated very similar to palmar block despite having two injections. Thus, the subcutaneous techniques of ring block palmar subcutaneous block are recommended over transthecal block mainly related to patient preference and residual pain, and ring block is recommended as the first line technique as it is less likely to have incomplete anesthesia of the dorsal finger. There are no quality studies for hematoma block in the hand, but they have been reported effective in distal radius, ulnar, and ankle injuries. Hematoma block may provide advantage for proximal metacarpal injuries over ulnar/radial blocks.

### *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.

## **Medications**

### **NSAIDs/Acetaminophen**

*Recommendation: NSAIDs or Acetaminophen for Phalangeal or Metacarpal Fractures*

**NSAIDs or acetaminophen are recommended to control pain from phalangeal or metacarpal fractures.**

*Indications* – Pain due to phalangeal or metacarpal fracture.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

### *Rationale for Recommendation*

There is no quality evidence, however these medications are thought to be effective for control of swelling and pain in the initial stages of injury, are not invasive, have low adverse effects, are low cost, and thus are recommended. While there have been some concerns regarding delayed fracture healing, other studies have suggested no delayed bone healing (see Distal Forearm Fractures section). These concerns appear outweighed by pain management concerns.

### *Evidence for the Use of NSAIDs or 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: 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.

## Antibiotic Prophylaxis

*Recommendation: Antibiotic Prophylaxis for Open Phalangeal Fractures*

**There is no recommendation for or against the use of antibiotic prophylaxis for open phalangeal fractures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

Antibiotic prophylaxis for open phalangeal fractures are commonly used but may not be necessary based on the results of a prospective (non-randomized) trial of 91 open phalangeal fractures in fingers with intact digital arteries which compared aggressive irrigation and debridement with antibiotics. There were equal numbers of soft tissue infections and no cases of osteomyelitis in either group.(1274) However, the study may have been underpowered for these infrequent complications.

### *Evidence for the Use of Antibiotic Prophylaxis*

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.

## Tetanus Immunization

*Recommendation: Tetanus Immunization Status for Open Fractures*

**For open fractures, it is recommended that tetanus immunization 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.(1277)*

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

### *Rationale for Recommendation*

There are no quality studies of tetanus immunization updating for these fractures. However, these immunizations are widely used and believed to have been successful on a population basis in reducing risk of tetanus over many decades. Tetanus immunizations are minimally invasive, have low adverse effects and are low cost. As the adverse effects of not immunizing may be fatal, tetanus immunization updating for open wounds is recommended. Wounds that are not clean or burns should require immunization if over 5 years since last immunization, rather than 10 years.(1277) Patients without a completed immunization series of 3 injections should receive tetanus immune globulin along with immunization.

### *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 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 fractures, 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.*

## Physical Methods/Rehabilitation

### Exercise

Exercise is not indicated acutely. Some patients have considerable, functional deficits after casting and require exercise. For patients with residual deficits, particularly after casting or post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

## Middle and Proximal Phalanx Fractures

### Immobilization and Surgery

There are no quality studies comparing non-operative treatment, percutaneous fixation, bone screws, or plates for middle and proximal phalangeal fractures. There also are no quality studies defining acceptable limits of displacement for non-operative management, determining the ideal splint time or duration of internal or external fixation, making comparisons of fixation techniques or defining ideal post-operative rehabilitation impractical. Immobilization or fixation technique is therefore dictated by the physical and radiographic findings. More than 90% of phalangeal fractures can be managed non-operatively.(83, 1291) Non-operative management techniques include padded aluminum splints, buddy tape, functional splinting, and gutter casting.

#### 1. *Recommendation: Immobilization for Middle and Proximal Phalanx Fractures*

**Immobilization is recommended for treatment of middle and proximal phalanx fractures.**(83, 1291)

*Frequency/Duration* – When percutaneous fixation with wire is used, supplemental stabilization with splint or casting for 3 to 4 weeks should also be used as the wire does not provide sufficient rigidity.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendation*

For middle and proximal phalangeal fractures that do not fit the criteria addressed in the specific fracture types, splinting for 3 to 4 weeks is recommended.

#### 2. *Recommendation: Immobilization for Non-displaced and Stable Transverse Diaphyseal Fractures of the Middle and Proximal Phalanges*

**Non-operative management (immobilization) of non-displaced and stable transverse diaphyseal fractures of the middle and proximal phalanges is 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 1 to 3 weeks.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendation*

There are no quality studies that address non-operative management of acute non-displaced and stable transverse diaphyseal fractures of the middle and proximal phalanges. These fractures have good results with non-operative management. The affected digit is immobilized with neighboring digit in 70 to 90° of MCP flexion for 1 to 3 weeks. 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.(68, 87)

#### 3. *Recommendation: Non-operative Management of Non-displaced Oblique Fractures of the Middle and Proximal Phalanges*

**Non-operative management of non-displaced oblique fractures of the middle and proximal phalanges is recommended as these fractures are usually stable and require rigid immobilization alone.**

*Frequency/Duration* – Examinations weekly for the first 3 weeks.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendation*

There are no quality studies for management of oblique fractures. Buddy taping should not be used as rotational correction may not occur. The fracture must be examined weekly for the first 3 weeks. Displaced fractures can be stabilized with closed reduction and percutaneous Kirschner wires or through open reduction with interfragmentary screw or plate-and-screw devices. Long oblique fractures (length double the diameter of bone at fracture site) can be stabilized by closed reduction and percutaneous Kirschner wires(78, 87) or with intramedullary wires.(89)

#### 4. *Recommendation: Closed Reduction with Splinting for Base Phalanx Fractures*

**Closed reduction with splinting is recommended for base phalanx fractures.(1282)**

*Indications* – Involvement of less than 40% of the middle phalanx base.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

#### *Rationale for Recommendation*

There are no quality studies for management of base fractures. However, base fractures are commonly a fracture-dislocation of the PIP joint and consists of an avulsion fracture of the volar lip of the middle phalanx with dorsal subluxation of the remaining base of the middle phalanx. Closed reduction with splinting is recommended(1282) if the fracture involves less than 40% of the middle phalanx base. If this fails, treatment is by pin fixation. Dynamic traction is another effective described technique for base fractures and also for the treatment of comminuted intra-articular fractures (Pilon fractures) of the base of the middle phalanx. Unstable displaced articular fractures at the base of the proximal phalanx are treated with percutaneous wires crossing the MCP joint to hold the joint reduced, and a transverse wire holding the fracture alignment similar to Bennett's fracture of the thumb.(1282)

#### 5. *Recommendation: Surgical Management of Condylar Fractures*

**Surgical management of condylar fractures is recommended as these fractures are unstable.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

### *Rationale for Recommendation*

Displaced oblique fractures involving a single condyle are unstable, and are stabilized operatively with two transverse pins or screws. Bicondylar fractures are reconstructed with screws and connected to the shaft with a pin or through the use of a condylar plate.(78, 1282)

#### 6. *Recommendation: Surgical Management for Malrotated Phalangeal Fractures*

**Surgical management for malrotated phalangeal fractures is recommended as deformity and impairment may result.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *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.

## **Metacarpal Fractures**

Except for 5th metacarpal neck fractures, there are no quality studies comparing non-operative management, percutaneous fixation, bone screws, or plates. Further, there are no quality studies defining acceptable limits of displacement for non-operative management, determining the ideal splint time or duration of internal or external fixation, making comparisons of fixation techniques or defining ideal post-operative rehabilitation. Metacarpal head fracture in an uncommon fracture, usually intra-articular and frequently results in late traumatic arthrosis.

#### 1. *Recommendation: Non-operative Treatment of Distal Metacarpal Head Fracture*

**Non-operative treatment of distal metacarpal head fractures using closed reduction and protective immobilization with radial or ulnar gutter splint is recommended for fractures with less than 20% of joint involvement.**

*Indication – Fractures with less than 20% of joint involvement.*

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

There are no quality studies that address non-operative treatment of acute distal metacarpal head fractures. Metacarpal neck fractures are common extra-articular fractures at the base of the head, usually the result of axial impaction, resulting in the neck being displaced dorsally and the metacarpal head being displaced volarly. Recommendations are based on prior clinical experience. Cases with greater than 20% joint involvement likely require open reduction and internal fixation followed by nearly immediate motion.(84)

#### 2. *Recommendation: Non-operative Treatment of Distal Metacarpal Head Fracture with Acceptable Angulation*

**Non-operative treatment of distal metacarpal head fracture using angulation is recommended.**

*Indication – Degree of angulation 15° in the ring finger and 10° in the index and long fingers.*

*Frequency/Duration – These fractures heal quickly in 3 to 4 weeks with a gutter or radial splint maintaining MCP joint flexion. Operative fixation is usually with percutaneous pinning.(84)*

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

Treatment of Boxer's fracture, or 5th metacarpal neck fracture, varies widely, with proponents of casting, splinting, taping, and operative fixation. There are no quality studies comparing non-operative and operative techniques, although there are two prospective trials with long-term follow-up suggesting non-operative treatment with early mobilization provides comparable outcomes to operative intervention, and perhaps is superior as operative fixation may increase the risk for metacarpophalangeal joint osteoarthritis,(1292) although it may result in slightly more cosmetic deformity.(1293)

3. *Recommendation: Non-operative Treatment of Fifth Metacarpal Neck Fractures (Boxer's Fracture)*  
**Non-operative treatment is recommended before surgical treatment for most 5th metacarpal neck fractures as the outcomes are similar both functionally and anatomically.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

4. *Recommendation: Use of Functional Therapies Rather than Casting or Splinting for Fifth Metacarpal Neck Fractures*  
**The use of functional therapies including taping, functional bracing, and strapping is moderately recommended over casting or ulnar splinting for 5th metacarpal neck fractures.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendations*

There are eleven moderate-quality studies available comparing the effectiveness of different non-operative measures and no clear evidence of superiority of one approach over another.(1294-1304) A Cochrane review also concluded that no single non-operative treatment regimen for fracture of the neck of the 5th metacarpal can be recommended as superior to another in results.(1305) However, there is moderate evidence supporting functional therapies in general, with two moderate-quality studies supporting functional therapies over casting or splinting. Functional taping provided better functional outcome with no increase in deformity over casting,(1294) and treatment by compression bandage without reduction or splinting with a mean angulation angle of 48° had equal functional outcomes with closed reduction and splinting.(1296) Another moderate-quality study supports the use of strategic metacarpal bracing (3-point brace), another type of functional therapy, which provided equivalent functional outcomes to neighbor strapping but with less pain.(1295)

Ulnar gutter cast was compared with functional mobilization (pressure bandage for 1 week) in patients with 70° angulation or less and no rotation of the 5th metacarpal. Although the study was limited by small sample size, there were no differences in subjective symptoms of pain, return to work and hobby, or the need for physiotherapy.(1297) Several non-randomized prospective and retrospective trials with long-term follow up (up to 4 years) of patients treated without immobilization support these findings.(1306-1308) Other methods described in the literature for non-operative management with reported efficacy include fracture brace,(1309) modified Thomine brace,(1310) and a glove cast.(1311) However, there is no recommendation for or against any of these interventions as there is insufficient evidence.

There is no consensus on the degree of acceptable volar angulation manageable with non-operative treatment. It is reported as 30° in a small prospective case series of 18 patients(1312) followed for a mean of 20 months, and 60° and 70° in early mobilization trials.(1296, 1297) Intra-articular fractures have also been reported to be successfully treated non-operatively, although comparison of non-operatively and operative management demonstrated high level of intermittent pain (38%), 49% decreased grip, and 65 radiographic signs of osteoarthritis in both groups.(1313)

#### *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

### 5. Recommendation: Routine X-rays in Follow-up of Fifth Metacarpal Neck Fractures

**Routine x-ray for follow-up of non-operative treatment of 5th metacarpal fractures is not recommended as it has little clinical impact on fracture management.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### Rationale for Recommendation

Routine radiographs in follow-up of non-operative treatment for 5<sup>th</sup> metacarpal neck fracture were not found to be of clinical utility(1319) except in only one case from two retrospective studies of 307 patients and 288 patients. Follow-up radiographs are indicated if physical examination suggests loss of reduction or instability within one week of the fracture.

## Shaft Metacarpal Fractures

Shaft metacarpal fractures are usually transverse, oblique, spiral or comminuted. Determination of whether or not a fracture can be managed non-operatively is unclear.

### 1. Recommendation: Non-operative Management of Metacarpal Shaft Fractures

**There is no recommendation for or against non-operative management of metacarpal shaft fractures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### Rational for Recommendation



There are no quality studies and there are conflicting opinions regarding whether any angulation of the middle and index finger is acceptable,(84) versus whether up to 15° of dorsal angulation of the middle and index finger(89) can be tolerated. The ring finger is thought to tolerate 20°.(84) There is general agreement that rotational deformity is poorly tolerated. Thumb shaft fractures are rare, and those with less than 30° angulation can be managed with forearm-hand-based opponens splint for 3 to 4 weeks. Parameters of fifth digit fractures are discussed separately (see Metacarpal Fractures [Boxer's Fracture]). Ultimately, decisions for non-operative versus surgical intervention balance acceptance of metacarpal shortening with risks accompanying surgical intervention.

Oblique fractures likely benefit from fixation (intra-medullary wires)(89) to prevent shortening. If adequate closed reduction is achieved and the fracture is stable, a 3-point brace (pressure points over the fracture apex and two counter-pressure points proximal and distal on the opposite side) can be used. Metacarpal shaft fractures that cannot be reduced, are unstable, or have multiple neighboring shaft fractures require fixation (pinning, wire, plate, lag screws).

2. *Recommendation: Surgical Management for Base Fractures of the Proximal Metacarpal*

**Surgical management of base fractures of the proximal metacarpal is recommended as these fractures are rarely stable and require percutaneous pins or screws to maintain reduction.**

*Indications* – Extra-articular fractures with up to 15° of deformity in the 4th and 5th metacarpals, and only 5° in the 2nd and 3rd metacarpals can be managed with immobilization using a gutter splint holding the MCP in 70° flexion, wrist in neutral position, and allowing movement of the PIP and DIP joints.(84)

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

3. *Recommendation: Operative Fixation for Bennett's Fracture and Rolando's Fracture*

**Operative fixation is recommended for Bennett's and Roland's fractures as these fracture types are unstable.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

4. *Recommendation: Surgical Management for Malrotated Phalangeal Fractures*

**Surgical management for malrotated phalangeal fractures is recommended as deformity and impairment may result.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

*Rationale for Recommendations*

There are no quality studies for Bennett's or Rolando's fractures of the thumb. Bennett's fracture of the thumb is a common metacarpal base fracture associated with dislocation, and requires operative fixation with one or two wires to maintain alignment of the shaft and joint surface, as does the base of the 5<sup>th</sup> metacarpal.(68) Rolando's fracture is a comminuted intra-articular burst fracture at the thumb base requiring internal and external fixation to preserve metacarpal length and reapproximate articular fragments.(84)

*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: 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.

## Follow-up Visits

There are no quality studies on frequency or timing of return visits. X-rays for follow-up of all metacarpal fractures are reasonable; however, fractures at risk for displacement after reduction are particularly recommended to have repeat radiographic studies 7 to 10 days after injury to ensure no further displacement or malrotation has occurred –

**Recommended, Insufficient Evidence (I), Level of Confidence - Moderate.** Motion and other hand exercises should be started at the earliest date the fracture becomes stable.

## Physical Methods/Rehabilitation

### 1. Recommendation: Ice, Compression, and Elevation for Acute Metacarpal Fractures

**Ice, compression, and elevation are recommended for controlling edema related to acute metacarpal fractures.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### 2. Recommendation: Early Mobilization for Acute Metacarpal Fractures

**Early mobilization of acute metacarpal fracture (before 21 days) is recommended.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### Rationale for Recommendations

There are no quality studies for physical methods of metacarpal fracture management. However, it is believed that controlling edema and early mobilization result in a more favorable outcome. Inflammation associated with traumatic injury, fracture hematoma and any resultant soft tissue damage from fracture displacement including adjacent tendons and ligaments results in edema and routine tissue repair processes. Immobilization in the presence of these inflammatory processes can result in adhesions to tendons, ligaments, capsules, or skin and subsequent stiffness and loss of function.(1320) Phalangeal fractures respond less favorably to immobilization than metacarpal fractures, with a predicted 84% return of motion, compared to 96% return in metacarpal fractures. Immobilization continued longer than 4 weeks is reported to further reduce the return to motion to 66%.(1278)

There are no quality studies defining the efficacy or advantages of specific physical methods in reducing the effect of inflammation and immobilization. Control of edema after injury has been thought to be important in restoring function.(1321) Ice, compression, and elevation should be emphasized, with particular emphasis on hand elevation overnight.(1322)

Early mobilization to promote venous return via muscle contraction and thus reduce swelling and propensity towards complex regional pain syndrome (CRPS) is advocated for stable fractures. Early motion of simple metacarpal fractures initiated within 21 days of injury is likely to result in earlier recovery of motion and strength, and earlier return to work without adversely impacting fracture alignment.(1323) Tendon gliding range of motion exercises should be initiated as soon as possible based on the fracture immobilization method.

### Evidence for the Use of Joint Mobilization

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.

## Distal Forearm Fractures

### Special Studies and Diagnostic and Treatment Considerations

#### X-Rays

*Recommendation: X-ray for Suspected Distal Forearm Fractures*

**X-rays in the posterior-anterior and lateral views are recommended as a first-line study for suspected distal forearm fractures.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

#### *Rationale for Recommendation*

There is no quality evidence for evaluation of x-ray studies for evaluation of suspected distal radial fractures. However, x-ray studies are standard of practice for suspected fracture. Therefore, as a first-line study, PA, lateral and if available oblique x-ray image views are recommended. 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*

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.

#### MRI

*Recommendation: MRI for Diagnosing Distal Forearm Fractures*

**MRI is 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.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

#### *Rationale for Recommendation*

There is no quality evidence that MRI is superior to radiographs for the initial detection of distal radial fractures and should not be generally used as a first line test. 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.(1324-1326)

#### *Evidence for the Use of MRI*

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.

## **CT**

*Recommendation: CT for Diagnosis and Classification of Occult and Complex Distal Forearm Fractures*

**CT is 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.(1327)**

*Indication* – Negative x-rays with occult fracture strongly suspected.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

- Acute  Subacute  Chronic
- Preoperative  Perioperative  Postoperative
- Mild  Moderate  Severe

#### *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.(1327, 1328) The value of CT has been demonstrated by Katz et al, who showed the use of CT scanning for evaluation of articular step off and gaping, comminution, and treatment influenced observers to change treatment plans developed from radiographs and resulted in increased interobserver reliability in the proposed management of these injuries.(1329)

#### *Evidence for the Use of CT*

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.

## Follow-up Visits

No quality evidence exists for specific follow-up care of distal radial injuries outside of identified recommendations listed in this section. Routine follow-up as with other fractures should be followed, with consideration of forearm girth changes with reduced swelling after the immediate injury period that may necessitate re-casting or immobilization device adjustments, and monitoring the potential for reduction failure with subsequent radiographic studies.

## Medications

### NSAIDs

*Recommendation: NSAIDs for Acute Colles' Fracture (Distal Forearm Fracture) Analgesia*

**The use of NSAIDs to control bone pain associated with Colles' fracture is recommended as there does not appear to be any negative effect on bone fracture union or functional recovery.**

*Indications* – Bone pain associated with Colles' fracture.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Moderate

### *Rationale for Recommendation*

There are three moderate-quality studies that show NSAIDs are effective for pain relief of distal forearm fracture.(1331-1333) Flurbiprofen was more effective than placebo in conjunction with Bier block manipulation and for post manipulation pain.(1333) Piroxicam was more effective than paracetamol,(1331) and diflunisal was equally effective as mefenamic acid. No changes in Gartland and Werley functional assessment scores(1333) or functional recovery in post menopausal women(1331) were found, indicating there is no significant benefit other than pain relief from the use of NSAIDs.

### *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.

## Initial Care

### Non-Displaced Distal Radial Fracture

1. *Recommendation: Immobilization Period of Three or Less Weeks (Early Mobilization) for Non-displaced or Minimally Displaced Distal Radius Fractures*

**Immobilization of non-displaced or minimally displaced distal forearm fractures limited to 3 weeks is moderately recommended and has equivalent or superior functional outcomes than periods greater than 3 weeks for non-displaced or minimally displaced distal radius fracture.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*  
*Level of Confidence – Moderate*

*Rationale for Recommendation*

Six moderate-quality studies(1335-1340) support limiting immobilization of non-displaced or minimally displaced non-articular fractures of the distal radius to a period of 3 weeks or less. The clinical definition of minimally displaced fractures, however, is not established by quality evidence, as the available literature lacks a consistent standardized fracture classification, such as Frykman's or the AO classification systems. In general, the inclusion and exclusion criteria for entry into interventional studies reviewed in this Guideline may act as a defacto guideline, defining minimally displaced as fractures with less than 10° of dorsal angulation, less than 10° of radial angulation, and less than 2 to 3mm of radial shortening.(106, 1336, 1341-1343)

In each study comparing immobilization of 3 or 5 weeks, patients demonstrated either improved functional measures such as pain scores(1336) wrist swelling, wrist and grip strength, and better subjective patient assessments with shorter immobilization periods, or no measurable differences between the groups indicating there is no advantage to longer immobilization periods. There were no differences in radiographic findings in any of the studies associated with duration of immobilization.(1335, 1337) There is no quality evidence supporting immobilization for periods greater than 3 weeks in these cases. Although there is one low-quality study that suggests equivalent functional results are achieved with fewer cases of complex regional pain syndrome (1 vs. 5),(106) there is insufficient evidence to support 1-week immobilization.

2. *Recommendation: Use of Functional Brace or Splint over Traditional Casting for Non-displaced or Minimally Displaced Distal Radius Fractures*

**The use of functional bracing or splinting that will allow mobilization of the radial-carpal joint while maintaining stabilization of the fracture is moderately recommended over traditional casting to immobilize the forearm and wrist for non-displaced or minimally displaced Colles' fractures.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*  
*Level of Confidence – Moderate*

*Rationale for Recommendation*

There are multiple moderate-quality studies providing moderate evidence in support of functional bracing or splinting over traditional casting for non-displaced or minimally displaced fractures of the distal radius.(1336, 1337, 1344-1347) Functional bracing or splinting techniques described allow for mobilization at the radiocarpal joint. Various splinting techniques have been described, including the use of the lightweight removable splints,(1347) posterior splint with tubigrip,(1336) crêpe bandage,(1337) elastic bandage,(1344) triple point loading brace with adjustable Velcro straps,(1346) and 3-point loading functional plaster brace.(1345)

As there are no direct comparisons between types of functional bracing, no specific recommendation can be made as to which if any technique is superior. The importance of early radiocarpal joint mobilization appears to be most important factor. Improved functional outcome through early mobilization may be a surrogate or confounder to the recommendation for shorter durations (3-week period) of immobilization, which essentially achieves the same objective of reducing immobilization of the radiocarpal joint. The literature is unclear if there might be an additive effect for functional bracing combined with immobilization of the fracture for 3 weeks or less, as functional bracing was compared to traditional casting of 4 to 6 weeks duration.

3. *Recommendation: Casting/Bracing Non-displaced or Minimally Displaced Colles' Fractures in Pronation or Supination*

**There is no recommendation for or against casting/bracing the forearm and wrist in pronation or supination for non-displaced or minimally displaced Colles' fractures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*  
*Level of Confidence – Low*

*Rationale for Recommendation*

There are two moderate-quality studies on cast positioning of the forearm and hand, either supination or pronation, and functional outcomes. One study found no advantage to supination over conventional Colles' casting;(1348) the other found forearm casting in pronation superior to above-elbow supination.(1349) As both techniques were last reported on more than 20 years ago, and with more recent evidence indicating that functional splinting is more effective casting, no recommendation is made regarding casting in pronation or supination in patients with non-displaced Colles' fractures, although pronation is likely superior to supination if casting is attempted. Casting the forearm and wrist in pronation may provide benefit over casting in supination, although neither is recommended if functional bracing or splinting is an available treatment option.

#### *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; Rosetzsky 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.

## **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 radial shift require reduction to reduce the risk for deformity and disability. Closed reduction should result in no more than 5° of dorsal angulation and no more than 2mm of radial shortening. 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. Examples include fractures with dorsal comminution or radial lateral shift of more than 2mm, have been proposed as limits for consideration of surgical intervention.(107, 108)

#### **CLOSED REDUCTION TECHNIQUE**

*Recommendation: Closed Reduction Technique for Displaced Distal Radial Fractures*

**Manipulation and dynamic traction devices are recommended for closed reduction technique for displaced distal radial fractures as they have demonstrated equivalent ability to achieve initial reduction of injury.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Moderate*

*Rationale for Recommendation*

For closed reduction, there is one high-quality and two moderate-quality studies comparing the effectiveness of manipulation and traction techniques for displaced Colles' fracture. There was no difference in immediate reduction results using Chinese finger dynamic traction devices compared to manipulation under anesthesia.(1341, 1366, 1367) Long-term outcomes also showed no differences in post reduction failures, as both methods have 25 to 29% loss of reduction with casting. It is likely the loss of reduction is unrelated to reduction technique, and rather more related to immobilization technique. In a group of elderly patients, there were no differences in functional outcomes or deformity between those that underwent manipulation and casting versus those that were non-reduced and casted if the degree of displacement had less than 30° of dorsal angulation and 5mm of radial shortening.(1368)

Despite non-superiority of reduction outcomes for manipulation or dynamic traction, one author in two papers reports lower rates of severe reduction pain and reduced long-term neurological deficits with dynamic traction (paresthesia, reduced 2-point discrimination) compared with manipulation under hematoma block.(1366, 1367) This author suggests the difference may have been related to the anesthetic technique rather than the reduction technique.

As noted earlier, the lack of a standard fracture classification system across each of these studies inhibits prognostic or treatment indications to be generalized. For these studies, Earnshaw used criteria of >10° of dorsal angulation, > 5 mm radial shortening, no marked comminution or displacement of articular surfaces. Kongsholm included mostly Frykman II, VI, VII, VIII fractures in the study, which may have included comminuted fractures, and those enrolled by Kelly included up to 5 mm of radial shortening and 30° of dorsal angulation.

*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.

**CASTING OR FUNCTIONAL BRACING**

Unlike casting for non-displaced and minimally displaced distal radial fractures, there are few studies comparing casting technique and functional bracing for displaced distal radial fractures and most of the available work was conducted more than 20 years ago. There is no defined standard for casting technique and forearm positioning that provides significant advantage over any other technique for displaced distal forearm fractures.

*Recommendation: Use of Functional Brace or Splint over Traditional Casting for Displaced Distal Radial Fracture*

**There is no recommendation for or against the use of a functional brace or splint that will allow mobilization of the hand while maintaining stabilization of the reduced displaced distal radial fracture.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

*Rationale for Recommendation*

There are few studies that compare specific casting or immobilization techniques. Rather, bracing and casting has been studied in the greater context of allowing hand functionality (functional brace) compared with traditional Colles' casting (elbow flexion, forearm pronation with ulnar deviation) as well as position of the wrist (palmar flexion, neutral,



dorsiflexion) and forearm position (pronation, supination).(1339, 1356-1361) One moderate-quality study of 339 patients with non-specific displaced fractures showed no difference in casting versus functional bracing.(1360) Two moderate quality studies found bracing in the supine position may have advantages for intra-articular fractures,(1356, 1359) whereas bracing in pronation may provide advantage for extra-articular fracture.(1357) However, another moderate-quality study with 250 participants found no differences between hand and ulnar positioning.(1369) In several of these studies, the authors concluded results were related to displacement of original fracture and degree of successful reduction more than immobilization technique. Thus, there are insufficient data to recommend specific casting or immobilization techniques for displaced Colles' fractures.

#### *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.

#### **REDUCTION ANALGESIA**

1. *Recommendation: Bier Block Analgesia for Manipulation of Acute Displaced Distal Forearm Fractures*

**Bier block analgesia is moderately recommended as a first-line technique for manipulation of acute displaced distal forearm fractures.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

2. *Recommendation: Hematoma Block Analgesia for Manipulation of Acute Displaced Distal Forearm Fractures*

**Hematoma block analgesia is recommended for manipulation of acute displaced distal forearm fractures.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

3. *Recommendation: Dynamic Reduction for Acute Distal Forearm Fractures*

**Dynamic reduction is recommended as an alternative technique for distal forearm fractures as it may result in less reduction pain than hematoma block, and may have a lower neurologic complication rate than a hematoma block.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

#### *Rationale for Recommendations*

There are three moderate-quality studies that support the use of Bier block (intravenous local anesthetic) over hematoma (local infiltration) block for pain control during manipulation and reduction of displaced Colles' fracture.(1370-1372) In addition, those manipulated under Bier block were found to have better anatomic outcomes,(1371, 1372) lower remanipulation rates,(1371) and better grip strength at 6 months.(1372) Interestingly, medical staff may prefer hematoma infiltration over bier block based on perception of ease of technique, analgesia quality, and risk avoidance despite patient satisfaction and preference for Bier block.(1370) There are no quality studies comparing Bier block with any of the other techniques. Thus, Bier block is recommended as a first-line technique for achieving adequate analgesia and for potentially improving chance for better anatomic and functional outcome.

Dynamic reduction which does not require anesthesia block may hold slight advantage over hematoma block from the patient's perspective, although there is one study of moderate quality available on the topic, wherein less severe pain was reported during dynamic reduction than those receiving local infiltration.(1366) There was no difference in

reduction quality, and no longitudinal results were reported. The same author reported in a different paper, likely of the same study group, that hematoma infiltration resulted in higher subjective paresthesia or mild deficit in 2-point discrimination at 5 weeks and 1 year compared with the dynamic traction group.(1367) Hematoma infiltration provided lower pain scores during reduction and quicker onset of analgesia than patients receiving I.V. pentazocine (Talwin®) and diazepam (Valium®).(1373) Finally, in one moderate-quality study, hematoma block showed no difference with cubital block, and both were judged to be substandard.(1374)

#### *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.

## Physical Methods/Rehabilitation

### Electromagnetic Fields

*Recommendation: Use of Low Frequency Electromagnetic Fields to Stimulate Bone Healing of Distal Radial Fractures*

**The use of extremely low frequency (1-1000 Hz) electromagnetic field therapy to stimulate bone healing in patients with non-displaced fractures is not recommended.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There is one moderate-quality study of extremely low frequency (ELF) electromagnetic field (EMF) therapy, which is hypothesized to stimulate bone healing as measured by scintigraphy. The study found early increased bone activity in the first two weeks vs. control, but the differences disappeared after Week 2. In a subset of patients with displaced fractures that were re-displaced during the study, EMF of ELF resulted in higher scintimetric scores; however, the clinical significance of this finding is unknown.(1376)

#### *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.

### Exercise

Exercise is not generally indicated acutely. Some patients have deficits after casting or surgery and require exercises and rehabilitation.

1. *Recommendation: Education after Cast Removal for Acute Colles' Fracture*  
**Referral of select patients needing education after cast removal for acute Colles' fracture is recommended.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

2. *Recommendation: Use of Physical or Occupational Therapy after Cast Removal for Acute Colles' Fracture for Patients with Functional Deficits Unable to Return to Work*

**Referral of patients with functional deficits or those unable to return to work for physical or occupational therapy after cast removal for acute Colles' fracture is recommended.**

*Frequency/Duration* - In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

3. *Recommendation: Routine Referral for Physical or Occupational Therapy after Cast Removal for Colles' Fracture for Patients Able to Return to Work*

**Routine referral for physical or occupational therapy after cast removal for Colles' fracture of otherwise healthy patients who are able to return to work is not recommended.**

*Strength of Evidence – Not Recommended, Evidence (C)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendations*

There are two moderate-quality studies on the effects of physical or occupational therapy to hasten functional recovery once the cast is removed in non-surgical patients. One study, despite lack of blinding in the control group and small sample size, showed no added benefit to the addition of occupational therapy to home exercise instructions by the provider. This finding was consistent regardless of fracture angulation and functional scores.(1379) Conversely, in another study also weakened by small sample size and lack of blinding, physical therapy (passive joint mobilization) was found more effective than no therapy in increasing wrist extension and grip strength in the immediate cast removal period. However, there were no long-term measures to determine the duration of benefit in the intervention group.(1380) One low-quality study(1381) and one case series(1382) also found no functional benefit for physical therapy.

A few appointments for educational purposes for select patients are recommended. The numbers of appointments are dependent on the degree of debility, with one or 2 educational appointments appropriate for mildly affected patients. Patients with severe debility or those unable to return to work may necessitate 8 to 12 appointments that particularly emphasize progressive strengthening exercises. Additionally, while routine use may be of limited benefit, those patients who have muscle weakness or other debilities may also derive benefit from therapy including self-training exercises, particularly if unable to return to work. Therefore, occupational or physical therapy is recommended for select patients.

#### *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.

## Surgery

1. *Recommendation: Closed Reduction or External Fixation for Severely Displaced Extra-articular Fractures, Comminuted, or Displaced Intraarticular Fractures of the Distal Forearm*

**Closed reduction or external fixation is moderately recommended for treatment of severely displaced extra-articular fractures, and for comminuted, displaced intra-articular fractures of the distal forearm.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – High*

2. *Recommendation: Cast Immobilization or External Fixation for Moderately Displaced Extra-articular Fractures, Non-comminuted or Non-displaced Intra-articular Fractures of the Distal Forearm*

**Cast immobilization is moderately recommended for treatment of extra-articular fractures or distal forearm fractures that include moderately displaced extra-articular fractures, non-comminuted or non-displaced intra-articular fractures. External fixation is moderately recommended as a second option for fractures that fail reduction while immobilized.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

3. *Recommendation: Medullary Pinning As an Alternative to External Fixation*

**Medullary pinning (k-wire or intramedullary fixation techniques) is recommended as an alternative to external fixation.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

4. *Recommendation: Bone Cement As an Alternative to External Fixation*

**Remodellable bone cement (injected or open reduction) is recommended as an effective alternative to external fixation and casting.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

5. *Recommendation: Open Reduction and Internal Fixation Via Dorsal or Volar Plating*  
**Open reduction and internal fixation by either dorsal or volar plating is recommended if fracture remains unstable by other treatment methods.** There is no clear evidence of a preferential approach.

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*

6. *Recommendation: Triangular Fibrocartilage Complex (TFCC) Repair for Distal Radial Fractures*  
**There is no recommendation for or against TFCC repair associated with distal radial fractures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*  
*Level of Confidence – Low*

#### *Rationale for Recommendations*

Most comparative studies for surgical intervention of distal radial fractures includes external fixation using various named external fixators. In consideration of the topic, all studies using external fixators are considered as one particular treatment group, as few comparisons are made between individual types or brands of fixators. There are several moderate-quality studies available for this treatment. Overall, the available data is weakened by studies with small sample sizes, a lack of consistency in fracture types included in each study, and inconsistency in reported final outcomes measures (i.e., functional, radiographic) and duration of follow-up. Extra-articular fractures or distal forearm fractures that include non-displaced intra-articular fractures can be treated initially with external immobilization, using external fixation as a second option for fractures that fail reduction while immobilized. External fixation likely does not provide improved functional results in the elderly.

In consideration of support for external fixation, 5 moderate-quality studies that included either mixed fracture types or were limited to extra-articular, non comminuted and non-displaced intra-articular fracture types, generally showed equivocal or non-statistically significant positive trends in radiographic or functional outcomes when compared with casting.(1389-1393) Another moderate-quality study compared plaster cast to external fixation and found that patients with plaster casts showed significantly higher Maximum Voluntary Contraction than patients with primary external fixation on day immobilization device was removed until between 18 weeks and 1 year when the groups equalized.(1343) Therefore, there is evidence supporting non-operative treatment for these fractures using non-invasive immobilization techniques. However, for the more severe fractures, including comminuted extra-articular and displaced comminuted intra-articular types, there are 6 moderate-quality studies that support improved clinical outcomes from external fixation over casting.(1394-1399) Thus, there is strong evidence to support more invasive immobilization techniques for these more severe injuries. One exception to this may be for those over age 65, as there is one moderate-quality study that showed no difference in functional outcomes despite worse anatomical outcomes, suggesting the final anatomical outcome is less important in this age group.(1400) As there is only one study supporting this, there is insufficient evidence to make recommendation for or against greater emphasis on non-operative treatment in older populations.

Two moderate-quality comparison studies of external fixation with medullary pinning (percutaneous) resulted in mostly equivocal studies for radiographic and clinical outcomes measures,(1401, 1402) although both authors felt there were financial and post-operative care advantages with pinning over external fixation. One moderate-quality study, weakened by co-intervention differences, demonstrated improved outcomes with combined external fixation and additional k-wire fixation for displaced intra-articular fractures.(1397) If pinning is selected, there does not seem to be any difference in technique comparing Kapandji and Willenegger procedures,(1403) nor in the length of post-operative cast immobilization comparing 1 vs. 6 weeks.(1404) An alternative method for the treatment of distal radial fracture includes the use of bone cement. There are five moderate-quality studies found, although one author reported on the same study population in two different papers. The injection of remodellable bone cement, or the open reduction and use of remodellable bone cement, was shown to provide improved anatomic and functional outcomes compared to casting(1405, 1406) and external fixation(1407, 1408) and reducing immobilization time.(1409) There is only one moderate-quality study on the repair of triangular fibrocartilage complex (TFCC) with distal radial fractures.(1410) In a small sample size study limited to Frykman II and VI, closed reduction and casting had equivocal results to surgical repair. However, this study was published in 1989, prior to more recent anatomic studies and case series reports on TFCC. Therefore, no recommendation is made for TFCC repair based on insufficient evidence.

There is no quality evidence for specific internal fixation techniques in comparison to external fixation or other immobilization techniques. However, there is one moderate-quality study of two internal fixation techniques, which recommends against the use of pi-plates, which were more difficult to match properly to distal radius, and resulted in worse wrist flexion and extension outcomes than from ¼ tube plates.(1411) Thus, with insufficient evidence for comparison, there are no recommendations for internal fixation techniques.

#### *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.*

### Special Studies and Diagnostic and Treatment Considerations

There are no quality randomized trials for diagnostic testing in the evaluation of ganglia of the upper extremity. Generally, diagnosis is based on physical examination findings. Diagnosis is usually confirmed upon aspiration of mucinous fluid from the mass.

#### X-Rays

1. *Recommendation: Routine X-rays for Diagnosis of Wrist Ganglia*

**X-ray to diagnose dorsal or volar wrist ganglia in select patients is recommended.**

*Indications* – Ganglia, especially occurring in the context of trauma where fracture may be present.

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

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

2. *Recommendation: Routine Use of X-rays for Evaluation of Dorsal or Volar Wrist Ganglia*

**The routine use of x-ray to evaluate dorsal or volar wrist ganglia is not recommended.**

*Strength of Evidence* – **Not Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendations*

Patients develop ganglia for numerous reasons, ranging from trauma to arthritis to idiopathic. The threshold for obtaining x-rays should be low. Patients incurring ganglia due to trauma or other inciting events that may result in other traumatic sequelae such as fractures, dislocations, and sprains, should have x-rays. Patients incurring ganglia through non-traumatic means are candidates for initial management without x-rays. Some practitioners advocate the use of x-rays for routine evaluation of all patients with dorsal or volar wrist ganglia. However, there is no supporting evidence for this practice. In a prospective case series of 103 patients with volar and dorsal ganglia, three view wrist radiographs were obtained and a retrospective review of medical records completed. Findings on x-ray altered the course of management in 1 case (1%).(1425)

#### *Evidence for the Use of X-rays*

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.

#### MRI

*Recommendation: MRI for Evaluation of Wrist Pain with Suspected Occult Dorsal or Volar Wrist Ganglia*

**There is no recommendation for or against the use of MRI for the evaluation of wrist pain with suspected occult dorsal or volar wrist ganglia as it may be of limited benefit in deciding on the course of treatment.**

*Strength of Evidence* – **No Recommendation, Insufficient Evidence (I)**

*Level of Confidence* – Low

#### *Rationale for Recommendation*

In a small study of 20 patients with suspected occult ganglia, an MRI was obtained prior to surgical exploration and excision of the cyst. Comparison of MRI diagnosis with intra-operative findings and histological evaluation of the



excised specimen resulted in MRI scanning sensitivity of 83%, specificity of 50%, and a positive predictive value of 94%.<sup>(292)</sup> The findings suggest in the absence of palpable mass, with no history of trauma or other conditions such as arthritis, an MRI may be beneficial for the diagnosis of occult symptomatic ganglia. However, in light of the results reported by Lowden,<sup>(114)</sup> which found nearly half of the asymptomatic population have an occult ganglia, the accuracy of these findings for screening purposes are questionable and the utility of a positive result may be of less clinical consequence. MRI may be useful in distinguishing synovitis from ganglion, which may be useful in determining the course of treatment.<sup>(1427)</sup> MRI is reasonable for patients who have had persistence of pain consistent with a ganglion lasting at least 3 weeks without trending towards improvement.

#### *Evidence for the Use of MRI*

There are 4 moderate-quality studies incorporated into this analysis.<sup>(1427-1430)</sup> (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.

## Ultrasound

*Recommendation: Ultrasound for Evaluation of Chronic Wrist Pain with Suspected Occult Dorsal or Volar Wrist Ganglia*  
**There is no recommendation for or against the use of ultrasound for the evaluation of chronic wrist pain with suspected occult dorsal or volar wrist ganglia. It may be beneficial in select cases in deciding on the course of treatment.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

In a small study of 57 patients with non-traumatic wrist pain and no palpable mass, ultrasound was used to determine the presence of ganglia at the wrist – 33 patients (58%) were found to have a ganglia of which 20 were treated with excision or aspiration and improvement of symptoms after the intervention. As MRI has demonstrated the prevalence of ganglia in asymptomatic study volunteers to be nearly 50%,<sup>(114)</sup> there is likely a high probability of finding ganglia on ultrasound as well. Thus, a positive finding of ganglion by ultrasound is of unknown clinical significance, particularly in that the study did not provide long-term follow-up for all of the patients that were found to have a ganglion cyst. If ultrasound is utilized, it would appear to be reasonable among patients who have had persistence of pain lasting at least 3 weeks without trending towards improvement.

#### *Evidence for the Use of Ultrasound*

There is 1 moderate-quality study incorporated into this analysis.<sup>(1431)</sup> (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.

## Initial Care

1. *Recommendation: Non-operative Management (No Treatment) for Acute Asymptomatic Wrist and Hand Ganglia*

**The use of non-operative management (no treatment) for acute asymptomatic wrist and hand ganglia is recommended as first-line management as the natural history for spontaneous resolution is more than 50%, and in recognition of the high recurrence rate of most other treatment strategies.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are many observational studies describing the natural history for ganglia to resolve without any treatment over time. More than 50% are likely to resolve within months to years. A recently published 6-year follow-up, reported a 58% spontaneous resolution rate in patients that received no intervention.(1432) Thus, 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 trial. However, patients may wish to have an intervention for cosmetic relief, and have reported higher satisfaction despite the higher risk of surgical or interventional complications.(1432)

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.

2. *Recommendation: Aspiration (without Other Intervention) for Acute Cosmetic and Ganglia Related Pain*  
**Aspiration (without other intervention) of the cystic fluid is recommended as it may result in immediate relief of acute cosmetic and ganglia related pain.**

*Duration* – One aspiration is recommended.(1433) However, a long-term course of aspiration is usually of no benefit in terms of resolution. There is no recommendation on how many times aspiration should be attempted before advancing to other intervention. Variants of simple aspiration include steroid injection, splinting, multiple punctures, hyaluronidase, and sclerosing agents, reviewed below.

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

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.*

3. *Recommendation: Aspiration with Steroids*  
**There is no recommendation for or against the addition of steroids with aspiration.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendations*

Aspiration with instillation of steroids is the most common treatment for upper extremity ganglia. Recurrence rates range from 14 to 83%. There are no quality studies that compare simple aspiration with the addition of steroids; thus, no quality evidence to address whether this results in potential benefits. However, a review of cohorts has shown an average recurrence rate of 51% for aspiration alone, and a recurrence rate of 52% with aspiration and steroids.(118) As the cystic structure has been shown histologically and with electron microscopy to have no synovial lining, but rather a network of collagenous fiber layers, there is little theoretical reason to believe that steroid agents would result in reducing inflammation, as there is theoretically no tissue in the cyst to be inflamed. There is no recommendation for or against steroids when aspiration is used for immediate relief.

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.*

#### 4. *Recommendation: Aspiration and Multiple Punctures of Cyst Wall*

**The technique of multiple punctures of the cyst wall is not recommended as it does not provide improved benefit over simple aspiration.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There is one quality study comparing simple aspiration with multiple wall punctures,(1434) which did not show any significant difference in efficacy. A review of non-RCT studies comparing aspiration with multiple punctures showed an average of 64% recurrence rate, which is worse than aspiration alone.(118) Thus, there is no added benefit to making multiple punctures in the cystic wall, and may result in additional skin trauma and higher risk of infection, making this intervention not recommended.

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.*

#### 5. *Recommendation: Splinting after Aspiration for Acute or Subacute Dorsal or Volar Wrist Ganglia*

**There is no recommendation for or against the use of splinting after aspiration for the treatment of acute or subacute dorsal or volar wrist ganglia as splinting may have uncertain efficacy and may lead to prolonged joint stiffness.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies comparing immobilization as an adjunct treatment. In a prospective series, immobilization after aspiration was not found to be of any significant benefit compared those without immobilization in a 1-year prospective study of volar, dorsal and digital ganglia.(1435) However, in an earlier study including multiple punctures, immobilization had a positive effect for successful outcomes.(1436) These conflicting results, in the absence of quality experimental data, preclude making recommendation for or against this intervention.

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.

#### 6. *Recommendation: Hyaluronidase Instillation after Aspiration*

**There is no recommendation for or against the instillation of hyaluronidase into the cystic structure after aspiration.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

One moderate-quality study compared the standard therapy of aspiration and steroids with the addition of hyaluronidase to the mixture.(1437) Although the study showed a positive effect on the patient reporting for excellent results, it was not statistically significant for good and excellent combined between the two groups. Thus, there is insufficient evidence for recommendation for or against this intervention.

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.*

#### 7. *Recommendation: Aspiration and Sclerosing Agents*

**Sclerosing agents such as phenol and hypertonic saline, which when instilled are intended to result in scarring and closure of the cystic potential space, are not recommended.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

As the cystic structure as described histologically and with electron microscopy have determined there is no synovial lining, rather a network of collagenous layers, there is little theoretical reason to believe that sclerosing agents would result in inciting an inflammatory reaction. In one small prospective study of 29 patients in Africa, 2cc of hypertonic saline injected into the cyst structure after aspiration was reported to result in only one recurrence after a 2-year follow-up.(1438) A small study of 10 patients treated with phenol injection was reported with good results.(1439) From anatomic studies, it has been shown that the cystic structure is connected to the synovial space in some cysts, so that there is some theoretical risk that instilling sclerosing agents will directly enter into a joint with resultant poor consequences. Thus, these therapies are only reported in small studies with higher risk of causing harm, and are not recommended.

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.*

8. *Recommendation: Surgical Excision for Subacute or Chronic Upper Extremity Ganglia*  
**Surgical intervention is recommended for treatment of subacute or chronic upper extremity ganglia after a trial of non-operative management.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

Surgical intervention is the most effective treatment method for upper extremity ganglia despite the significant recurrence rates and higher risk of complications.(115, 1433, 1440-1442) (Head 15; Tadjerbashi 14) As most upper extremity ganglia are asymptomatic, consideration of surgical risks and a trial of non-operative management are prudent before performing a surgical procedure for cosmetic reasons. One moderate-quality study exists comparing the recurrence rates of surgery to aspiration with steroids.(115) With a sample size of 28 dorsal ganglia, the success rate at 6 months was significantly higher with surgery (82% vs. 38%, p <0.05). The generalizability of the study is limited because of the small sample and the exclusion of other ganglia types. The success of surgery reported in non-randomized prospective case series suggest an overall recurrence rate between 5% and 40%. More recent surgical techniques that include comprehensive dissection and excision of the cyst, pedicle, and a cuff of the adjacent joint capsule are believed to have better results.(118)

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.

#### 9. Recommendation: Arthroscopic versus Open Excision

**There is no general indication for one surgical technique (arthroscopic or open excision) over another for all cases and both are recommended.** There may be advantages of arthroscopic procedures for ganglia originating in the radiocarpal joints, whereas open excision may have advantages in ganglia originating in midcarpal joints, although both have the same success rate.

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

#### Rationale for Recommendation

There are two moderate-quality studies comparing open excision to arthroscopic resection of wrist ganglia. In both studies, rates of recurrence were low and not significantly different,(1443, 1444) thus showing no clear advantage for either technique. However, when comparing outcomes results for lost time, complications and functionality, arthroscopic excision of radiocarpal ganglia had faster recovery time and fewer complications than open excision, whereas open excision had better recovery and fewer complications than arthroscopic excision for midcarpal ganglia.(1444) However, these conclusions are weakened by small sample size and lack of statistical analyses to make recommendation for or against difficult. In a non-randomized trial,(116) the effectiveness of arthroscopic excision of dorsal ganglia in a 2-year follow-up study demonstrated 5% recurrence, although failure with arthroscopy was treated with open excision.

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)

## Follow-up Visits

Because of the natural course of spontaneous resolution and recurrence, follow-up should be dictated by the course of treatment selected by the patient and physician.

## Prescription Medications

No prescription medications are shown to be effective for treatment of upper extremity ganglia. By inference from other musculoskeletal conditions, NSAIDs may be of benefit as an analgesic for ganglia associated wrist pain, although there is no evidence of their efficacy.

### *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: 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.

## Physical Methods/Rehabilitation

### Exercise

Exercise is not generally indicated acutely. For those with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders.

### *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, 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.

## Hand Arm Vibration Syndrome (HAVS)

### Special Studies and Diagnostic and Treatment Considerations

Currently there is no “gold standard” for the diagnosis and staging of hand-arm vibration syndrome (HAVS). Most authorities have adopted the Stockholm workshop scale(1448, 1449) which is subjective and relies on patient recall.(1450) This subjective system presents problems with reliability, particularly from patients pursuing compensation claims, which has been demonstrated in at least one study of persons reporting HAVS-related Raynaud’s phenomenon and submitting photographs of their hands during an active episode for review. Approximately 50% of the study population that reported to have captured their episode did not have supporting photographic evidence for what they were reporting.(1451)

In the pursuit of objective testing, there are a number of reported physical methods that attempt to provide measurable physiologic changes to support the diagnosis of HAVS. For measurement of vascular changes, the cold provocation test (CPT) has long been a cited maneuver. CPT is conducted by immersing the hands in water at 10° C-15° C for 10 minutes, and comparing skin temperature recovery at 5 and 10 minutes with baseline prior to the cold water bath. The observer also looks for signs of blanching or white finger. There are several variations of this technique, which include adding more sophisticated temperature measurement instruments for measurement of finger skin temperature (FST) changes, or thermographic studies such as with infrared and dynamic infrared imaging. Finger systolic blood pressure (FSBP) measurement has also been described. Each of these tests attempts to reproduce or measure vascular changes associated with cooling.(1452-1456) Neurological testing has also been described through various methods. Most include measurement of sensory and motor functions, rather than nerve conduction or EMG studies. These tests include vibrotactile threshold tests, thermal aesthesiometry, grip strength, and dexterity testing.

*Recommendation: 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*

**There is no recommendation for or against the use of a 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 (HAVS).**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendations*

Despite the widespread acceptance of physiologic testing, there are no quality RCTs comparing the utility of diagnostic methods for HAVS. Furthermore, there is poor correlation of these various physiological tests with the Stockholm workshop scales,(1457) and a general inability of these tests to reliably differentiate HAVS from controls.(1458, 1459)

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, never



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.

1. *Recommendation: Serologic Tests (Thrombomodulin, Soluble Intracellular Adhesion Molecule 1 [s1-CAM 1]) to Diagnose Hand Arm Vibration Syndrome*

**Serologic tests – thrombomodulin, soluble intracellular adhesion molecule 1 (s1-CAM 1) – are not recommended to diagnose HAVS.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

2. *Recommendation: Testing for Connective Tissue Disorders to Diagnose Hand Arm Vibration Syndrome*

**There is no recommendation for or against the use of testing for connective tissue disorders to diagnose HAVS.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

*Rationale for Recommendations*

There are no quality randomized studies on the utility of serologic testing or connective tissue disorders testing for HAVS. There does not appear to be any serologic tests that currently provide objective evidence or staging of HAVS. Objective serum tests, such as levels of soluble thrombomodulin (sTM) and soluble intercellular adhesion molecule-1 (sICAM-1), may provide some utility in the future as they have been shown to be statistically different in exposed groups with HAVS symptoms, but the usefulness is hampered currently by the lack of clear reference ranges,(1450) as each of the measurements for both comparison groups were still in the range considered normal. Testing for other causes of Raynaud's phenomenon, particularly connective tissue disorders such as scleroderma and systemic lupus erythematosus may be beneficial when occupational exposure histories are not consistent with clinical presentation and the threshold for such testing should be low.

*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, never 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.

## Initial Care

There are no quality randomized clinical studies for the treatment of physiologic manifestations associated with HAVS. The most prudent form of treatment is to first remove or reduce the exposure to vibration, particularly in the earlier stages of symptom presentation. Smoking has been identified as a risk factor for HAVS.(1473) By inference, smoking cessation is a frequent recommendation to patients with HAVS. The effects of smoking on HAVS, if any, are thought to be a result of chronic platelet function inhibition,(1474) effects on the microvasculature and that of nicotine on smooth muscle function. However, there is no quality evidence that smoking cessation will affect the course. **As a risk factor, smoking cessation is recommended.**

Other common advice based on the proposed pathophysiology of vasospasm includes avoidance of beta-blockers, sympathetic stimulants including caffeine, decongestants, amphetamines and even cocaine 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.

## Follow-up Visits

There are no recommendations in the literature for the frequency or duration of follow-up visits. A few follow-up appointments to evaluate results of non-invasive measures, exposure avoidance, and serologic testing are indicated.

## Prescription Medications

There are no quality studies of medications that prevent or improve symptoms related to HAVS. As the vascular component of HAVS mimics other causes of Raynaud's phenomenon, calcium channel antagonists, which have positive benefit for many with non-vibration related cases, are often prescribed for HAVS.

### Calcium Channel Blockers

*Recommendation: Calcium Channel Blockers for Advanced Subacute or Chronic Hand Arm Vibration Syndrome*  
**Use of calcium channel blockers (nifedipine) for treatment of vascular symptoms similar to Raynaud's phenomenon is recommended for advanced subacute or chronic HAVS.**

*Indications* – Patients with HAVS. Generally used in patients with sufficient symptoms such that removal from exposure is insufficient for management.

*Frequency/Dose* – Per manufacturer's recommendations; generally initiated with low dose. Blood pressure should be monitored and may require lower doses, especially among those without higher blood pressures or among those with adverse effects.

*Discontinuation* – Resolution, intolerance, adverse effects.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

#### *Rationale for Recommendation*

There is no quality evidence for the use of calcium channel blockers in HAVS population. It is a commonly accepted treatment for Raynaud's phenomenon associated with connective tissue diseases with moderate benefit. A review of all calcium channel antagonist trials for non-HAVS Raynaud's is beyond the scope of this text. Rather, as this medication is already frequently used for advanced HAVS, and with the lack of other treatments available, it may be considered a treatment for symptomatic patients once exposure sources are reduced or eliminated and other personal health measures have started.

#### *Evidence for the Use of Calcium Channel Blockers*

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.

## Physical Methods/Rehabilitation

### Exercise

Exercise is not generally indicated. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

#### *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, 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.

## Laceration Management

### Special Studies and Diagnostic and Treatment Considerations

There are no quality studies on diagnostic testing for the evaluation of wounds with lacerations. However, among the minority of wounds of sufficient severity, the use of imaging to rule out traumatic injury to bone or other structures is generally considered effective and well established. Yet, detection of retained soft tissue foreign bodies remains a clinical dilemma, with one study reporting up to 38% of foreign bodies in hand wounds going undetected by the initial provider, resulting in the second-leading cause of lawsuits in emergency medicine.(1475) Furthermore, if nerve injury is detected or suspected, then EDS may be indicated 2 to 3 weeks post-injury. An immediate EDS is not recommended as Walerian degeneration will not have been completed until at least 2 weeks post-injury, making earlier studies falsely normal.

### X-Rays

*Recommendation: X-rays for Evaluation of Lacerations with Suspected Fracture or Foreign Body*

**X-rays are recommended for the evaluation of traumatic injury resulting in skin lacerations to rule out fracture or if a radiopaque foreign body is suspected.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### *Evidence for the Use of X-ray*

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.

## Ultrasound

*Recommendation: Ultrasound for Evaluation of Suspected Superficial Foreign Bodies*

**Ultrasound is recommended for evaluating suspected radiolucent materials or as an alternative test when radiopaque foreign body is suspected but not detected on x-ray images.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Evidence for the Use of Ultrasound*

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.

## CT

*Recommendation: CT for Evaluation of Suspected Superficial Foreign Bodies*

**There is no recommendation for or against the use of CT for suspected superficial foreign bodies. CT is not routinely recommended, but may be indicated 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.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Evidence for the Use of 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: 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.

### *Rationale for Recommendations*

Most work-related lacerations presenting to clinics are too superficial to involve the bone or joints. However, if the injury mechanism or location of injury suggests a possibility of fracture, x-rays are indicated (see specific fracture sections for further recommendations). There are no quality studies of imaging techniques for the evaluation of suspected foreign bodies. If a foreign body is suspected, additional diagnostic testing should be considered dependent on the suspected foreign body type. For suspected radiopaque substances such as metals or glass, traditional x-ray reliably detects the foreign body 80 to 95% of the time.(1475) However, x-ray images do not reliably detect radiolucent foreign bodies such as wood, plastic, or vegetative material.

Ultrasound is increasingly being utilized for the evaluation of suspected radiolucent foreign bodies,(1475) although there are no quality studies available. There are several case series and cadaver studies(1480-1484) providing reports of high sensitivity, although there are also a small number of false positives related to tendons or other

artifacts. CT has reported high sensitivity for radiopaque substances, and moderate sensitivity for radiolucent materials. Because of increased costs, higher radiation exposure, with intermediate sensitivity, CT may be best used when a foreign body is suspected but not detected by x-rays or ultrasound. MRI is not indicated for evaluation of metallic foreign bodies in particular.

## Treatment

As previously stated, optimal results are accomplished by preventing infection through thorough wound cleansing, approximating wound edges with appropriate closure techniques, and providing a clean, moist environment to accelerate wound healing. If nerve injury is detected or suspected then appropriate surgical consultation should be considered.

## Wound Preparation

Infection is one of the primary factors that interfere with wound healing. Contamination of the wound from inoculation of skin flora or environmental bacteria, foreign bodies such as gravel, vegetation, dirt, and other industrial related compounds can act as a nidus for wound infection. Adequate wound anesthesia may be required for wound preparation. Anesthetic technique is reviewed later in this section.

1. *Recommendation: Wound Cleansing, Irrigation, and Debridement*

**Meticulous wound preparation after appropriate anesthesia using saline irrigation or copious amounts of running tap water, scrubbing, and debridement of devitalized tissue is recommended.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

2. *Recommendation: Wound Irrigation with Sterile Saline or Tap Water*

**The use of either sterile saline or tap water is recommended for an irrigating solution.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – High*

3. *Recommendation: Sterile or Clean Glove Use During Wound Cleaning*

**The use of either sterile or clean gloves during wound cleaning is recommended.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – High*

### *Rationale for Recommendations*

Wounds become infected when they contain more than  $10^5$  bacteria per gram of tissue.(1485) As there is no test to determine the immediate bacterial load of a particular laceration, it seems prudent that all wounds should undergo some form of cleansing to decrease the amount of soil or presence of small foreign bodies to reduce the inoculation of bacteria and prevent infection. There are no quality studies comparing infection rates in wounds that are irrigated vs. non-irrigated or cleansed. However, it is widely accepted that irrigation and cleansing are best practice. Therefore, although there is a lack of quality evidence, wound cleansing, irrigation, and debridement are recommended. Optimal irrigating solutions and techniques are more controversial.

There is moderate evidence that irrigation solution does not make a significant difference in infection rates of routine laceration management. A high-quality study comparing tap water to sterile saline in a pediatric population showed no difference in infection rates at 48 hours.(1486) Another moderate-quality study of 715 lacerations randomized to irrigation under regular tap water vs. sterile saline using pressure syringe irrigation also found no significant difference in infection rates.(1485) Patients enrolled in tap water irrigation were instructed to wash their wound under regular tap water (U.S. location) for a minimum of 2 minutes. However, the power of these studies to detect differences in infection rates may be too low to conclude inferiority. On balance, there appears to be no difference in infection rates between the common practice of using sterile saline for routine laceration repair or

using regular tap water for uncomplicated extremity lacerations and either wound irrigation with sterile saline or tap water is recommended. There is no quality evidence supporting the use of concentrated povidine-iodine solution instillation into the wound, although a low-quality study suggests some benefit in reduced infection rates,(1487) another low-quality study found no difference in infection rates between normal saline, povidine, and Shur Clens®.(1488) There is some concern that concentrated povidine-iodine, hydrogen peroxide, and detergents may cause tissue toxicity.(195)

There are no quality studies on irrigation pressures. High-pressure irrigation may result in increased trauma.(195) Optimal pressures of 5 to 8 psi generated by large syringe and 16- to 19-gauge needle have been recommended.(195) One moderate-quality study compared a commercial pressurized canister irrigation system with a standard syringe and 20-gauge catheter at maximal plunger force using saline and benzalkonium chloride.(1489) The study had weaknesses but found no difference in infection rates or soft tissue trauma between the groups. The only advantage was that irrigation times were shorter (3.9 versus 7.3 minutes) using the canister.

For lacerations that involve skin areas where significant hair may hamper closure efforts, removal by clipping rather than shaving is commonly suggested to reduce potential sources of contamination resultant from disturbing bacteria on hair shafts, although there is no evidence to support this method in routine laceration repair. Debridement of devitalized tissue through surgical excision and scrubbing may also reduce the risk of infection. Generally, sterile technique has been recommended. However, there is one large moderate-quality study of 816 lacerations that showed no difference in infection rates in repair using sterile gloves versus non-sterile clean gloves,(1490) thus either is recommended.

#### *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.

## **Wound Anesthesia**

Wound anesthesia is commonly obtained after completing a sensory examination through local infiltration, digital nerve block or topical application of anesthetic preparations. Anesthetic technique is most commonly performed based on wound location and the preference of the treating health care professional.

1. *Recommendation: Local Infiltration plus Topical Anesthetic or Digital Block for Finger Laceration Repair*  
**Adequate anesthesia by either topical anesthetic plus local infiltration or digital block is moderately recommended for finger laceration repair. There is no recommendation of one technique over the other. For distal finger lacerations, digital block may be substantially less painful than local infiltration performed without topical anesthetic. If the operator and patient preference is digital block, the various techniques are described and evaluated in the management of phalangeal fracture section in this guideline.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

2. *Recommendation: Local Infiltration for Extremity Wound Repair*

**Instillation of local anesthetic for extremity wounds after sensory testing is recommended as the first-line technique for most laceration repairs unless the size or complexity would require potentially toxic doses of local anesthetic. Local anesthetic with epinephrine (except digits) is recommended.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*

3. *Recommendation: Topical Anesthetics for Lacerations*

**The use of topical anesthetics, Tetracaine-Adrenaline-Cocaine (TAC) and EMLA, are recommended as an alternative to local infiltration for lacerations of the extremities (excluding digits) or as pre-treatment to reduce pain related to needle infiltration. However, these anesthetics have longer times to onset of effective anesthesia.**

*Strength of Evidence – Recommended, Evidence (C)*  
*Level of Confidence – Low*

*Rationale for Recommendations*

There are numerous quality studies of different anesthetic techniques for management of laceration repairs of the finger. There is one high-quality and one moderate-quality study comparing local infiltration to digital block for finger lacerations. However, in the high-quality study, both received topical anesthesia which may have otherwise confounded the results. The authors found no difference in pain of providing anesthesia or quality of anesthesia between the two techniques.(1491) Digital anesthesia was preferred by providers and patients for both the application and quality of anesthesia in a moderate quality study,(1492) although it was uncertain if the comparison groups had similar baseline pain. Although there may be a modest advantage to digital anesthesia, there is not enough evidence to support one technique over the other, and both are recommended based on operator and patient preference.

There is one quality study that compared topical anesthetics with placebo,(1493) and that trial demonstrated efficacy, although it is a remote study utilizing Tetracaine-Adrenaline-Cocaine (TAC) and topical lidocaine. However, there are many trials comparing different topical agents. Topical anesthetics are applied to provide analgesia for subsequent local infiltration, or to provide anesthesia for wound repair. Topical anesthetics used for laceration repair without local infiltration are best used in highly vascularized regions, although they have also been used successfully in the extremity. In the past, TAC has been used effectively,(1493-1495) but concerns of toxicity have resulted in the development and use of non-cocaine containing products. Lidocaine-Adrenaline-Tetracaine (LAT, LET) and EMLA are now the primary topical anesthetics used in the United States. LAT has been shown to be more effective than TAC in one high-quality study(1496) for topical anesthesia and as effective in another high-quality study(1497) for topical pre-treatment for infiltration. EMLA was also shown to be more effective for topical anesthesia than TAC in a moderate quality study.(1498) There is one high-quality study comparing EMLA and LAT for topical anesthesia that demonstrated equal efficacy, with a slight advantage to LET in the time to achieving anesthesia.(1499) Thus, there is sufficient evidence to support the use of LAT and EMLA for pretreatment and for primary anesthesia in select wounds in adult populations.

Although local infiltration is the most common technique, there are no quality studies of local anesthetic infiltration versus placebo. Nor are there any quality studies comparing topical anesthetics to local infiltration or nerve blocks. As local infiltration is the gold standard for most wound repair, and the failure of topical anesthetics is treated by local infiltration or nerve block in complicated wounds, there is no recommendation for the use of topical anesthetics over local infiltration.

There is one high-quality study comparing lidocaine solutions with buffering, the addition of epinephrine, and the use of diphenhydramine as an alternative(1500) for upper extremity wounds. Lidocaine with epinephrine with or without buffering was preferred by patients over diphenhydramine or buffered solutions without epinephrine. This result contradicts with common anecdote of using buffered solutions to reduce injection pain.

### *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.

## **Wound Repair**

Wound repair is most commonly performed through primary closure (immediate approximation of the wound edges) to reduce discomfort and speed healing. Closure of most low-risk wounds can occur 12 to 24 hours after the injury. Contaminated wounds or those at high risk of infection should be closed within 6 hours.<sup>(151)</sup> Wounds outside of these parameters can be treated by delayed primary intention after 2-3 days of antibiotics reducing risk for subsequent infection. Sutures are the most common method, followed by staples, adhesives, and tapes.

### *1. Recommendation: Non-surgical Management of Non-complicated Hand Lacerations Less than 2cm in Linear Length*

**It is recommended that non-complicated linear lacerations of the hand less than 2cm be managed without suturing by healing via secondary intention for some workers. Wounds should be carefully selected, not have tension, including not overlying or near joints and not have tension applied due to manual labor.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

### *2. Recommendation: Surgical Referral for Hand Lacerations with Evidence of Nerve Injury*

**Immediate referral to a surgeon is recommended if the laceration shows evidence of a nerve injury.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

### *3. Recommendation: Suture Repair for Hand or Forearm Lacerations*

**Suture repair is moderately recommended for lacerations of the hand or forearm as these lacerations respond well to common suture techniques and suture materials. There are no recommendations for one technique over another or for one suture material type over another.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

### *4. Recommendation: Use of Tissue Adhesive, Staples, and Surgical Tape (Steri-Strips) for Uncomplicated Laceration Repair*

**Tissue adhesives, staples and surgical tape are moderately recommended for routine skin repair of non-complicated extremity lacerations within the limitations of repair strength equivalent to 5-0 suture material or higher.**

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

## *Rationale for Recommendations*



There is one moderate-quality study comparing suture repair with non-surgical treatment (secondary intention) for hand lacerations less than 2 cm in length and uncomplicated by underlying joint, tendon, fracture, or nerve injury or medical conditions that would affect healing.(1501) There were no differences between the groups in cosmetic appearance, return to activity, or infection. As many hand lacerations are small and uncomplicated, this study suggests non-surgical management for non-gaping uncomplicated lacerations of the hand may be appropriate. Although, a comprehensive recommendation for working populations is not made as the provider should consider tensile forces on the wound and other environmental exposures resultant from occupational duties that likely reduce the ability to use non-surgical management for some patients in making a treatment decision.

There are no quality RCTs of upper extremity wound lacerations comparing suture repair with healing by secondary intent for gaping lacerations exceeding 2cm in linear length. However, wound closure most commonly by suture techniques has been long performed making suture repair the basis for other comparison studies. Therefore, although there is a lack of supporting studies, suturing is considered first line for laceration repair, with the strength of other repair recommendations made against using secondary intent in non-infected wounds.

Various suture techniques have been described to provide the approximation of skin margins. However, there is a relative lack of quality studies that are methodologically sound while also having sufficient follow-up time of greater than one year to derive robust conclusions regarding the relative merit of different suturing techniques. Optimal results are thought to be dependent on skin edge eversion to eliminate depressed scarring, elimination of dead space and minimization of tension of individual sutures to avoid tissue necrosis. Common techniques include simple interrupted, vertical mattress, and running sutures. There are two moderate-quality studies of suture techniques, although there were no direct comparisons between the common techniques. Two versions of vertical mattress were compared with no difference in outcomes in a low quality study.(1502) Simple running cutaneous suture was compared with running subcutaneous sutures (removed at 14 days and not removed non-absorbable suture) and subcutaneous polygalactin (absorbable) running suture for treatment of post-elliptical excisions, rather than traumatic lacerations.(1503) There were short and intermediate advantages of polygalactin vs. polypropylene subcutaneous sutures, which disappeared at 9 months. This study, however, may not be generalizable to laceration repairs. Comparison of single layer vs. bi-layer repair for minor lacerations showed no difference in cosmetic results, although this was a study of facial lacerations, and may not be applicable even though the face is considered cosmetically more sensitive than the extremity.(1504) Therefore, there is no quality evidence to recommend one technique over another, and there are multiple scenarios that one technique might offer technical advantage over another, so that the operator focus may best be on principles for assuring optimal results.

There is also a lack of quality data comparing suture types for extremity laceration repair. The available cosmetic studies are both methodologically weak and have inadequate follow-up times to derive clinically meaningful differences on cosmesis.(1505) One moderate-quality study showed comparability of absorbable catgut to nylon sutures for simple repair.(1506) A low-quality study showed no difference between absorbable suture with nylon suture.(1507) A systematic review in pediatric and adult populations of absorbable vs. non-absorbable sutures did not find superiority of one over the other.(1508) Another moderate-quality study compared Teno Fix<sup>®</sup> repair, which uses a multifilament stainless steel suture, to a simple repair with cruciate suture for flexor tendon lacerations and found that repairs with the Teno Fix<sup>®</sup> had lower rupture rates and similar functional outcomes when compared with conventional repair.(1509) Thus, there is insufficient quality evidence to make a recommendation for or against the use of absorbable or non-absorbable suture material for superficial closure of extremity lacerations.

In addition to evaluating different types of sutures, one moderate-quality study compared suturing to stapling and concluded that stapling is more cost-effective than sutures. However, no outcomes measures for cosmetic results or complications were presented.(1510)

There are 17 moderate-quality studies comparing tissue adhesives with standard suture repair of routine extremity lacerations that have shown at least equivalent or superior cosmetic results with no statistically significant increase in infections, dehiscence rates, or other complications.(151, 1511-1528) Advantages to using tissue adhesives also include elimination of the need for local anesthesia, significant reduction of repair time, and ease of performing the

procedure saving on visit time over suture repair. Disadvantages of wound characteristics (especially depth and length) and occupational tasks requiring considerable tension are considerable in working populations and are discussed below.

The most commonly used tissue adhesive is octylcyanoacrylate also known as Dermabond®. The other major glue is N-butyl 2-cyanoacrylate, also known as Histoacryl® and Histoacryl Blue® which has a blue tint for reported easier application.(1529) are only two direct comparisons of the compounds, which showed no difference in outcomes measures.(1530, 1531)

In each of the studies which included traumatic and surgical wounds of the hands, upper extremities, trunk and face in both pediatric (1-18 years of age) and adult populations, wound characteristics were usually limited to non-crush injuries, less than 4 cm in length, less than 5mm deep, and without other complicating factors including history of keloid or other scarring disorders, diabetes mellitus, corticosteroid or other immunosuppressant use, or debilitating illnesses. Thus, the results of equivalency in treatment may not be applicable to many with work-related upper extremity lacerations.

Tissue adhesive was also compared to the use of Steri-Strips in 7 moderate-quality studies as either a primary comparison(1527, 1528) or as part of the “standard care” treatment arm. (1512, 1516, 1519, 1522, 1523) In each trial, Steri-Strips were found to be equivalent in efficacy to tissue adhesive with the same inclusion and exclusion criteria. Tissue adhesive was also compared with the use of skin stapling in 5 moderate quality studies(151, 1513, 1516, 1522, 1523) as part of the non-surgical treatment arms. In each of these studies, the results were equivalent in all outcomes measures.

Therefore, there is strong evidence that tissue adhesives, skin stapling, and adhesive tapes are effective in the repair of routine lacerations of the upper extremity provided they are used on skin areas that are not subject to significant tension (i.e., joints, creases in hand, etc.). In appropriate cases, these have the added advantage of reduced operator or procedural time and material costs compared with suture repair.

#### *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.

## **Follow-up Wound Care**

### *1. Recommendation: Semi-occlusive or Occlusive Dressing of Wounds*

**There is no recommendation for or against the use of semi-occlusive or occlusive dressing for wounds. The use of semi-occlusive dressings is commonly used although there is little evidence that this practice improves infection rate or cosmetic outcomes. Dressings may be more indicated based on potential contamination at work or other workplace exposures.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*  
*Level of Confidence – Low*

### *2. Recommendation: Routine Wound Recheck by Health Professional*

**It is recommended that complicated wounds repaired with sutures or staples and heavily contaminated or infected at initial presentation be closely followed-up within 24 to 72 hours and at suture removal.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *Rationale for Recommendations*

There is no quality evidence on proper wound dressing of upper extremity lacerations, the timing and necessity of wound recheck by a health professional, and the timing of suture removal. Upon completion of wound repair, common practice remotely was to cover the wound with semi-occlusive non-adherent dressing for 24 to 48 hours with topical antimicrobial product.(1538) Based on two reports from the 1960s, it was common practice is to keep the wound moist, which was thought to promote re-epithelialization, and reduce risk of infection. However, there are no quality trials supporting this practice and some question the concept.(1539-1541) Current practice is to minimize the use of these dressings for most lacerations to promote movement and use of injured body part(s) and frequently involves the use of bacitracin or poly-antibiotic ointment.

There is one related moderate-quality study comparing infection rates after dermatological excision and repair of wounds that were either left uncovered after 12 hours and allowing normal bathing vs. those that were kept dry under bandage for 48 hours. In this post-surgical population of 857 patients, there was no statistical difference in the infection rate, demonstrating that wounds can be uncovered and allowed to get wet in the first 48 hours without significant risk.(1542) However, it is unclear if traumatic lacerations would react different from surgically controlled wounds so no recommendation is made for or against use of occlusive or semi-occlusive dressings. Physician discretion is indicated dependent on the wound and characteristics of workplace exposures of the wound.

Wound care instructions are usually provided verbally or in written format including information on monitoring for signs of infection. There are no studies on post-repair infection rates comparing persons who have received verbal or written instructions with those that return in 24 to 48 hours for a wound check. However, there is one case series of 433 patients that on follow-up evaluation were asked to rate their wound based on wound care instructions provided for signs of infection. On physician examination, 21 were deemed to have a wound infection. Of these 21, 10 patients did not rate their wound as infected giving a false negative rate of 48% (10/21), although the false positive rate was low at 8%. It is, however, uncertain if these would have resolved or resulted in serious infection, as the follow-up visit occurred at different times, including suture removal. Thus, providing wound care instructions is likely useful, costs little except additional provider time, and may prevent serious infections from going undetected. Routine wound check at 24 to 72 hours is also a common practice and is recommended for complicated wound repair, those that are contaminated or with suspicion of retained foreign bodies, already infected at initial presentation, or if patient is working in unclean environments.(403)

Suture removal for optimal results in upper extremity lacerations is not well defined by quality studies. Common practice is removal of sutures or staples in cosmetically sensitive areas with low tension in 3 to 5 days, 1 week in lower tension areas on the upper extremities, and 10 to 14 days in high-tension areas.(151, 403, 1543) Wounds closed with cyanoacrylates or surgical tape are less likely to have concerns and follow-up may not be needed except for documentation of healing for patients in workers compensation systems.

#### *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.

## Prescription and Other Medications

### Antibiotic Prophylaxis

*Recommendation: Antibiotic Prophylaxis in Uncomplicated Hand and Forearm Lacerations*

**Routine antibiotic prophylaxis is not recommended for uncomplicated hand and forearm lacerations.**

*Strength of Evidence – Not Recommended, Evidence (C)*

*Level of Confidence – Moderate*

### Topical Antimicrobials

*Recommendation: Use of Topical Antimicrobials for Wound Care*

**There is no recommendation for or against the use of topical antimicrobials for wound care as there is little evidence that this practice improves clinical infection rate or cosmetic outcomes.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendations*

There are two moderate-quality studies conducted over 25 years ago that demonstrated no difference in infection rates between no treatment or placebo and prophylactic oral doses of clindamycin, flucloxacillin, trimethoprim, and aerosolized povidone – iodine applied directly into the wound.(1544, 1545) However, one moderate-quality study did find that wound irrigation with penicillin provided reduced rates of wound infection.(1546) Each of these studies had significant weaknesses, and strong conclusions cannot be drawn. Two low-quality studies of cephalexin and clindamycin demonstrated no improvement in infection rates but are excluded from the analysis because of lack of study details.(1547, 1548) There are no quality data or recent data on newer broad-spectrum antibiotics for prophylaxis. Adequate irrigation, cleansing, and debridement of non-complicated wounds is therefore recommended as first line treatment to prevent infection, whereas antibiotic prophylaxis is not recommended unless other complicating factors warrant.

The use of topical antimicrobials is also common, but it is controversial. A high-quality study(1549) demonstrated a lower infection rate in wounds treated with topical antibiotics vs. petroleum ointment, although the control group's treatment may preclude strong conclusions. Although there was lower incidence of infection in the active antimicrobial arms vs. petrolatum, the infection rates were similar to other reported incidences that did not use any ointment. It is not possible to determine if the use of antimicrobial is efficacious, or if the use of non-antimicrobial ointment may increase infection risk. Thus, there is insufficient evidence to recommend for or against the use of topical antimicrobials, although they are generally inexpensive, easy to apply, and have relatively low risks for adverse effects. Wounds closed with tissue adhesives should remain uncovered, and application of ointments or antimicrobials should be avoided to reduce risk of dehiscence.(403) An additional concern is that neomycin is considerably allergenic, thus neomycin-containing compounds may have a relative disadvantage.

#### *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.

### **NSAIDs/Acetaminophen**

*Recommendation: NSAIDs or Acetaminophen for Upper Extremity Post-laceration Repair*

**NSAIDs or acetaminophen are recommended to control pain associated with upper extremity post-laceration repair.**

*Indications* – Pain due to upper extremity post-laceration repair.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects, particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

#### *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, 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.

### **Opioids**

See Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol) in Carpal Tunnel Syndrome section.

## **Physical Methods/Rehabilitation**

### **Exercise**

Exercise is not indicated acutely. For a few patients with major trauma, or complex wounds, exercise in the recovery period is necessary. For patients with residual deficits, particularly post-operatively, see section on Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has

been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

#### *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: 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.

## Human Bites, Animal Bites and Associated Lacerations

### Special Studies and Diagnostic and Treatment Considerations

#### Wound Culture

*Recommendation: Routine Wound Culture and Sensitivity of Animal and Human Bites*

**Routine culture and sensitivity of animal and human bite wounds is moderately not recommended as it has not been shown to be an effective predictor for infection or subsequent treatment of infected wounds.**

*Strength of Evidence – Moderately Not Recommended, Evidence (B)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

There is 1 high-quality study and one moderate quality study of primarily animal, but also included some human bites where uncomplicated bite wounds were routinely cultured prior to treatment assignment.(162, 163) In both studies, there was no correlation between the pathogens that were cultured and any subsequent cultures from infected wounds.(162, 163) Another study also provided culture data, which confirmed expected flora, but no association was drawn in the analyses with subsequent infections.(1550) These analyses only apply to wounds that have no joint, tendon or tendon sheath involvement.

*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.

### Initial Care

1. *Recommendation: Blood Borne Pathogen Protocol for Human Bites*

**For human bites, it is recommended that exposures that could be considered high risk for viral blood borne pathogen transmission be evaluated and treated according to blood borne pathogen protocols.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Moderate*

*Rationale for Recommendation*

There is no quality evidence for or against implementing blood borne pathogens protocols for human bites. However, exposures that could be considered high risk for transmitting viral blood borne pathogens (HIV, HBV, HCV), such as a traumatic bite lacerations where the offender may have concurrent oral trauma (fight, accident, seizure) should be considered for testing and prophylaxis according to standard protocols particularly as needlestick injuries with HIV contaminated blood carry substantially reduced risk of transmission if prophylactic anti-virals are administered in a timely manner. Institutions where employees are at higher risk for human bites may consider implementing policies for this particular class of injuries. A recent study of police officer bite exposures reported an estimated exposure rate to possible viral transmission of 68/10,000/year. Of these measured exposures for this group, 89 (79%) sources were tested, finding 4% HBV-positive, 4% HIV-positive, and 18% HCV-positive.(161)

2. *Recommendation: Prophylactic Antibiotics for Dog Bite Wounds*

**Prophylactic antibiotics are recommended for treatment of dog bite wounds.**

*Indication* – All dog bites. It may be reasonable to omit antibiotics for minor wounds.

*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. Tailoring the antibiotic selection to anticipated local antibiotic resistance profiles is advisable.

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

*Rationale for Recommendations*

A pooled study of wound infection rates from dog bites was performed for this guideline that utilized the published data from all high- and moderate-quality studies antibiotics and showed a 37% reduction in wound infections compared with placebo (Odds Ratio 0.63, 95% CI 0.40, 0.97). These studies analyzed penicillin,(162, 163) penicillinase resistant penicillins,(1551-1553) sulfa compounds,(1554) erythromycin, (1551, 1553) or amoxicillin/ clavulanate.(1550) Thus, there is no clear preferential antibiotic to recommend. The individual studies all failed to show statistically significant reductions in infections, but were likely underpowered as infections are relatively infrequent and the studies had modest sample sizes. Prophylactic antibiotics are not invasive, have low adverse effects and are low cost particularly for generic compounds and thus are recommended for treatment of dog bites.

*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.*

### 3. Recommendation: Prophylactic Antibiotics for Uncomplicated Human Bite Wounds

#### **Prophylactic antibiotics are recommended for treatment of uncomplicated human bite wounds.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There is one moderate-quality study of human bites,(164) and another moderate-quality study that included human bites along with other animals(1550) comparing the utility of prophylactic antibiotics in preventing wound infections. However, despite a relatively modest sample size in the sole study addressing risk of infection from human bites, a broad-spectrum oral antibiotic or I.V. antibiotics was found to be effective in preventing infection.(164) The study, which included dogs, cats, humans, and other animals, did not find any significant differences using Augmentin®.(1550) Given the reported higher incidence of wound infections related to human bites and the sole quality study addressing this question documenting success, 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*

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.*

### 4. Recommendation: Prophylactic Antibiotics for Uncomplicated Cat Bite Wounds

#### **Prophylactic antibiotics are recommended for treatment of uncomplicated cat bite wounds.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

#### *Rationale for Recommendation*

There are no quality studies of antibiotic prophylaxis for cat bites. Only one study was found, but was relatively unhelpful due to limited sample size.(1555) However, the study showed a high incidence of wound infection in the placebo group (4 of 6) compared to none in the oxacillin prophylaxis group. Reported incidence rates of infections from cat bites is 20 to 40%,(153) 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, (1556) may be indicated.

#### *Evidence for the Use of Prophylactic Antibiotics*

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.*

#### 5. *Recommendation: Laceration Repair for Dog-Bite Wounds*

**Suturing of non-complicated dog bite wounds after adequate wound care is recommended as it may lead to a better cosmetic result and is not likely to result in increased wound infections over wounds allowed to heal by secondary intent.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Moderate*

#### *Rationale for Recommendation*

There is one moderate-quality study of laceration repair for dog bite wounds.(1551) There are no quality studies for human or cat bite lacerations. A low-quality study compared infection rates and cosmetic outcomes of dog bite wounds repaired with monofilament suture versus allowing to heal by secondary intent.(1557) There was no difference found in infection rates. Patients were less satisfied with the cosmetic outcome in the non-sutured group. No statistically significant difference was found in infection rates in sutured wounds.(1551) These and several other studies considered in the antibiotic prophylaxis recommendation section have concluded that wound care (irrigation, debridement, cleansing) is the primary factor for preventing infection.

#### *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.

## **Follow-up Visits**

There are no quality studies on the frequency and timing of follow-up visits for animal or human bites, or the effectiveness of wound care instruction and education. As the incidence of infection related to human and cat bites is much higher than for dog bites, there may be a stronger argument for having these patients present for wound check in

48-72 hours post injury. Follow-up for non-routine wounds should be dictated by the clinical presentation, or by other indications such as blood borne pathogens protocols and concurrent injury management.

## Prescription Medications

There are no recommendations for the use of prescription medications except as noted for antibiotics and blood borne pathogens elsewhere.

## Hand/Finger Osteoarthritis

### Diagnostic Criteria

For most purposes, a history and physical examination is sufficient but sometimes x-rays are used. X-rays are sometimes used in medicolegal situations to document the degree and extent of involvement. However, x-rays can be negative in those with osteoarthritis as well as show evidence of disease among those asymptomatic.

### Special Studies and Diagnostic and Treatment Considerations

#### X-Rays

*Recommendation: X-rays to Evaluate Hand Osteoarthritis*

**X-rays are recommended to define objective evidence of the extent of hand osteoarthritis.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

#### *Rationale for Recommendation*

There are no quality studies evaluating x-rays for hand osteoarthritis. Most patients do not require x-rays for diagnosis and can be managed clinically. However, in some cases, x-rays are helpful and may assist in some patients in diagnosing and treating the condition. Thus, x-rays are recommended for hand osteoarthritis.

#### *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, 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.

### Initial Care

Relative rest, splints, ice, and heat have been utilized for treatment of hand osteoarthritis.(1558-1560) Uncontrolled trials have reported splinting reduced the need for hand surgery.(910, 1561) Exercises have been recommended as well.(1560, 1562-1567)

1. *Recommendation: Relative Rest and Self-application of Ice for Chronic Hand Osteoarthritis*

**Relative rest and self-application of ice are not recommended for chronic hand osteoarthritis.**

*Strength of Evidence – Not Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

2. *Recommendation: Splinting for Acute Flares or Chronic Hand Osteoarthritis*

**Splinting is recommended for acute flares or chronic hand osteoarthritis.**

*Indications* – Hand osteoarthritis symptoms insufficiently treated with NSAIDs, acetaminophen, and/or topical medications. Prefabricated or custom-made orthoses may be utilized.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Low

3. *Recommendation: Exercise for Acute Flares or Chronic Hand Osteoarthritis*

**Exercise is recommended for treatment of acute flares or chronic hand osteoarthritis.**

*Indications* – Hand osteoarthritis symptoms insufficiently treated with NSAIDs, acetaminophen, and/or topical medications.

*Frequency/Dose* – One or 2 appointments for teaching home exercises. An additional subsequent appointment or two a few weeks later may be helpful to reinforce exercises and techniques. In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Low

4. *Recommendation: Self-application of Heat for Acute Flares or Chronic Hand Osteoarthritis*

**Self-application of heat is 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.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

*Rationale for Recommendations*

There are no quality studies of these treatments other than splinting and exercise. Relative rest does not appear to improve the disease in any other joint in the body (see Hip and Groin Disorders Guideline), and instead may promote debility. Thus, while not invasive, potential adverse effects may occur. Although it is generally low cost provided the patient is able to continue to work, it is not recommended.

All quality studies of splinting addressed thumb CMC/trapeziometacarpal OA. There is one quality study evaluating splinting versus no splinting that suggested modest benefits,(1568) although that trial may have been biased by a non-interventional control. Two crossover trials of different splints suggest a flexible splint or support across the thumb CMC joint is superior to other, more rigid splint options.(1558, 1569) A fourth study compared two different exercise and splint regimens and found no differences,(1570) thus whether splints are beneficial compared with no splint is unclear. Splinting, particularly with a soft elastic support, is not invasive, has few adverse effects, is generally low cost and thus is recommended.

Most patients find heat superior to cryotherapies; however, there are no quality studies of either for treatment of hand OA. Heat may help with symptomatic relief, is not invasive, has no adverse effects, is not costly when self-applied and thus is recommended.

Exercise has not been widely investigated for treatment of hand OA, but has not been found to be harmful for hip or knee osteoarthritis patients (see Hip and Groin Disorders Guideline) and those patients obtain superior benefits with active exercise, and by inference may suggest rest is not appropriate for hand osteoarthritis patients. One quality study found a home exercise program performed daily after a single 30-minute training session superior to educational

controls for treatment of hand osteoarthritis.(1567) An uncontrolled trial found strength training increased grip strength and reduced pain;(1565) however, a subsequent moderate-quality crossover trial by the same researcher did not find an exercise regimen of range of motion and strengthening exercises superior to another.(1566) As well, a study of combined exercises and splints failed to find one program superior.(1570) However, it is possible the trial by Rogers et al that evaluated exercises placed emphasis on flexibility exercises, thus biasing towards the null when additional trials may demonstrate clinically meaningful results. Exercises are not invasive, have low adverse effects and are low cost after an appointment or two for teaching purposes and are recommended.

#### *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, 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.

## Follow-up Visits

Many patients require no follow-up appointments as the main thrust of the initial treatment generally focuses on securing the diagnosis and initiating treatment. Patients may require a few follow-up appointments, depending on severity and need for workplace limitations.

## Medications

### NSAIDs/Acetaminophen

NSAIDs and acetaminophen are widely used to treat pain associated with osteoarthritis (OA), and are considered highly efficacious, although most studies evaluating their use lasted not longer than 6 weeks.(1578-1581) Most quality studies evaluated NSAIDs and acetaminophen in hip and/or knee OA patients and some evaluated low back pain patients (see Hip and Groin, and Low Back Disorders Guidelines). Few have evaluated hand osteoarthritis patients.(1582-1584)

- 1. Recommendation: NSAIDs for Acute Flares, Subacute, or Chronic Hand Osteoarthritis*  
**NSAIDs are moderately recommended to control pain associated with acute flares, subacute, or chronic hand osteoarthritis.** [Evidence is robust and strongly recommended for the treatment of osteoarthritis in other body regions – Strongly Recommended, Evidence (A) (see Hip and Groin Disorders Guideline). Evidence is also present for efficacy of these agents for treating symptoms from OA flares (see Hip and Groin Disorders guideline).]  
*Strength of Evidence – Moderately Recommended, Evidence (B)*  
*Level of Confidence – High*
- 2. Recommendation: NSAIDs for Acute Flares, Subacute, or Chronic Hand Osteoarthritis*  
**There is no recommendation for or against one NSAID over another as there is no consistent quality evidence that one NSAID is superior to another.**  
*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*  
*Level of Confidence – High*
- 3. Recommendation: NSAIDs for Acute Flares, Subacute, or Chronic Hand Osteoarthritis*  
**There is no recommendation for or against enteric-coated vs. sustained release preparations as there is no consistent quality evidence demonstrating superiority of one or the other** (see Hip and Groin Disorders guideline).  
*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*  
*Level of Confidence – High*
- 4. Recommendation: Acetaminophen for Acute Flares, Subacute, or Chronic Hand Osteoarthritis*  
**Acetaminophen (or the analog paracetamol) may be a reasonable alternative for treatment of osteoarthritis pain – Recommended, Evidence (C),**(1585, 1586) **although quality evidence is available that documents these are consistently less efficacious in comparison with NSAIDs [Evidence (A)]**(1587-1594) and at least two quality trials with placebo comparisons have been negative including one with a large sample size of 779 patients.(1589, 1595) Yet, acetaminophen may be preferable for initial treatment of elderly patients and others with risks for gastrointestinal bleeding.  
*Level of Confidence – High*

Risk of adverse events from chronic NSAID use should be incorporated, especially including risk of gastrointestinal bleeding. Risk assessment should particularly include: prior history of gastrointestinal bleeding and source, length of treatment, age, smoking, diabetes mellitus and other medical factors. **It is strongly recommended that patients with greater risk should be considered for treatment with either acetaminophen, NSAID plus misoprostol, proton pump inhibitors or a COX-2 selective agent – Strongly Recommended, Evidence (A)** (see Hip and Groin Disorders Guideline).(1578, 1579, 1596-1599) While COX-2 selective agents have generally been recommended as either third- or fourth-line medications for routine use in osteoarthritis patients, when there is a risk of gastrointestinal complications, they are often preferred. Proton pump inhibitors and misoprostol are also gastro-protective and have quality evidence of efficacy and are recommended (see Hip and Groin Disorders Guideline),(1596, 1597, 1599-1608) while there is substantially less evidence in support of sucralfate.(1607) COX-2 selective agents may still be used for those with contraindications to other medications, especially those with a

history of gastrointestinal bleeding or past history of peptic ulcer disease. For patients at high risk of gastrointestinal bleeding, there is evidence that a combination of proton pump inhibitor plus COX-2 selective agent is efficacious.(1602) Should rofecoxib become available, it is suggested that it be considered as a fourth- or fifth-line medication for treatment of osteoarthritis, likely paired with low-dose aspirin, and be positioned as a second-line medication for those with contraindications for the first- and second-line medication and in whom acetaminophen and celecoxib appear ineffective.

*Indications* – For hand osteoarthritis patients, NSAIDs and acetaminophen are recommended for treatment. Over-the-counter agents may suffice and may be tried first.

*Frequency/Duration* – As-needed use may be reasonable for many patients. However, nearly all trials used scheduled doses. While not evaluated in hand OA patients, there is evidence that nocturnal dosing is superior for treatment of hip OA if the patient primarily has morning or nocturnal pain,(1609) although the study was of indomethacin and may only apply to shorter half-life agents as reproducibility of these findings and generalizability to other NSAIDs such as celecoxib with a longer half-life has not been shown.(1610)

*Indications for Discontinuation* – Resolution of hand pain, lack of efficacy, or development of adverse effects that necessitate discontinuation.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – High

5. *Recommendation: NSAIDs for Patients at Risk for GI Adverse Effects*

**Concomitant prescriptions of cytoprotective medications are strongly recommended for patients at substantially increased risk for gastrointestinal bleeding.** There are four commonly used cytoprotective classes of drugs: misoprostol, sucralfate, double-dose histamine Type 2 receptor blockers (famotidine, ranitidine, cimetidine, etc.), and proton pump inhibitors (esomeprazole, lansoprazole, omeprazole, pantoprazole, rabeprazole). There is not generally believed to be substantial differences in efficacy for prevention of gastrointestinal bleeding,(1611) although evidence for sucralfate is limited. There also are combination products of NSAIDs/misoprostol that have documented reductions in risk of endoscopic lesions (see Hip and Groin Disorders Guideline).

*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 gastro-intestinal bleeding, the elderly, diabetics, and cigarette smokers.

*Frequency/Duration* – As recommended.

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

*Strength of Evidence* – **Strongly Recommended, Evidence (A)**

*Level of Confidence* – High

6. *Recommendation: Discussion Regarding 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.**

*Frequency/Dose* – 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.(1612)

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

7. *Recommendation: Acetaminophen or Aspirin for Patients at Risk for Cardiovascular Adverse Effects*

**Acetaminophen or aspirin is strongly recommended as the first-line therapy for patients with known or multiple risk factors for cardiovascular disease.**

*Frequency/Dose* – See above.

*Strength of Evidence* – **Strongly Recommended, Evidence (A)**

*Level of Confidence* – High

8. *Recommendation: Acetaminophen for Acute Flares, Subacute, or Chronic Hand Osteoarthritis*  
**Acetaminophen is recommended to control pain associated with acute flares, subacute, or chronic hand osteoarthritis pain, particularly for patients with contraindications for NSAIDs.**

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

*Level of Confidence – High*

*Rationale for Recommendations*

There is abundant quality evidence that COX-1 and COX-2 NSAIDs improve pain and produce higher functional status among chronic osteoarthritis patients (see Hip and Groin Disorders Guideline), and two quality studies included hand OA patients. There are a few studies of osteoarthritis flares that also consistently document benefits, although not involving hand OA patients. There are many quality trials comparing the various NSAIDs, however, there is no consistent quality evidence of superiority of one over another or of one class over another class. There is one quality study suggesting that evening dosing of indomethacin results in better pain control, but the study has not been replicated(1609) and there is no similar result with the longer half life agent celecoxib.(1610) There is quality evidence that NSAIDs are less impairing than opioids, yet with comparable efficacy (see Chronic Pain and Low Back Disorders guidelines).

Quality evidence documents NSAIDs as superior to acetaminophen for symptomatic relief of OA (see Chronic Pain, Hip and Groin Disorders, and Low Back Disorders Guidelines).(1587-1593, 1613) However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rationale for utilization of acetaminophen to treat some patients, particularly the elderly and others prone to GI complications.

NSAIDs are not invasive, have low side effect profiles in a healthy working age patient population, and when generic medications are used are low cost. The potential for NSAIDs to increase the risk of cardiovascular events needs to be carefully considered in patients and will likely require additional quality studies to fully address. Acetaminophen is a recommended alternative, particularly for first line treatment or for patients at increased risk for GI complications. These medications are recommended.

*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, Osteoarthritis, 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, Osteoarthritis, 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.

## Topical NSAIDs

Topical NSAIDs are used for treatment of hand osteoarthritis(1620-1622) that include over-the-counter products.

*Recommendation: Topical NSAIDs for Hand Osteoarthritis*

**Topical NSAIDs are 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.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

### *Rationale for Recommendation*

Topical NSAIDs have been widely used. There are two quality studies are single-application studies precluding an evaluation is a regular treatment regimen, although they do suggest weak efficacy.(1620, 1621) Thus, there are not quality studies, and they appear to have quality evidence of efficacy for conditions with target tissue that is close to the skin, such as lateral epicondylitis (see Elbow Disorders Guideline) which is analogous to the skin in the dorsal hands. These medications are generally well tolerated, have few adverse effects, and are not costly when generic prescriptions are used, although they can be costly with name-brand prescription use over time. These medications are recommended.

### *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.



## Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol)

See Opioids – Oral, Transdermal, and Parenteral (Includes Tramadol) in Carpal Tunnel Syndrome.

## Complementary/Alternative Therapies

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. (These are reviewed in detail in the Hip and Groin Disorders guideline.)

1. *Recommendation: Capsaicin for Chronic Hand Osteoarthritis or Acute Flares of Osteoarthritis*

**Capsaicin is 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).(1624, 1625)

*Frequency/Duration* – Up to 4 times a day.

*Dose* – Fixed dose per manufacturer.

*Indications for Discontinuation* – Excessive burning of the skin or other intolerance. Not recommended for continual use, rather periods without use have been recommended.

Strength of Evidence – **Recommended, Evidence (C)**

Level of Confidence – Low

2. *Recommendation: Yoga for Chronic Hand Osteoarthritis or Acute Flares of Osteoarthritis*

**Yoga is recommended for treatment of chronic hand osteoarthritis or acute flares of osteoarthritis.**

*Indications* – Hand osteoarthritis pain in motivated patients.

*Frequency/Duration* – Self-directed program after up to 8 supervised sessions.(1626)

*Indications for Discontinuation* – Intolerance, non-compliance.

Strength of Evidence – **Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

3. *Recommendation: Glucosamine, Chondroitin Sulfate, Methyl-sulfonyl Methane, Diacerein (Diacerhein, Diacetylrhein), Harpagophytum, Avocado Soybean Unsaponifiables, Ginger, Oral Enzymes, Nettle Leaf, or Rose Hips for Chronic Hand Osteoarthritis or Acute OA Flares*

**There is no recommendation for or against use of glucosamine, chondroitin sulfate, methyl-sulfonyl methane, diacerein (diacerhein, diacetylrhein), harpagophytum, avocado soybean unsaponifiables, ginger, oral enzymes, nettle leaf, or rose hips for treatment of chronic hand osteoarthritis or acute flares.**

Strength of Evidence – **No Recommendation, Insufficient Evidence (I)**

Level of Confidence – Low

### *Rationale for Recommendations*

There is one quality study of capsaicin for treatment of these patients and it suggests benefits over a 4-week trial, thus it is recommended.(1624) There is one low-quality study of yoga,(1626) that suggested benefits. As yoga is not invasive, has few adverse effects, and is low cost, it is recommended for select, motivated patients.

There are more than 30 quality studies reviewed in the Hip and Groin Disorders Guideline. The largest volume of studies addresses glucosamine and chondroitin sulfate. This quality literature mostly addresses hip or knee osteoarthritis or low back pain. Of the 5 quality, double-blinded studies that used x-rays for evaluation of glucosamine/chondroitin, three have documented delayed progression of joint space narrowing. There are 3 low-quality studies of chondroitin sulfate for treatment of hand arthrosis with one suggesting delay of hand x-ray changes.(1627) Yet, there are quality studies of knee and hip OA that have been both sizable and negative. However, glucosamine and chondroitin have problems with lack of standardization of doses. Nettle leaf(1628) has an additional problem of relative unavailability. This problem affects the other, less studied agents in this group of treatments. Consequently, although these agents are not invasive, have low adverse effects profiles, and may be costly over time, there is no recommendation for or against these agents.

### *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.

## **Low-Level Laser Therapy**

Low-level laser therapy has been used for treatment of hand osteoarthritis patients, although the evidence has been noted to conflict.(1633-1635)

### *Recommendation: Low-Level Laser Therapy for Hand Osteoarthritis*

**Low-level laser therapy is moderately not recommended for treatment of hand osteoarthritis.**

*Strength of Evidence* – **Moderately Not Recommended, Evidence (B)**

*Level of Confidence* – Moderate

### *Rationale for Recommendation*

There is one high-quality study that suggests low-level laser therapy is ineffective for treatment of hand osteoarthritis.(1636) Low-level laser therapy is not invasive and has low adverse effects, but it is costly and in the absence of efficacy is therefore not recommended.

### *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.

## **Injections**

### **Intraarticular Injections**

Intraarticular glucocorticosteroid and hyaluronidate injections are sometimes performed to attempt to deliver medication with minimal systemic effects to the arthritic joint,(1637-1645) particularly when acetaminophen and NSAIDs have failed. These injections are generally performed without fluoroscopic or ultrasound guidance in the distal upper extremity.

#### *1. Recommendation: Intraarticular Glucocorticosteroid Injection for Subacute or Chronic Hand Osteoarthritis*

**Intraarticular glucocorticosteroid injections are recommended 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 (1) injection should be scheduled, rather than a series of 3. Various medications have been used, as well as adjuvant anesthetic agents. There are no head-to-head comparisons in quality studies of different medications to ascertain optimum medication(s).

*Dose* – Various doses have been utilized without evidence to identify an ideal dose for hand or phalangeal joints.

*Indications for Discontinuation* – A second glucocorticosteroid injection is not recommended if the first has resulted in significant reduction or resolution of symptoms. If there has not been a response to a first injection, there is generally less indication for a second. 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. If placement is thought to be difficult, ultrasound or fluoroscopic guidance may be particularly indicated for a second injection. In patients who respond with a pharmacologically appropriate several weeks of temporary partial relief of pain, but who then have worsening pain and function and who are not (yet) interested in surgical intervention, a repeat injection is an option. There are not believed to be benefits beyond approximately 3 injections in a year. Patients requesting a 4th injection should have reassessment of non-operative management measures and be counseled for possible surgical intervention.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Low

2. *Recommendation: Intraarticular Hyaluronate Injection for Subacute or Chronic Hand Osteoarthritis*

**Intraarticular hyaluronate injections are recommended for the treatment of subacute or chronic hand osteoarthritis.**

*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.

*Frequency/Duration* – Number and frequency of injections are unclear (one trial found no differences between 1, 2, or 3 injections).(1642) Most physicians perform 3 injections.(1638)

*Dose* – See manufacturer’s recommendations.

*Indications for Discontinuation* – Sufficient relief to not require additional injection(s), failure to improve, or allergic reactions.

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Low

*Rationale for Recommendations*

There are several quality studies for treatment of hand osteoarthritis with glucocorticosteroids. However, the studies conflict regarding the length of benefits. However, nearly all studies have suggested benefits.(1638, 1639, 1643, 1645) No studies have suggest prolonged benefits with more than approximately 3 months benefits, thus this intervention is a short to intermediate term intervention. Optimal glucocorticoid doses and preferable adjuvant anesthetic agents are unclear. These injections are invasive, have low adverse effects, and are moderately costly. They are recommended as an option for treatment of hand OA patients particularly after inadequate results from NSAID trials or other non-operative interventions.

There are a few quality studies of hyaluronate injections for treatment of hand osteoarthritis. These suggest benefits. Duration of improvement is uncertain, although one trial suggested pain relief as far as 26 weeks.(1639) These injections are invasive, have moderate adverse effects and are costly. In select cases where other treatments have failed, these injections are recommended.

*Evidence for the Use of Intraarticular Injections*

There is 1 high-(1646) and 5 moderate-quality RCTs(1643, 1647-1650) 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 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 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.*

## **Prolotherapy Injections**

*Recommendation: Prolotherapy Injections for Subacute or Chronic Hand Osteoarthrosis*

**There is no recommendation for or against the use of prolotherapy injections for treatment of subacute or chronic hand osteoarthrosis.**

**Strength of Evidence – No Recommendation, Insufficient Evidence (I)**

*Level of Confidence – Low*

### *Rationale for Recommendation*

Prolotherapy injections are invasive as they require numerous, repeated injections in phalangeal joints. The magnitude of the purported benefits is modest. The results of Reeves' 2000 study suggesting some benefits compared with placebo injections(1629) needs to be replicated, including with a larger sample size, evaluation of functional outcomes and with sufficient follow-up duration to allow for adequate assessment of risks and benefits of these procedures prior to a recommendation in favor of this treatment.

### *Evidence for the Use of Injections for Hand Osteoarthrosis*

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, 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 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, 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 0 articles. Zero articles met the inclusion criteria.*

## Surgery

Various surgical procedures are utilized to treat patients with hand osteoarthritis.(1652-1665) Among these are arthrodesis, arthroplasty and various other reconstructive procedures, although many have been developed and utilized to primarily treat patients with rheumatoid arthritis.(1666-1668)

1. *Recommendation: Reconstructive Surgery for Select Patients with Trapeziometacarpal Arthrosis*  
**Reconstructive surgery is recommended for treatment of select patients with trapeziometacarpal arthrosis.**  
*Strength of Evidence – Recommended, Evidence (C)*  
*Level of Confidence – Low*
2. *Recommendation: Trapeziectomy with Ligament Reconstruction and Tendon Interposition for Thumb CMC Joint Osteoarthritis*  
**Trapeziectomy with ligament reconstruction and tendon interposition (LRTI) is not recommended for treatment of thumb CMC joint osteoarthritis.**  
*Strength of Evidence – Not Recommended, Evidence (C)*  
*Level of Confidence – Low*
3. *Recommendation: Fusion for Select Patients with Hand Osteoarthritis*  
**Fusion is recommended for treatment of select patients with hand osteoarthritis.**  
*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*

### *Rationale for Recommendation*

There are several moderate-quality studies evaluating surgery for hand osteoarthritis, all of which concern the basal thumb joint (trapeziometacarpal joint). (1652-1654, 1656, 1657, 1660, 1663-1665, 1669, 1670) There are a few quality studies of surgery for rheumatoid arthritic joints, such as MCP joint replacement.(1671-1674) However, these are beyond the scope of this document. Most of the OA studies address a comparison between trapeziectomy and trapeziectomy with ligament reconstruction or arthroplasty versus tendon interposition arthroplasty. Regardless, ligament reconstruction and tendon interposition procedures do not appear to be superior to the simpler trapeziectomy,(1654, 1655, 1661, 1669, 1670, 1675, 1676) and some studies suggest longer recovery and higher complication rates with the more extensive procedures. Thus, the ligament reconstruction with tendon interposition procedure is generally not recommended. One moderate-quality study has concluded that earlier mobilization is superior to delayed mobilization after surgery.(1657)

Surgery is often career ending for patients who perform manual labor or requires cessation of manual tasks. Thus patients should be appropriately counseled as they may decide that the fulfillment from performing physical labor outweighs the discomfort. There are no quality studies of joint fusion. However, joint fusion is generally helpful for patients with significantly symptomatic osteoarthritis who fail to achieve sufficient relief from other treatments.

### *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, Osteoarthritis, trapeziometacarpal arthrosis, trapeziectomy with ligament reconstruction and tendon interposition, thumb CMC joint osteoarthritis, fusion, hand 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 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.

## Post-operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders

Post-operative rehabilitation and rehabilitation for patients with distal upper extremity musculoskeletal disorders has long been prescribed. Post-operative splinting was previously widely used as evidenced in the older quality literature.(911, 915, 937, 1678, 1679) But, plaster casts have been replaced by splints which were later replaced by soft bandages and dressings(907, 918, 922-924, 928, 932, 935, 953, 958) which has also coincided with, or been facilitated by, less invasive and smaller incisions.

### Soft Bandages and Splints

1. *Recommendation: Soft Bandages During Post-operative Rehabilitation*

**Soft bandages are recommended during post-operative rehabilitation.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*

2. *Recommendation: Splints During Post-operative Rehabilitation*

**Splints are recommended during post-operative rehabilitation for select patients.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*  
*Level of Confidence – Low*

#### *Rationale for Recommendations*

As surgery has become less invasive, the degree or whether to splint, has become questionable as splints encourage lack of mobility which likely impairs or delays recovery with potentially increasing risk of complex regional pain syndrome, debility and delayed recovery. Three low-quality studies all suggest that splints are not effective;(784, 1679, 1680) however, there is no quality data and some splints appear indicated for select patients. Thus, there are limited indications for splints in patients with select diagnoses generally involving more extensive surgical procedures or other needs to utilized splints for protective purposes.

#### *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.

### NSAIDs/Acetaminophen

1. *Recommendation: NSAIDs During Post-operative Rehabilitation*

**NSAIDs are moderately recommended to control pain during post-operative rehabilitation.**

*Indications* – All hand, wrist, forearm post-operative patients may be candidates other than those with contraindications for use.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable initially.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects, particularly gastrointestinal.

*Strength of Evidence* – **Moderately Recommended, Evidence (B)**

*Level of Confidence* – High

2. *Recommendation: Acetaminophen During Post-operative Rehabilitation*

**Acetaminophen is recommended to control pain during post-operative rehabilitation.**

*Indications* – All hand, wrist, forearm post-operative patients may be candidates other than those with contraindications for use.

*Frequency/Duration* – Scheduled dosage rather than as needed is generally preferable initially.

*Indications for Discontinuation* – Resolution of pain, lack of efficacy, development of adverse effects, particularly gastrointestinal.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

*Rationale for Recommendations*

Acetaminophen has been shown to be less efficacious than naproxen, but is recommended due to its lower adverse effects.(639)

*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.

## Arnica

*Recommendation: Arnica During Post-operative Rehabilitation*

**Arnica is not recommended during post-operative rehabilitation.**

*Strength of Evidence* – **Not Recommended, Evidence (C)**

*Level of Confidence* – Low

*Rationale for Recommendation*

Arnica has been utilized for post-operative recovery in CTS patients,(772, 1696) with the two quality studies conflicting. However the higher quality study suggests a lack of efficacy, thus there is overall weak evidence that arnica is ineffective, and thus it is not recommended.

*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.

## Cryotherapy/Cooling Blanket

### 1. Recommendation: Cryotherapy During Post-operative Rehabilitation

**Cryotherapy is recommended for post-operative rehabilitation for carpal tunnel release patients.**

*Strength of Evidence – Recommended, Evidence (C)*

*Level of Confidence – Low*

### 2. Recommendation: Cooling Blanket During Post-operative Rehabilitation

**A cooling blanket is recommended during post-operative rehabilitation.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – Low*

### Rationale for Recommendations

Cryotherapy has been shown to be effective for post-carpal tunnel release patients and is therefore recommended during post-operative rehabilitation. The evidence is in favor of a cooling blanket versus ice therapy and therefore, a cooling blanket is recommended during post-operative rehabilitation.(1697)

### 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.

## Activity/Exercise/Physical or Occupational Therapy

### 1. Recommendation: Activity During Post-operative Rehabilitation for Patients with Functional Deficits

**It is recommended that post-operative patients or those with functional deficits stay as active as possible and use the hand as much as possible post-operatively or post-injury.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

### 2. Recommendation: Exercise During Post-operative Rehabilitation for Patients with Functional Deficits

**It is recommended that post-operative patients or those with functional deficits perform graded, increased exercises post-operatively or post-injury. A home exercise program may accomplish this for many patients.**

*Strength of Evidence – Recommended, Insufficient Evidence (I)*

*Level of Confidence – High*

### 3. Recommendation: Formal Physical or Occupational Therapy During Post-operative Rehabilitation for Patients with Functional Deficits

**Post-operative patients should be observed particularly for failure to progress as expected, as well as for complex regional pain syndrome (see Chronic Pain guideline) or other complications, and it is recommended that there should be a low threshold for institution of formal physical or occupational therapy for rehabilitation. Patients with functional deficits should have a home exercise program with low**



**threshold to refer to therapy for formal treatment if deficits are considerable or there is a failure to progress as expected with a home exercise program.**

*Indications* – Failure to progress, or moderate to severe functional deficits.

*Frequency* – In the event it is needed for recovery or post-operative, appointments should be scheduled generally weekly for up to 5-6 visits. If there has been functional improvements yet there are ongoing objective functional deficits, an additional set of 5-6 appointments is often helpful (up to 12 visits total). More than 12 visits (or more than once a week appointments) may be rarely needed when the initial functional deficits were more severe, and there is ongoing functional gain that is measured towards the end of a set of visits (e.g., increased grip strength, key pinch strength, range of motion, advancing work abilities, increased duration of exercises or work). Additional sets of 5-6 appointments are appropriate when there is evidence of ongoing functional gain, but are not advised absent objective functional gain. Home exercises should be performed in conjunction with the therapy.

*Discontinuation* – Achievement of goals, failure to progress, adverse effects, non-compliance.

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Moderate

*Rationale for Recommendations*

Most of the quality studies that have described post-operative rehabilitation components have not prescribed formal physical or occupational therapy for rehabilitation.(907, 918, 923, 1678) Instead, most instructed patients to “keep fingers moving” or perform finger exercises,(922, 928) perform mobility exercises,(946) use the hand daily as tolerated,(922) use “as comfort allowed,”(917) or “use as much as possible” or “as soon as possible.”(778, 940, 953) Unfortunately, there is little quality evidence comparing approaches and there is likely a significant difference between using the hand “as tolerated” and “as much as possible.” There also are no quality studies comparing specific exercises for rehabilitation of patients with deficits compared with no treatment or home exercise programs. Quality studies are needed to address these issues, particularly as they may impact the sizable lost-time problems. In the absence of quality evidence, but inferring from numerous other MSD diagnoses that suggest activity is helpful, it is recommended that patients stay as active as possible and use the hand as much as possible post-operatively, as well as for those with functional deficits, and that there should be a low threshold for institution of formal physical or occupational therapy for rehabilitation.

*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.

## **Appendix 1. Dupuytren’s Disease**

Dupuytren’s disease is a disorder of the hand involving the formation of fibrosis (scar tissue) in the palm and digits with subsequent contractures.(1712) It has strong age and inheritance patterns.(1713-1717) There is insufficient evidence relating Dupuytren’s disease to occupational activities.(1718, 1719) Purported risks include the use of alcohol, smoking, diabetes mellitus, and epilepsy.(1713) However, although there are no quality studies involving occupational factors, there are some reported associations with both heavy(1720) and manual work.(1721) Therefore, to help provide improved care for patients, this disorder is included as an appendix to the Hand, Wrist, and Forearm Disorders Guideline.

Many treatments have been used for patients with Dupuytren's disease, including radiotherapy, dimethylsulfoxide injections, topical applications of vitamins A and E, physical therapy, ultrasound, corticosteroid injections, 5-Fluorouracil, and gamma interferon injections. Almost all of these treatments have been found ineffective.(1722) While surgery is currently the most effective treatment for Dupuytren's disease, the contracture often reoccurs with time.

## Radiotherapy

Radiotherapy has been used to attempt to slow or prevent the progression of Dupuytren's disease.(1723) Treatment involves irradiating the nodules and cords associated with Dupuytren's with x-rays or electrons.

*Recommendation: Radiotherapy for Prevention of Progression of Dupuytren's Disease*

**There is no recommendation for or against the use of radiotherapy to prevent the progression of Dupuytren's disease.**

*Strength of Evidence – No Recommendation, Insufficient Evidence (I)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

One moderate-quality trial of radiotherapy found no differences between two types of radiotherapy treatment regimens.(1723) However, the trial had no placebo group and there was no comparison between treatments. In addition, results suggested regression over 1 year. Radiotherapy is non-invasive and has moderate adverse effects, but it is moderately costly and there is no quality evidence of its efficacy. Therefore, there is no recommendation for or against the use of radiotherapy to prevent the 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.

## Collagenase Injections

Collagenase injections have been utilized for treatment of Dupuytren's disease to lyse and rupture the finger cords that are causing the joint contracture.(1724-1726) (

*Recommendation: Collagenase Injections for Treatment of Dupuytren's Disease*

**Collagenase injections are moderately recommended for treatment of Dupuytren's disease.**

*Indications – Dupuytren's contractures sufficient to result in impairment, nearing impairment, or sufficient to result in significant cosmetic deformity.*

*Frequency/Dose – Clostridial collagenase 10,000 U injection; repeat injection(s) at 4 to 6 week intervals.*

*Discontinuation – Resolution of contracture, sufficient reduction for patient to decline additional injection, adverse effects, or failure to respond to 3 injections.*

*Strength of Evidence – Moderately Recommended, Evidence (B)*

*Level of Confidence – Moderate*

### *Rationale for Recommendation*

Quality studies evaluating the efficacy of clostridial collagenase show considerable benefits.(1724, 1725, 1727, 1728) These injections are minimally invasive, have relatively few reported adverse effects (skin tears if prolonged contracture), but are costly. Therefore, collagenase injections are moderately recommended for treatment of Dupuytren's disease. One trial recommended post-operative manipulation but had no placebo or sham group.(1729)

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.*

## Intra-Operative 5-Fluorouracil

5-Fluorouracil (5-FU) is a chemotherapy drug that has been used for many years to treat cancer, principally as a thymidylate synthase inhibitor. It is administered intravenously or as a topical cream. 5-FU is also used in ophthalmic surgery as an anti-scarring agent, and topically to treat actinic (solar) keratoses and some types of basal cell skin carcinomas. 5-FU has also been used topically to attempt to slow or prevent recurrence of Dupuytren's disease after surgery by reducing proliferation rates of fibroblasts.(1720)

*Recommendation: 5-Fluorouracil for Recurrence of Dupuytren's Disease in Surgical Patients*

**5-Fluorouracil is not recommended to prevent the recurrence of Dupuytren's disease in surgical patients.**

*Strength of Evidence – Not Recommended, Evidence (C)*

*Level of Confidence – Low*

### *Rationale for Recommendation*

There is one moderate-quality trial of 5-fluorouracil administered intraoperatively which showed no difference when compared with placebo.(1720) 5-Fluorouracil is not invasive, but has adverse effects and is moderately costly. Therefore, 5-Fluorouracil is not recommended to prevent recurrence 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: 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.*

## Post-Operative Use of NSAIDs and Acetaminophen

NSAIDs have been used to treat post-operative swelling from surgery for Dupuytren's disease and appear to be superior to acetaminophen (paracetamol).(639) Naproxen may also be useful as an analgesic during the immediate post-operative phase.(639)

1. *Recommendation: NSAIDs to Treat Post-operative Swelling from Surgery for Dupuytren's Disease*

**NSAIDs are moderately recommended to treat post-operative swelling from surgery for Dupuytren's disease.**

*Indications – Dupuytren's disease surgical patients.*

*Frequency/Dose* – Naproxen 500mg BID.(639)

*Duration* – Trial utilized 3 days of treatment.

*Strength of Evidence* – **Moderately Recommended, Evidence (B)**

*Level of Confidence* – High

2. *Recommendation: Acetaminophen for Dupuytren’s Surgery*

**Acetaminophen is recommended for Dupuytren’s surgery.**

*Frequency/Dose* – Paracetamol 1g QID trialed for 3 days. (Note: an FDA advisory committee recommended a maximum dose of 650mg and there is a suggestion of toxicity at 1g QID especially over a few days and particularly in patients consuming excess alcohol or who have liver disease.)(1730)

*Strength of Evidence* – **Recommended, Evidence (C)**

*Level of Confidence* – Moderate

*Rationale for Recommendations*

There is one high-quality study evaluating the effect of drugs on acute post-operative swelling after surgery for Dupuytren’s; it documents the efficacy and superiority of naproxen to paracetamol, which in turn was superior to placebo.(639) However, there is no quality evidence that other NSAIDs are inferior to naproxen. NSAIDs and acetaminophen are non-invasive, have low adverse effects (particularly over 3 days), and are low cost. Therefore, they are recommended to treat post-operative swelling and pain resulting from surgery 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: 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.

## **Surgery**

Surgical procedures have long been used to attempt to improve range of motion in patients with contracture from Dupuytren’s disease.(1719) The goal of surgical care is to excise or incise the diseased fascia. This treatment does not cure the disease, but is meant to improve severe debilitating joint contractures. Several types of surgery have been used to treat Dupuytren’s disease, depending on the contracture. **Extensive fasciectomy** involves removing as much fascia as possible, including that which is grossly normal. Today, this procedure is not commonly performed because of increased morbidity which often included hematoma, edema, and prolonged post-operative stiffness.

**Dermofasciectomy** removes the diseased fascia and the overlying skin. This requires resurfacing (covering) the wound with a full-thickness skin graft. Recurrence rates are quite low with this approach. Because of the radical nature of this procedure, it is usually reserved for patients with recurrent or severe disease. **Regional or selective fasciectomy** involves excising only grossly involved fascia. Although the disease process clearly extends into clinically normal palmar fascia, this approach has proven successful in correcting MCP joint contractures and some PIP joint contractures; this procedure carries an acceptably low morbidity rate. Some surgeons prefer to leave the skin wound open to heal by secondary intention as a means of decreasing hematoma risk. This approach is commonly used today.

1. *Recommendation: Surgery for Treatment of Dupuytren’s Contracture*

**Surgery using the technique of regional or selective fasciectomy is recommended for contracture due to Dupuytren’s disease.**

*Strength of Evidence* – **Recommended, Insufficient Evidence (I)**

*Level of Confidence* – Low

2. *Recommendation: Percutaneous Needle Fasciotomy (aka Needle Aponeurotomy) for Treatment of Dupuytren’s Contracture*

**Percutaneous needle fasciotomy (aka needle aponeurotomy) is not recommended for patients with contractures due to Dupuytren’s disease due to the high recurrence rates common with this technique.**

**Strength of Evidence – Not Recommended, Insufficient Evidence (I)**

Level of Confidence – Low

3. Recommendation: “Firebreak” Full-thickness Skin Graft for Dupuytren’s Contracture, Extensive Fasciectomy, or Dermofasciectomy for Treatment of Dupuytren’s Contracture

**“Firebreak” full-thickness skin graft, extensive fasciectomy, or dermofasciectomy for Dupuytren’s contracture is not recommended for routine Dupuytren’s contracture surgery.**

**Strength of Evidence – Not Recommended, Evidence (C)**

Level of Confidence – Low

*Rationale for Recommendations*

There are no quality studies comparing surgical results with non-surgical treatments or with no treatment.(1718, 1719, 1731) Considering the high propensity for Dupuytren’s contracture to progress or reoccur (estimated at 27 to 80% after surgery(1719, 1732-1734)), surgical studies with sufficient follow-up to determine long-term benefits are needed. However, as some patients with functional limitations appear to improve at least in the short to intermediate term lasting many months to years, regional or selective fasciectomy is recommended. Surgery is invasive, has known adverse consequences including recurrences, and is costly. However, it also appears effective for at least a limited period of time and for some patients it may be the only treatment option available; thus, surgery is recommended particularly for patients with functional limitations. Full-thickness skin graft has been found to be ineffective and thus is not recommended.(1718)

*Evidence for Dupuytren’s Disease*

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.*

## Appendix 2: Excluded 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)



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