
AMERICAN COLLEGE OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE

# Hand, Wrist, and Forearm Disorders

*Effective June 28, 2023*

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## 1. SUMMARY OF RECOMMENDATIONS

The following summary table contains general recommendations for evaluating and managing hand, wrist, and forearm disorders from the Evidence-Based Hand, Wrist, and Forearm Panel. These recommendations are based on critically appraised higher-quality research evidence or, when such evidence was unavailable or inconsistent, on expert consensus as required in ACOEM's Methodology. Recommendations are made under the following categories:

- Strongly Recommended, "A" Level
- Moderately Recommended, "B" Level
- Recommended, "C" Level
- Insufficient – Recommended (Consensus-based), "I" Level
- Insufficient – No Recommendation (Consensus-based), "I" Level
- Insufficient – Not Recommended (Consensus-based), "I" Level
- Not Recommended, "C" Level
- Moderately Not Recommended, "B" Level
- Strongly Not Recommended, "A" Level

The reader is cautioned to utilize the more detailed indications, specific appropriate diagnoses, temporal sequencing, preceding testing or conservative treatment, and contraindications that are elaborated in more detail for each test or treatment in the body of this guideline in using these recommendations in clinical practice or medical management. These recommendations are not simple "yes/no" criteria.

## 2. WORKFLOWS

# 3. INTRODUCTION

## 3.1. 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.

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.

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 Work Disability Prevention and Management and Chronic Pain guidelines).

### 3.1.1. 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 (1). In 2013, there were 345,560 work-related upper extremity disorders for an incident rate of 32.5 per 10,000 full-time workers (2). This was the leading cause of work-related injury (2), and it is estimated that 20% of the population in any given month will complain of at least one type of upper limb disorder (3). In 1998, a study involving more than 10,800 participants concluded that 30.5% had a self-reported neck or limb disorder (4). 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 (5). These disorders account for nearly one-third (31.4%) of the missed days of work (2). 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.

### 3.1.2. RISK AND CAUSATION

There are numerous occupational and non-occupational risk factors for hand, wrist, and forearm (upper limb) musculoskeletal disorders (MSDs) (6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21). Most available quality evidence has been reported for carpal tunnel syndrome (CTS), with sparse information on other disorders. While some risk factors (e.g., age, obesity (22,23), diabetes mellitus, and metabolic syndrome (24)) generally appear in common with most MSDs, other risk factors do not appear in common across the disorders (e.g., low-density lipoprotein (25), 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 (26,27,22,23,28,29,30,31).

### 3.1.3. WORK-RELATEDNESS

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 (31). Another prospective study of production workers reported associations of hand/wrist tendonitis to repeated forceful pinching at work (32). 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 (33). 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%) (34). 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 (27,35,23,36,37,38,39), which is consistent with findings from numerous cross sectional studies (9,40,41,42,43,44,45,46,47,48,49). Attributable CTS risk from high-risk occupations in France is estimated to range from 36 to 93% (50).

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 (19,51). 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 (52,53,54)). 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).

## 3.2. HISTORY AND PHYSICAL EXAMINATION

### 3.2.1. 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 osteoarthrosis, 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”).

### 3.2.2. HISTORY

*Download a PDF version of the Hand, Wrist, and Forearm Disorders Medical History Questionnaire here.*

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, osteoarthrosis, rheumatoid arthritis, other arthritides, renal disease etc.)

## 3.2.3. 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.

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 (55). 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 (56).

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.

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.

## 3.2.4. DIAGNOSTIC CRITERIA

The criteria presented in the Diagnostic Criteria for Hand, Wrist, or Forearm Disorders table (Table 1) 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 1. Diagnostic Criteria for Hand, Wrist, or Forearm Disorders**

| Probable Diagnosis/Injury | Unique Mechanism | 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)<br>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 osteoarthrosis. | 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 |
| Myotendinous Strain | Unaccustomed forceful use.<br>May be from acute loading or fall.<br>Worse pain with motion | Focal pain at a discrete myotendinous junction | Tenderness over myotendinous junction.<br>Pain or weakness on strength or resistance testing of the affected myotendinous junction.<br>Crepitus on motion particularly if accompanied by tenosynovitis or peritendinitis. | None |

| | | | | |
|---|---|---|---|---|
| Tendinosis/<br>Tendinitis/ tenosynovitis | High force combined with repetition,<br>repeated awkward motions, combinations of physical factors<br>Direct pressure (unusual)<br>Blunt trauma (rare)<br>(Diagnosis of "tendinitis" also frequently used as a diagnostic label for "pain" without pathophysiological correlation.) | Pain localized to flexor or extensor compartment.<br>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)<br>Synovial thickening<br>Triggering or locking<br>Crepitus<br>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<br>Direct pressure (unusual)<br>Blunt trauma (rare) | Pain over radial styloid in area of first dorsal compartment | Tenderness over radial styloid<br>Mass over radial styloid (rare)<br>Crepitus over extensor compartment<br>Thick tendon sheath<br>Pain upon passive abduction<br>Triggering (rare)<br>Pain worse with ulnar deviation, thumb flexion, adduction, stretch of first dorsal compartment<br>(Finkelstein test) | None |
| Trigger Finger, Trigger Thumb | High force and repetition<br>Blunt trauma (rare) | Triggering<br>Pain at volar metacarpal phalangeal joint<br>Locked finger | Triggering<br>Tender volar metacarpal crease<br>Tendon nodule<br>Synovial thickening of specific parts of flexor retinaculum | None |
| Carpal Tunnel Syndrome | High force and repetition, combinations of physical factors<br>Vibration<br>(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<br>Volar hand pain radiating into forearm may be present.<br>Decreased grip strength<br>Difficulty picking up small objects<br>Hand symptoms diagram | Atrophy or decreased strength of abductor pollicis brevis, opponens (advanced cases)<br>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 |

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.

## 3.2.5. 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<br>History of deformities with or without spontaneous reduction or self-reduction<br>Focal, severe non-radiating pain combined with history of trauma<br>Inability to use the joint | Significant swelling<br>Deformity with displaced, rotated or spiral fractures<br>Point tenderness<br>Swelling, hematoma<br>Ecchymosis<br>Compartment syndrome |
| Dislocation | History of significant trauma<br>History of deformities with or without spontaneous or self-reduction<br>Inability to use the joint | Deformity present<br>Tenderness and instability with history of deformity with reduction<br>Hemarthrosis<br>Compartment syndrome |
| Infection | History of systemic symptoms: fever, chills/rigor<br>History of immunosuppression (e.g., transplant, chemotherapy, HIV)<br>Diabetes mellitus<br>Portal of infection (e.g., laceration, distant infection) | Tenderness with motion<br>Systemic signs of sepsis<br>Local heat, swelling, erythema<br>Drainage of a sinus tract<br>Painful, red, swollen area(s) |
| Tumor | History of rapidly growing, painful, firm or hard mass of hand or wrist not consistent with ganglion<br>History of immunosuppression (e.g., transplant, chemotherapy, HIV)<br>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<br>Clinical history consistent with inflammatory or crystal arthropathies | Swelling and deformity<br>Mostly symmetrical joint involvement for more common inflammatory arthropathies (e.g., rheumatoid arthritis)<br>Erythematous, swollen, warm usually solitary joint for acute crystal arthropathy<br>Painful swollen joints, usually without systemic symptoms |
| Rapidly Progressive Neurologic Compromise | Rapidly progressive numbness, paresthesias, or weakness in radial, ulnar, or median nerve distribution<br>Inciting traumatic event or history to produce acute neurological compromise<br>Progressive weakness<br>Stroke, cervical spine disorders or other central nervous system compromise | Sensory deficit in ulnar, median, or radial distribution<br>Loss of finger or grip strength when picking up objects<br>Atrophy<br>Compartment syndrome |

| | | |
|---|---|---|
| Vascular Compromise | History of vascular disease<br>History of diabetes mellitus<br>Compartment syndrome<br>Inflammatory arthropathies with vasculitis | Decreased pulses<br>Decreased capillary filling<br>Cold, cool, or pale hand<br>Compartment syndrome |
| Severe Carpal Tunnel Syndrome | Continuous median distribution tingling and numbness after acute trauma, especially fracture<br>Severe flexor compartment pain after repeated, unaccustomed, forceful use with continual median distribution tingling and numbness | Reduced median distribution sensation<br>Muscle atrophy (late) and severe weakness of thenar muscles |

## 3.2.6. MANAGEMENT APPROACH

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.

## 3.2.7. AUDITING / MONITORING CRITERIA

The provider is recommended to assure:

1. Patients with carpal tunnel syndrome are treated at some point with nocturnal, cockup wrist splinting. Target >50%
2. Patients undergoing carpal tunnel release have had a prior glucocorticosteroid injection. Target >80%
3. Patients with deQuervain's are treated at the first appointment with glucocorticosteroid injection. Target >40%
4. Patients with trigger digit are treated at the first appointment with glucocorticosteroid injection. Target >40%
5. Trauma patients have tetanus status documented and compliance is assured with CDC recommendations. Target 100%
6. Patients with closed-injury mallet finger are treated with hyperextension splinting. Target 100%

## 3.2.8. 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.

### 3.2.9. FOLLOW-UP CARE

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.

## 4. EDUCATION

Part of the initial treatment plan for all disorders should include patient education. For most diagnoses, this is critical to successful treatment.

### EDUCATION FOR HAND, WRIST, OR FOREARM DISORDERS

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/Duration**

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.

**Rationale**

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.

**Evidence**

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.

## 5. ERGONOMIC INTERVENTIONS

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 (57). 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 (58,59,60,61).

### ERGONOMIC INTERVENTIONS FOR CTS AND COMMON DISTAL UPPER EXTREMITY TENDINOSES

**Recommended**

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

**Rationale**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel

et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), 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 (Sperling, 1951, Moore, 2000, Fahey et al., 1954, Compere, 1933, Hadji-Zavar, 1959, Hauck, 1923). 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 (Gerr et al., 2005). "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 (Figure 3) (Rempel et al., 1999). 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 (Tittiranonda et al., 1999). Additional quality studies are needed. Forearm supports for typing have been reported to result in fewer neck/shoulder symptoms (Rempel et al., 2006, Conlon et al., 2008). 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 (Rempel et al., 2006). 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 (Rempel et al., 2006, Gerr et al., 2005).

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 (van den Heuvel et al., 2003). Various types of breaks have been utilized including stretching breaks and exercise programs (Galinsky et al., 2007, Galinsky et al., 2000, Lee et al., 1992, Carter et al., 1994, Fenety et al., 2002, Feuerstein et al., 2004, Henning et al., 1997, Silverstein et al., 1988, Balci et al., 2004). Quality evidence supporting the efficacy of breaks is weak, especially for symptomatic patients (van den Heuvel et al., 2003, Galinsky et al., 2007, Galinsky et al., 2000). 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 (van den Heuvel et al., 2003, Galinsky et al., 2000, Henning et al., 1997, Balci et al., 2004, Balci et al., 2003, Floru et al., 1987, Kopardekar et al., 1994, McLean et al., 2001, Sauter et al., 1992). 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 (Rempel et al., 2006) and another found benefits for the neck, but not distal upper extremity (Ketola et al., 2002). Thus, other benefits of training may be possible. However, an RCT comparing wrist splinting with ergonomic education found splinting superior (Werner et al., 2005). Thus, if there is a benefit, it may be modest, and it is suggested that such training should consist of quality information.

## TYPING POSTURE FOR PREVENTION AND TREATMENT OF CTS AND COMMON DISTAL UPPER EXTREMITY TENDINOSES

**Not Recommended**

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)
**Level of confidence** Low

**Rationale**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), 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 (Sperling, 1951, Moore, 2000, Fahey et al., 1954, Compere, 1933, Hadji-Zavar, 1959, Hauck, 1923). 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.

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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 (Figure 3) (Rempel et al., 1999). 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 (Tittiranonda et al., 1999). Additional quality studies are needed. Forearm supports for typing have been reported to result in fewer neck/shoulder symptoms (Rempel et al., 2006, Conlon et al., 2008). 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 (Rempel et al., 2006). 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 (Rempel et al., 2006, Gerr et al., 2005).

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## TYPING POSTURE FOR TREATMENT OF CTS AND COMMON DISTAL UPPER EXTREMITY TENDINOSES

**Not Recommended**

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, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), although reductions in injuries have not been shown in quality studies.

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2003, Galinsky et al., 2007, Galinsky et al., 2000). 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 (van den Heuvel et al., 2003, Galinsky et al., 2000, Henning et al., 1997, Balci et al., 2004, Balci et al., 2003, Floru et al., 1987, Kopardekar et al., 1994, McLean et al., 2001, Sauter et al., 1992). 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.

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## SPLIT KEYBOARDS FOR TREATMENT OF COMMON DISTAL UPPER EXTREMITY TENDINOSES

**Recommended**

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

**Rationale**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), although reductions in injuries have not been shown in quality studies.

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Relatedness). Management/supervisor and labor/employee support are often necessary for optimal success of these programs.

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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 (Rempel et al., 2006) and another found benefits for the neck, but not distal upper extremity (Ketola et al., 2002). Thus, other benefits of training may be possible. However, an RCT comparing wrist splinting with ergonomic education found splinting superior (Werner et al., 2005). Thus, if there is a benefit, it may be modest, and it is suggested that such training should consist of quality information.

## FOREARM SUPPORT FOR TYPING TO PREVENT NECK/SHOULDER SYMPTOMS

**Recommended**

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

**Rationale**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), although reductions in injuries have not been shown in quality studies.

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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 (Rempel et al., 2006) and another found benefits for the neck, but not distal upper extremity (Ketola et al., 2002). Thus, other benefits of training may be possible. However, an RCT comparing wrist splinting with ergonomic education found splinting superior (Werner et al., 2005). Thus, if there is a benefit, it may be modest, and it is suggested that such training should consist of quality information.

## TRACKBALLS FOR TREATMENT OF SELECT PATIENTS WITH CTS

**Recommended**

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

**Rationale**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), 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 (Sperling, 1951, Moore, 2000, Fahey et al., 1954, Compere, 1933, Hadji-Zavar, 1959, Hauck, 1923). 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 (Gerr et al., 2005). "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 (Figure 3) (Rempel et al., 1999). 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 (Tittiranonda et al., 1999). Additional quality studies are needed. Forearm supports for typing have been reported to result in fewer neck/shoulder symptoms (Rempel et al., 2006, Conlon et al., 2008). 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 (Rempel et al., 2006). 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 (Rempel et al., 2006, Gerr et al., 2005).

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 (van den Heuvel et al., 2003). Various types of breaks have been utilized including stretching breaks and exercise programs (Galinsky et al., 2007, Galinsky et al., 2000, Lee et al., 1992, Carter et al., 1994, Fenety et al., 2002, Feuerstein et al., 2004, Henning et al., 1997, Silverstein et al., 1988, Balci et al., 2004). Quality evidence supporting the efficacy of breaks is weak, especially for symptomatic patients (van den Heuvel et al., 2003, Galinsky et al., 2007, Galinsky et al., 2000). 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 (van den Heuvel et al., 2003, Galinsky et al., 2000, Henning et al., 1997, Balci et al., 2004, Balci et al., 2003, Floru et al., 1987, Kopardekar et al., 1994, McLean et al., 2001, Sauter et al., 1992). 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 (Rempel et al., 2006) and another found benefits for the neck, but not distal upper extremity (Ketola et al., 2002). Thus, other benefits of training may be possible. However, an RCT comparing wrist splinting with ergonomic education found splinting superior (Werner et al., 2005). Thus, if there is a benefit, it may be modest, and it is suggested that such training should consist of quality information.

## COMPUTER TYPING BREAKS FOR PATIENTS WITH CTS, OTHER COMMON EXTENSOR AND FLEXOR HAND/WRIST TENDINOSES, OR FOR PRIMARY PREVENTION

**Recommended**

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

**Rationale**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), 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 (Sperling, 1951, Moore, 2000, Fahey et al., 1954, Compere, 1933, Hadji-Zavar, 1959, Hauck, 1923). 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 (Gerr et al., 2005). "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 (Figure 3) (Rempel et al., 1999). 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 (Tittiranonda et al., 1999). Additional quality studies are needed. Forearm supports for typing have been reported to result in fewer neck/shoulder symptoms (Rempel et al., 2006, Conlon et al., 2008). 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 (Rempel et al., 2006). 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 (Rempel et al., 2006, Gerr et al., 2005).

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 (van den Heuvel et al., 2003). Various types of breaks have been utilized including stretching breaks and exercise programs (Galinsky et al., 2007, Galinsky et al., 2000, Lee et al., 1992, Carter et al., 1994, Fenety et al., 2002, Feuerstein et al., 2004, Henning et al., 1997, Silverstein et al., 1988, Balci et al., 2004). Quality evidence supporting the efficacy of breaks is weak, especially for symptomatic patients (van den Heuvel et al., 2003, Galinsky et al., 2007, Galinsky et al., 2000). 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 (van den Heuvel et al., 2003, Galinsky et al., 2000, Henning et al., 1997, Balci et al., 2004, Balci et al., 2003, Floru et al., 1987, Kopardekar et al., 1994, McLean et al., 2001, Sauter et al., 1992). 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 (Rempel et al., 2006) and another found benefits for the neck, but not distal upper extremity (Ketola et al., 2002). Thus, other benefits of training may be possible. However, an RCT comparing wrist splinting with ergonomic education found splinting superior (Werner et al., 2005). Thus, if there is a benefit, it may be modest, and it is suggested that such training should consist of quality information.

## ERGONOMICS TRAINING IN MODERATE- OR HIGH-RISK MANUFACTURING SETTINGS

**Recommended**

Ergonomics training is recommended in moderate- or high-risk manufacturing settings.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), 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 (Sperling, 1951, Moore, 2000, Fahey et al., 1954, Compere, 1933, Hadji-Zavar, 1959, Hauck, 1923). 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.

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Thus, if there is a benefit, it may be modest, and it is suggested that such training should consist of quality information.

## ERGONOMICS TRAINING FOR PREVENTION OF MSDS IN OFFICE SETTINGS

**No Recommendation**

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**

Ergonomics interventions have been attempted in numerous occupational settings (Rempel et al., 1999, Rempel et al., 2006, Verhagen et al., 2004, Rempel et al., 2012). 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") (Tittiranonda et al., 1999, Rempel et al., 1999, Rempel et al., 2006, Gerr et al., 2002). 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 (Rempel et al., 2012). 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) (Arnetz et al., 2003). Despite the lack of quality evidence in most settings, reductions in job physical factors, particularly high force, are thought to be beneficial (Rempel et al., 2012, Herbert et al., 2000) (see Work-Relatedness). There also are experimental studies of different equipment (Simmer-Beck et al., 2006), although reductions in injuries have not been shown in quality studies.

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# 6. CARPAL TUNNEL SYNDROME

## 6.1. OVERVIEW

CTS is the most common and widely known of the entrapment neuropathies in which the body's peripheral nerves are compressed or traumatized (6,600,66,601,69,70), affecting an estimated 4 to 10 million Americans (601). 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 policis brevis and flexor pollicis brevis.) in the hand that allow the fingers and thumb to move. Often, the condition arises without apparent cause (6,7,602). 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.

There are numerous occupational and non-occupational risk factors for CTS, as well as other hand, wrist, and forearm musculoskeletal disorders (9,40,41,64,18,19,21,43,45). 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) (9).

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 (9,10,13,14,11,8,6,7,12,15,16,17,64,20,50,603,604,605,606). 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 (607). Determining whether a complaint of a hand, wrist, or forearm symptom are related to work requires a careful analysis and all associated or possible causal factors operative at the time must be weighed (19,51). 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 (27,35,33,23,36,37,38,32). The risk appears present when pinch forces are greater than 10 N (1kg) (41,36,32). Carpal tunnel syndrome risk appears most strongly increased in jobs involving high-force gripping such as meat processing, manufacturing, and farming (50,608,609,610).

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 (34,606,611,612,613,614,615,616,617,618,619,620,621,622,623,624). Prospective cohort studies have failed to find associations between CTS and keyboard use (606,612,307,625), however, one of these studies reported increased risk with increased mouse use in both its baseline/cross-sectional analyses and cohort analyses (612). Case-control studies have reported conflicting results, with one reporting reduced risk with increased hours spent typing (614) and one reporting increased risk with typing more than 4 hours per day (621). 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 (307,314,626). Split keyboards have been associated with reduction in pain and disorders (315,316). Thus, there is insufficient evidence to relate keyboard or computer activities to CTS.

## 6.2. RISK AND CAUSATION

There are numerous purported risk factors for CTS (see Table 2), 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 (6,7,8,9,10,40,62,11,12,63,41,13,14,42,15,16,17,64,18). 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 (35,23,65,28,36,29,37,38).

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

| Category | 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 | Female gender, pregnancy, menopause |
| Causes (Heredity) | 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 ($m^2$) |
| | 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, | Nonspecific tenosynovitis with synovial swelling and thickening |
| including Inflammatory | Arthropathies |
| and Non-Inflammatory | Osteoarthrosis |
| | Rheumatoid arthritis |
| | Scleroderma |
| | Chondrocalcinosis |
| | Dermatomyositis |
| | Amyloidosis with amyloid deposits |
| | Multiple Myeloma |
| | Paget's disease |
| | Gout, as well as other crystal arthropathies |
| Other Inflammatory and | Histoplasmosis |
| Infectious Conditions | 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 | Diabetes Mellitus |
| Alterations in Fluid Balance | Alcoholism |
| | Vitamin $B_6$ 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 |
| 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 |

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.

## 6.3. SIGNS AND SYMPTOMS

CTS patients typically have a constellation of symptoms with some variation in clinical presentations (66,67,68) and a lack of a criterion standard (69). Symptoms most typically start gradually in the thumb, index, and middle fingers with tingling, numbness, or burning (70,67). Symptoms may also include subjective hand swelling (71). 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 (72,73,74,75,68,76). 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) (69,67,68) 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% (22,77,78,79,80,81,82,83,84,85,33,86,87) while the incidence rate for working populations is near 2.3 per 100 person-years (88). Differences in diagnostic criteria and population characteristics between these studies may play a role in the differences in reported CTS prevalence (89).

## 6.4. PHYSICAL EXAMINATION

The physical examination is particularly helpful for assuring other condition(s) are not present. Some believe the physical examination is highly useful (90) 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 (69,56). 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 (91). 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 (92,93,94,95).
- 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 (96).
- 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 (97). 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 (98).
- 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.

## 6.5. 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) (99) 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 (100) – 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.

## 6.6. DIAGNOSTIC RECOMMENDATIONS

### 6.6.1. 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 (69,78,81,84,85)(627,628,629,630,631,632,633,634,635,636,637,638,639,640,641,642,643,644,645,646,647,648,649,650,651,652,653,654,655,656,657,658,659,660,661,662,663,664,665,666,545,667,668). In select or more difficult cases, especially if cervical radiculopathy is a concern, electromyography (EMG) studies should be incorporated (627). 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 (74).

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 (669).

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 (669). However, the quality of EDS varies widely in practice (670) 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 (70,67). 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) (627):

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 (671).
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 (669).
7. If abnormal in the index limb, then measuring the contralateral limb is helpful for both comparison and for diagnosis of systemic disorders.

## ELECTRODIAGNOSTIC STUDIES FOR DIAGNOSIS AND PRE-OPERATIVE ASSESSMENT OF CARPAL TUNNEL SYNDROME

**Recommended**

Quality electrodiagnostic studies (EDS) are recommended to assist in securing a firm diagnosis for those patients without a clear diagnosis of carpal tunnel syndrome (CTS). EDS are also recommended to objectively secure a diagnosis of CTS prior to surgical release in workers compensation patients (Buch-Jaeger et al., 1994). 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 cases.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Moderate

**Frequency/Dose/Duration**

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.

**Rationale**

EDS are the only unequivocally objective measures of median nerve function (Rempel et al., 1998, Jablecki et al., 2002, Buch-Jaeger et al., 1994, Atroshi et al., 2003, Kuntzer, 1994, Nathan et al., 1993). 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 (Dale et al., 2015, Elkowitz et al., 2005, American Association of Electrodiagnostic et al., 1999); and some studies have suggested there may have sufficient accuracy (Leffler et al., 2000, Dale et al., 2015), 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**

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.

## ELECTRODIAGNOSTIC STUDIES FOR INITIAL EVALUATION OF CARPAL TUNNEL SYNDROME

**Not Recommended**

Electrodiagnostic studies (EDS) are not recommended for initial evaluation of most patients with carpal tunnel syndrome (CTS), who have a confirming history and clinical signs because they do not change the management of the condition. EDS are also not recommended prior to glucocorticosteroid injection because a good history and clinical suspicion is believed to be sufficient to warrant the intervention.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

EDS are the only unequivocally objective measures of median nerve function (Rempel et al., 1998, Jablecki et al., 2002, Buch-Jaeger et al., 1994, Atroshi et al., 2003, Kuntzer, 1994, Nathan et al., 1993). 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 (Dale et al., 2015, Elkowitz et al., 2005, American Association of Electrodiagnostic et al., 1999); and some studies have suggested there may have sufficient accuracy (Leffler et al., 2000, Dale et al., 2015), 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**

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.

## COMMERCIAL PRODUCTS TO PERFORM ELECTRODIAGNOSTIC STUDIES FOR CARPAL TUNNEL SYNDROME

**Not Recommended**

There is no recommendation for the use of automated devices to accomplish electrodiagnostic studies (EDS) (Dale et al., 2015, Elkowitz et al., 2005).

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

EDS are the only unequivocally objective measures of median nerve function (Rempel et al., 1998, Jablecki et al., 2002, Buch-Jaeger et al., 1994, Atroshi et al., 2003, Kuntzer, 1994, Nathan et al., 1993). 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 (Dale et al., 2015, Elkowitz et al., 2005, American Association of Electrodiagnostic et al., 1999); and some studies have suggested there may have sufficient accuracy (Leffler et al., 2000, Dale et al., 2015), 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**

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.

## 6.6.2. ULTRASOUND

Ultrasound and high-resolution sonography have been investigated for the evaluation and diagnosis of CTS (101,102,103,104,105,106,107,108,109,110,111,112).

### ULTRASOUND FOR EVALUATION AND DIAGNOSIS OF CARPAL TUNNEL SYNDROME

**Not Recommended**

Ultrasound is not recommended for diagnosing carpal tunnel syndrome (CTS).

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

Multiple moderate-quality comparative studies report that ultrasound does not outperform and often modestly underperforms compared with EDS for the diagnosis of CTS (Pastare et al., 2009, Seror, 2008, Descatha et al., 2012, Ziswiler et al., 2005, Visser et al., 2008). Thus, ultrasound is not recommended for diagnosing CTS. There are other diagnostic uses of ultrasound at the wrist (e.g., evaluating a cyst).

**Evidence**

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.

## 6.6.3. MAGNETIC RESONANCE IMAGING

MRI and especially diffusion tensor imaging (diffusion MRI) are being investigated for the evaluation and diagnosis of CTS (113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129, 130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,152, 153,154,155,156,157,158,159,160,161,162,163).

### MAGNETIC RESONANCE IMAGING (MRI) FOR EVALUATION AND DIAGNOSIS OF CARPAL TUNNEL SYNDROME

**Not Recommended**

Magnetic resonance imaging (MRI) is moderately not recommended for diagnosing carpal tunnel syndrome (CTS).

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

Multiple moderate-quality comparative studies report that MRI does not outperform and often modestly underperforms compared with EDS for the diagnosis of CTS (Zagnoli et al., 1999, Brienza et al., 2014, Bulut et al., 2014, Jarvik et al., 2002). Thus, MRI is not recommended for diagnosing CTS. There are other diagnostic uses of MRI at the wrist.

**Evidence**

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.

## 6.6.4. DIFFUSION TENSOR IMAGING

MRI and especially diffusion tensor imaging (diffusion MRI) are being investigated for the evaluation and diagnosis of CTS (113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163).

### DIFFUSION TENSOR IMAGING FOR EVALUATION AND DIAGNOSIS OF CARPAL TUNNEL SYNDROME

**Not Recommended**

Diffusion tensor imaging is moderately not recommended for diagnosing carpal tunnel syndrome (CTS).

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

Multiple moderate-quality comparative studies report that diffusion tensor imaging does not outperform and often modestly underperforms compared with EDS for the diagnosis of CTS (Zagnoli et al., 1999, Brienza et al., 2014, Bulut et al., 2014, Jarvik et al., 2002). Thus, diffusion tensor imaging is not recommended for diagnosing CTS.

**Evidence**

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.

## 6.6.5. PROGRESS MONITORING

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 (672). These include the DASH (673,674,675,676,677,678,679,680,681,682,683,684,685,686,687,688,689,690,691,692,693,694) and Boston Carpal Tunnel Questionnaire (628,137,673,674,677,678,682,

683,684,686,688,689,691,694,695,696,697,698,699,700,701,702,703,704,705,706,707,708,709,710,711,712,713,714,715). Michigan Hand Outcomes Questionnaire (MHQ) has been used in many studies as a measurement outcome of CTS (685,693,697,716). The Short Form-36 (SF-36) (680,686,695), the Flinn Performance Screening Tool (FPST) (717), the Patient Evaluation Measure questionnaire (PEM) (679,694), the Amadio questionnaire (690), the Historical-objective-distribution based scale (Hi-Ob-Db) (698,710), and the Alderson-McGali hand function questionnaire (AMHFQ) (695) have been used to diagnose CTS. VAS symptoms and pain scores may also be used (680,684,695) even though many patients with CTS have no pain. Functional status scores (628,673,686,690,696,701)(705,706,708,711,713,717,718,719) and Global Symptom Scores (720) are also used, particularly in some research studies. Grip strength (679,684,695,702,703,708,715,721,722,723,724) 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 (673,677,683,697,705,713,720,725,726,727,728).

### PROGRESS MONITORING INSTRUMENTS FOR CARPAL TUNNEL SYNDROME

**No Recommendation**

There is no recommendation for or against the use of instruments to monitoring the progress of patients with carpal tunnel syndrome (CTS).

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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**

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.

## 6.7. TREATMENT RECOMMENDATIONS

## 6.7.1. ACTIVITY MODIFICATION AND EXERCISE

Various exercise regimens have been utilized to treat patients with CTS, most commonly tendon-gliding and nerve-gliding exercises (164,165,166,167,168,169,170,171). These exercises are thought to help prevent adhesion formation (169,172,173,174). Yoga has been used to treat CTS (175), although its main uses have been in treating spine pain and other more widespread MSDs (see Chronic Pain and Low Back Disorders Guidelines).

Wrist splinting has been utilized to treat CTS (176,165,175,59,177, 178,179,180,181,182,183,184,185,186,187). A precise mechanism of action is unclear, although it is believed to prevent hyperflexed postures, particularly while sleeping, that provoke symptoms (182,184). Placement of the wrist in functional neutral posture (approximately 15° of extension) is most typically performed (59); however, most studies do not specify the posture and at least one study utilized a neutral posture of 0° (168) which actually is a modest degree of flexion. Whether those differences in postures are clinically meaningful is unknown.

## EXERCISES FOR PATIENTS WITH SIGNIFICANT DEFICITS

**Recommended**

Exercise is recommended for the postoperative rehabilitation of patients with carpal tunnel syndrome (CTS) who have significant deficits.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Post-operative CTS patients with significant functional deficits.

**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.

**Indications for discontinuation**

Completion of a course of therapy of approximately 6 visits. Independence in performing exercises at home. Non-compliance.

**Rationale**

There are multiple moderate quality studies, but none has clearly found benefit of exercises, including tendon-gliding, for treatment of CTS (Abdolrazaghi 2023). Two moderate-quality studies suggest there is no statistically significant incremental benefit from adding tendon-gliding exercises to wrist splinting (Akalin et al., 2002) (Abdolrazaghi 2023) although modest trends towards benefit appear present in both studies. Another moderate-quality study found a combination of tendon-gliding exercise with ultrasound and splinting superior to two other combinations (Baysal et al., 2006). 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 section for guidance that may be adapted for such patients).

**Evidence**

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.

## EXERCISES FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CARPAL TUNNEL SYNDROME

**No Recommendation**

There is no recommendation for or against the use of exercises for treatment of carpal tunnel syndrome (CTS) in the absence of functional deficits, as quality evidence is lacking.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**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.

**Rationale**

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 (Akalin et al., 2002), 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 (Baysal et al., 2006). 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 section for guidance that may be adapted for such patients).

**Evidence**

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 FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CTS

**No Recommendation**

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**

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 (Garfinkel et al., 1998). While yoga appears beneficial for treatment of spine patients (Williams et al., 2009), 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**

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.

## NOCTURNAL WRIST SPLINTING FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**Recommended**

Nocturnal wrist splinting is moderately recommended for treatment of acute, subacute, or chronic CTS (Stevinson et al., 2003).

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** High

**Indications**

Symptoms consistent with carpal tunnel syndrome.

**Frequency/Dose/Duration**

Wrist splints are recommended to be worn while sleeping (Werner et al., 2005, Gerritsen et al., 2002, Premoselli et al., 2006, Walker et al., 2000, Manente et al., 2001). 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 (King et al., 2003); 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 (Walker et al., 2000). 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 (Brininger et al., 2007, De Angelis et al., 2009, Storey P, 2013).

**Indications for 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.
**Rationale**

Wrist splints have been shown to be effective compared to not splinting (Premoselli et al., 2006, Manente et al., 2001) or to ergonomic education (Werner et al., 2005). Splinting is also comparable to and in some measures superior to oral steroids (Mishra et al., 2006). One trial found splinting combined with NSAIDs comparable to glucocorticosteroid injection (Celiker et al., 2002). 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 (Akalin et al., 2002). 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 (Gerritsen et al., 2002), particularly in light of a subsequent report that those with shorter duration of symptoms had superior results with splinting (Gerritsen et al., 2003). Another trial compared splinting versus injection versus surgery and found few differences except for a modest trend favoring surgery over the long term (Ucan et al., 2006). A trial conducted in the Netherlands comparing splinting with surgery found little clinical difference, but concluded surgery was more cost-effective (Korthals-de Bos et al., 2006). A recent report suggests splinting is more likely to be effective in those with milder symptoms of less than 1-year duration (Gerritsen et al., 2003). Wrist splints are

not invasive, have no significant adverse effects, and are not costly. They are moderately recommended for treatment of CTS.

**Evidence**

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.

## 6.7.2. MEDICATIONS

### 6.7.2.1. NSAIDS AND 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 (188,189,190,191,192,193) (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.

#### NSAIDS FOR SUBACUTE OR CHRONIC CARPAL TUNNEL SYNDROME

**Not Recommended**

NSAIDs are not recommended as a primary treatment for subacute or chronic carpal tunnel syndrome (CTS) (Chang et al., 1998).

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Low
**Frequency/Dose/Duration**

See manufacturer's recommendations.

**Rationale**

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 (Chang et al., 1998). 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 (Chang et al., 1998). 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 (Davis et al., 1998) and lidocaine patch (Nalamachu et al., 2006) 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 (Celiker et al., 2002). 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 (Chang et al., 1998, Davis et al., 1998, Nalamachu et al., 2006). 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 (Husby et al., 2001). 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**

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.

## ACETAMINOPHEN FOR SUBACUTE OR CHRONIC CARPAL TUNNEL SYNDROME

**Not Recommended**

Acetaminophen are not recommended as a primary treatment for subacute or chronic carpal tunnel syndrome (CTS) (Chang et al., 1998).

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Low

**Frequency/Dose/Duration**

See manufacturer's recommendations.

**Rationale**

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 (Chang et al., 1998). 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 (Chang et al., 1998). 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 (Davis et al., 1998) and lidocaine patch (Nalamachu et al., 2006) 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 (Celiker et al., 2002). 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 (Chang et al., 1998, Davis et al., 1998, Nalamachu et al., 2006). 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 (Husby et al., 2001). 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**

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.

## NSAIDS FOR POST-OPERATIVE MANAGEMENT OF CTS-RELATED PAIN

**Recommended**

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

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** High

**Indications**

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

**Frequency/Dose/Duration**

See manufacturer's recommendations.

**Indications for discontinuation**

Resolution of pain, adverse effects, intolerance.

**Rationale**

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 (Chang et al., 1998). 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 (Chang et al., 1998). 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 (Davis et al., 1998) and lidocaine patch (Nalamachu et al., 2006) 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 (Celiker et al., 2002). 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 (Chang et al., 1998, Davis et al., 1998, Nalamachu et al., 2006). 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 (Husby et al., 2001). 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**

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.

## ACETAMINOPHEN FOR POST-OPERATIVE MANAGEMENT OF CTS-RELATED PAIN

**Recommended**

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

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

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

**Frequency/Dose/Duration**

See manufacturer's recommendations.

**Indications for discontinuation**

Resolution of pain, adverse effects, intolerance.

**Rationale**

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 (Chang et al., 1998). 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 (Chang et al., 1998). 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 (Davis et al., 1998) and lidocaine patch (Nalamachu et al., 2006) 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 (Celiker et al., 2002). 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 (Chang et al., 1998, Davis et al., 1998, Nalamachu et al., 2006). 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 (Husby et al., 2001). 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**

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.

## 6.7.2.2. GLUCOCORTICOSTEROIDS

Glucocorticosteroids are used to treat CTS and other tendinoses through both oral and injection routes (injections for CTS and other tendinoses) (194,195,196,197,198,177,199). 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 (199).

### ORAL GLUCOCORTICOSTEROIDS FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CARPAL TUNNEL SYNDROME

**Recommended**

Oral glucocorticosteroids are moderately recommended for treatment of acute, subacute, or chronic CTS among patients who decline carpal tunnel injection.

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** Moderate

**Indications**

CTS unresponsive to splinting. Most patients should be injected rather than given oral steroids (Wong et al., 2001). 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/Duration**

It is unclear what dose and duration of treatment is optimal. Two trials used 10 days of treatment with prednisolone acetate 25mg a day (Hui et al., 2001, Wong et al., 2001). A third used prednisolone 20mg a day for 2 weeks, then 10mg a day for 2 weeks (Chang et al., 1998, Mishra et al., 2006). Another used prednisone 20mg a day for 1 week, then 10mg a day for 1 week (Herskovitz et al., 1995). Another used prednisolone 20mg a day for 2 weeks on one treatment arm (Chang et al., 2002). There is evidence that 2 weeks of treatment is as effective as 4 weeks (Chang et al., 2002). 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.

**Rationale**

There is strong evidence that injected glucocorticosteroids are more effective (Wong et al., 2001) with longer duration of benefits. Nevertheless, there is consistent evidence that oral glucocorticosteroids are superior to placebo (Chang et al., 1998, Chang et al., 2002, Herskovitz et al., 1995, Hui et al., 2004), as well as compared with diuretics and NSAIDs (Chang et al., 1998). 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**

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

## 6.7.2.3. DIURETICS

Diuretics have been used to treat CTS, in part due to observations of swelling in some patients (59,192,194,200,201,202,203).

### DIURETICS FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CTS

**Not Recommended**

Diuretics are moderately not recommended for treatment of acute, subacute, or chronic carpal tunnel syndrome (CTS) in the absence of fluid retention states.

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

There are two quality studies evaluating diuretics for treatment of CTS patients and both failed to find evidence of efficacy compared with placebo (Chang et al., 1998, Pal et al., 1988). 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**

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.

## 6.7.2.4. OPIOIDS

Opioids have occasionally been used to treat pain for patients with CTS. Opioids are addressed in a separate Guideline. The treatment recommendations are summarized below. See Opioids Guideline for all supporting evidence.

### ROUTINE USE OF OPIOIDS FOR TREATMENT OF NON-SEVERE ACUTE PAIN

**Not Recommended**

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).

**Strength of evidence** Strongly Not Recommended, Evidence (A)
**Level of confidence** High

**Benefits**

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

**Harms**

May inadequately treat acute, severe pain.

**Evidence**

See Opioids Guideline.

### OPIOIDS FOR TREATMENT OF ACUTE, SEVERE PAIN

**Recommended**

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 (Karl et al., 2015) opioid may be indicated if there is 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.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** High

**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).
2) Other more efficacious treatments should have been instituted, 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.
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 (H1-blockers), and/or iii) illicit substances (Atluri et al., 2004, Cheng et al., 2013, Eriksen et al., 2006, Green et al., 2011). 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 (Cheng et al., 2013, Eriksen et al., 2006). 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 (Cheng et al., 2013, Dunn et al., 2010, Grattan et al., 2012, Hadidi et al., 2009, Hall et al., 2008, Manchikanti et al., 2004, Nyhlen et al., 2011, Paulozzi et al., 2012, Paulozzi et al., 2009, Shah et al., 2008, Toblin et al., 2010, Webster et al., 2011, Wunsch et al., 2009, Wysowski, 2007, Wysowski et al., 2006, Centers for Disease Control and Prevention, 2005, Centers for Disease Control and Prevention, 2010, Dean, 2004, Deyo et al., 2011, Fareed et al., 2009, Goodridge et al., 2010, Mills et al., 2005, Seal et al., 2012). Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis (Walter et al., 2011), 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).

**Benefits**

Improved short-term pain control.

**Harms**

Adverse effects are many (see section on "Opioids Benefits and Harms").

**Frequency/Dose/Duration**

Generally, opioids should be prescribed at night or while not working (Gomes et al., 2013). Lowest effective, short-acting opioid doses are preferable as they tend to have the better safety profiles, less risk of escalation (Cifuentes et al., 2010), less risk of lost time from work (Volinn et al., 2009), and faster return to work (Dersh et al., 2008). 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.

**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.

**Evidence**

See Opioids Guideline.

## SCREENING PATIENTS PRIOR TO INITIATION OF OPIOIDS

**Recommended**

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-H1 blocker (Cheng et al., 2013)), 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 (Eriksen et al., 2006, Reneman et al., 2002, Swinkels-Meewisse et al., 2006), adverse effects, and symptoms and signs of aberrancy.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**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.

**Harms**

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

**Evidence**

See Opioids Guideline.

## OPIOID DOSE LIMITS IN ACUTE PAIN

**Recommended**

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) (Bohnert et al., 2011) (see Figure 4). 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/Chronic 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.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Moderate

**Benefits**

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

**Harms**

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

**Evidence**

See Opioids Guideline.

## LIMITED USE OF OPIOIDS FOR POST-OPERATIVE PAIN

**Recommended**

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

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** High

**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) (Karl et al., 2015). 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 (Nader et al., 2012). 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 (Belknap et al., 2008).
2. The lowest effective dose of a short-acting opioid should be used (Cifuentes et al., 2010), as well as weaker opioids if possible (Volinn et al., 2009, Dersh et al., 2008).
3. Short-acting opioids are recommended for treatment of acute pain.
4. Dispensing should be only what is needed to treat the pain (U.S. Department of Labor et al., 2013).
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 (H1-blockers), and/or iii) illicit substances (Atluri et al., 2004, Cheng et al., 2013, Eriksen et al., 2006, Green et al., 2011). 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 (Cheng et al., 2013, Eriksen et al., 2006).

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 (Cheng et al., 2013, Dunn et al., 2010, Grattan et al., 2012). Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis (Walter et al., 2011), 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.

**Benefits**

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

**Harms**

Adverse effects are many (see section on "Opioids Benefits and Harms").

**Frequency/Dose/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 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.

**Evidence**

See Opioids Guideline.

## SCREENING PATIENTS PRIOR TO CONTINUATION OF OPIOIDS

**Recommended**

Screening of patients is recommended for patients requiring continuation of opioids beyond the second post-operative week.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**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.

**Harms**

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

**Rationale**

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-H1 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 (Eriksen et al., 2006, Reneman et al., 2002, Swinkels-Meewisse et al., 2006), and symptoms and signs of aberrancy.

**Evidence**

See Opioids Guideline.

## OPIOID DOSE LIMITS IN POST-OPERATIVE PAIN

**Recommended**

The maximum daily oral dose recommended for opioid-naïve, acute pain patients based on risk of overdose/death is 50mg morphine equivalent dose (MED) (Shanahan et al., 2006, Bohnert et al., 2011) (see Figure 4). 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/Chronic Opioid recommendations below).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Benefits**

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

**Harms**

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

**Evidence**

See Opioids Guideline.

## ROUTINE USE OF OPIOIDS FOR SUBACUTE AND CHRONIC NON-MALIGNANT PAIN

**Not Recommended**

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).

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** High

**Benefits**

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

**Harms**

May inadequately treat severe subacute or chronic pain.

**Evidence**

See Opioids Guideline.

## OPIOIDS FOR TREATMENT OF SUBACUTE OR CHRONIC SEVERE PAIN

**Recommended**

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 (Federation of State Medical Boards, 2013, International Association of Industrial Accident Boards and Commissions, 2013). 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) (Reneman et al., 2002) (see Appendix 1 of Opioids Guideline).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Patients should meet all of the following:
1. Reduced function is attributable to the pain. Pain or pain scales alone are insufficient reasons (Eriksen et al., 2006, Reneman et al., 2002, Brouwer et al., 2005, Buelow et al., 2009, Food and Drug Administration, 2013, Fox et al., 1979, Gross et al., 2003, Hartrick et al., 2003, Lund et al., 2005,

Mahowald et al., 2005, Morasco et al., 2013, Reneman et al., 2007, Schiphorst Preuper et al., 2008, Smeets et al., 2007).
2. A severe disorder warranting potential opioid treatment is present [e.g., CRPS, severe radiculopathy, advanced degenerative joint disease (DJD)] (Food and Drug Administration, 2013).
3. Other more efficacious treatments have been documented to have failed (Food and Drug Administration, 2013). 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 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 (Cifuentes et al., 2010). Weaker opioids should be used whenever possible (Volinn et al., 2009, Dersh et al., 2008). 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 (Wilson d'Almeida et al., 2008).
9. Extended-release/long-acting opioids are recommended to be used on a scheduled basis, rather than as needed (Food and Drug Administration, 2013). 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 (H1-blockers), and/or iii) illicit substances (Atluri et al., 2004, Cheng et al., 2013, Eriksen et al., 2006, Green et al., 2011). 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 (Cheng et al., 2013, Green et al., 2011).
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 (Cheng et al., 2013, Dunn et al., 2010, Grattan et al., 2012, Hadidi et al., 2009, Hall et al., 2008, Manchikanti et al., 2004, Nyhlen et al., 2011, Paulozzi et al., 2012, Paulozzi et al., 2009, Shah et al., 2008, Toblin et al., 2010, Webster et al., 2011, Wunsch et al., 2009, Wysowski, 2007, Wysowski et al., 2006, Centers for Disease Control and Prevention, 2005, Centers for Disease Control and Prevention, 2010, Dean, 2004, Deyo et al., 2011, Fareed et al., 2009, Goodridge et al., 2010, Mills et al., 2005, Seal et al., 2012). Considerable caution is also warranted among those with other comorbidities such as chronic hepatitis and/or cirrhosis (Walter et al., 2011), 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).

**Benefits**

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

**Harms**

Adverse effects are many (see section on "Opioids Benefits and Harms"). May initiate path to opioid dependency.

**Indications for discontinuation**

Opioids should be discontinued based on lack of functional benefit (International Association of Industrial Accident Boards and Commissions, 2013) (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).

**Rationale**

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 (Von Korff et al., 2011), at night or when not at work (Gomes et al., 2013). 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 (Cifuentes et al., 2010), less work loss (Volinn et al., 2009), and faster return to work (Dersh et al., 2008). Patients should have ongoing visits to monitor efficacy, adverse effects, compliance and surreptitious medication use. Opioid prescriptions should be shorter rather than longer duration (Cifuentes et al., 2012).

**Evidence**

See Opioids Guideline.

## SCREENING PATIENTS PRIOR TO INITIATION OF OPIOIDS

**Recommended**

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 (Dersh et al., 2008, Hartrick et al., 2012, Hartrick et al., 2003), other psychiatric disorder, substance abuse history, sedating medication use (e.g., anti-

histamine/anti-H1 blocker) (Webster et al., 2011), 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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**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.

**Harms**

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

**Evidence**

See Opioids Guideline.

## OPIOID DOSE LIMITS IN SUBACUTE AND CHRONIC PAIN

**Recommended**

The maximum daily oral dose recommended for subacute or chronic pain patients based on risk of overdose/death is 50mg Morphine Equivalent Dose (MED) (Dunn et al., 2010, Bohnert et al., 2011). 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 (Naliboff et al., 2011).

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 drug screening section); and v) at least semiannual review of medications, particularly to assure no sedating medication use (e.g., benzodiazepine, sedating anti-histamines).

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** High

**Benefits**

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

**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.

**Evidence**

See Opioids Guideline.

## USE OF AN OPIOID TREATMENT AGREEMENT (OPIOID CONTRACT, DOCTOR/PATIENT AGREEMENT, INFORMED CONSENT)

**Recommended**

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) (Federation of State Medical Boards, 2013, Chou et al., 2009, Goldberg et al., 2005, Manchikanti et al., 2006, Manchikanti et al., 2006, Starrels et al., 2010, Wiedemer et al., 2007, Chelminski et al., 2005, Compton et al., 2008, Hariharan et al., 2007, Ives et al., 2006, Vaglienti et al., 2003, Burchman et al., 1995). If consent obtained, it is recommended appropriate family members be involved in this agreement.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**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.

**Harms**

Negligible

**Evidence**

See Opioids Guideline.

## URINE DRUG SCREENING FOR PATIENTS PRESCRIBED OPIOIDS

**Recommended**

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 (Appenzeller et al., 2007, Cooper et al., 2012, Kulaga et al., 2009, Lamoureux et al., 2009, Lees et al., 2012, Politi et al., 2007) or blood (for acute toxicity) may be appropriate.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** High

**Indications**

All patients on opioids for subacute or chronic pain.

**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).

**Harms**

No adverse clinical effects if properly interpreted.

**Rationale**

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 (Substance Abuse and Mental Health Services Administration, 2013). 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 (International Association of Industrial Accident Boards and Commissions, 2013).

**Evidence**

See Opioids Guideline.

## 6.7.2.5. VITAMINS

Treatment of CTS with pyridoxine (Vitamin B6) has been attempted (192,201,204,205,206,207) 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 (208), but not all studies (209). Vitamin B12 has also been reported as a successful treatment for stroke patients with CTS (210).

## PYRIDOXINE FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CTS

**Not Recommended**

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

**Rationale**

There are two quality studies that reviewed pyridoxine to treat CTS patients. However, benefits have not been shown in the highest quality study (Spooner et al., 1993). 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 (Ellis et al., 1982). 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**

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.

## OTHER VITAMINS FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CTS

**No Recommendation**

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**

There are two quality studies that reviewed pyridoxine to treat CTS patients. However, benefits have not been shown in the highest quality study (Spooner et al., 1993). 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 (Ellis et al., 1982). 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**

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.

## 6.7.2.6. TOPICAL MEDICATIONS

Topical lidocaine patches have been increasingly used to treat numerous pain conditions through transdermal application of topical anesthetic (211,212,213).

### LIDOCAINE PATCHES FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CTS

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**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/Dose/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 (US Food and Drug Administration, 2009). 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.

**Rationale**

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 (Nalamachu et al., 2006). In one moderate-quality study, lidocaine patches were suggested to be somewhat more effective than naproxen (Nalamachu et al., 2006); 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL and Cochrane Library without date limits using the following terms: lidocaine or lidocaine patch, carpal tunnel syndrome, median neuropathy, CTS, carpal tunnel, median nerve, compression, entrapment, neuropathy, nerve disease, syndrome, meadian nerve, median neuropathy, burning, itching, numbness, tingling, hand, palm, finger, wrist, pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, retrospective, and prospective studies. We found and reviewed 56 articles in PubMed, 14 in Scopus, 2 in CINAHL, and 40 in Cochrane Library. We considered for inclusion 3 from PubMed, 1 from Scopus, 0 from CINAHL, Cochrane Library and other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 0 systematic studies met the inclusion criteria.

## 6.7.2.7. OTHER MEDICATIONS

Gabapentin has been used to treat carpal tunnel syndrome (214).

### GABAPENTIN FOR TREATMENT OF CARPAL TUNNEL SYNDROME

**Not Recommended**

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

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

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**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

[1]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, dihydrocodeiene, hydrocodone/codeine when compounded with an NSAID, Marinol. Class IV includes tramadol (in some states), carisoprodol, benzodiazepines, and long-activating barbiturates. Class V includes small amounts of codeine (e.g, 30mg, 60mg).

[2]Other indications beyond the scope of this guideline include acute myocardial infarction or agitation interfering with acute trauma management.

[3]Treatments to have tried generally include NSAIDs and acetaminophen. For LBP patients, additional considerations include muscle relaxants, progressive aerobic exercise, and directional exercise.

[4]Exceptions such as acute, severe trauma should be documented.

[5]Statistical significance present for acute and chronic pain at and above 50 mg per day of oral morphine equivalent dose.

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

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

[8]Statistical significance present for acute and chronic pain at and above 50 mg per day of morphine equivalent dose.

[9]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.

[10]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.

## 6.7.3. ALLIED HEALTH THERAPIES

## 6.7.3.1. ACUPUNCTURE

Acupuncture has been used to treat CTS and other hand, wrist, and forearm MSDs (215,216). 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).

### ACUPUNCTURE FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**Not Recommended**

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

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

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 (Yao et al., 2012). One trial found no differences between acupuncture and oral steroid (Yang et al., 2009, Yang et al., 2011). Another trial susceptible to contact time bias found minimal differences between acupuncture and nocturnal wrist splinting (Kumnerddee et al., 2010). Thus, the highest quality evidence suggests acupuncture is ineffective for treatment of CTS and acupuncture is not recommended.

**Evidence**

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.

## 6.7.3.2. 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 (217).

### BIOFEEDBACK FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**No Recommendation**

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**

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**

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.

## 6.7.3.3. LOW-LEVEL LASER THERAPY

Low-level laser treatment (LLLT) has been used to treat MSDs including CTS (215,218,219). 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) (220).

### LOW-LEVEL LASER THERAPY FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**Not Recommended**

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**

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 (Evcik et al., 2007, Irvine et al., 2004, Tascioglu et al., 2012). One trial found no differences when compared with ultrasound (Bakhtiary et al., 2004) and a second trial found ultrasound superior (Saeed et al., 2012). Another study found no additive benefits of LLLT over splinting (Yagci et al., 2009). 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**

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.

## 6.7.3.4. MAGNETIC THERAPY

Treatment of CTS and other hand, wrist, and forearm MSDs with magnets (221,222,223) and pulsed magnetic field therapy (224,225,226) has been attempted to manage pain (166,202,178).

## MAGNETS FOR MANAGEMENT OF PAIN FROM OF ACUTE, SUBACUTE, OR CHRONIC CARPAL TUNNEL SYNDROME

**Not Recommended**

Magnets are moderately not recommended for management of pain from acute, subacute, or chronic carpal tunnel syndrome (CTS).

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** High

**Rationale**

Quality evidence suggests magnets (Carter et al., 2002, Colbert et al., 2010) are ineffective for treatment of CTS. Low-quality evidence suggests pulsed magnetic field therapy (Dakowicz et al., 2011, Arikan, 2011) is not effective for treating CTS (Carter et al., 2002). 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**

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.

## PULSED MAGNETIC FIELD THERAPY FOR MANAGEMENT OF PAIN FROM OF ACUTE, SUBACUTE, OR CHRONIC CARPAL TUNNEL SYNDROME

**Not Recommended**

Pulsed magnetic field therapy is not recommended for management of pain from acute, subacute, or chronic carpal tunnel syndrome (CTS).

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

Quality evidence suggests magnets (Carter et al., 2002, Colbert et al., 2010) are ineffective for treatment of CTS. Low-quality evidence suggests pulsed magnetic field therapy (Dakowicz et al., 2011, Arikan, 2011) is not effective for treating CTS (Carter et al., 2002). 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**

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.

## 6.7.3.5. MANIPULATION AND MOBILIZATION

Manipulation and mobilization are two types of manual therapy which have been used for treatment of CTS (167,227,228,229,230,231,232,233). 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).

## 6.7.3.6. MASSAGE AND THERAPEUTIC TOUCH

Massage has been used to treat patients with CTS, particularly when combined with other forearm symptoms (61). Therapeutic touch, considered an alternative healing technique, involves the use of the practitioner's hands to focus and facilitate healing (234).

### MASSAGE FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**Not Recommended**

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

**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/Duration**

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.

**Indications for discontinuation**

Resolution, failure to objectively improve, or intolerance.

**Rationale**

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 (Madenci et al., 2012). 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**

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.

## MASSAGE FOR ACUTE, SUBACUTE, OR CHRONIC CTS WITH FOREARM MYOFASCIAL PAIN

**Recommended**

Massage is recommended for treatment of select patients with acute, subacute, or chronic CTS who have significant myofascial pain.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**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/Duration**

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.

**Indications for discontinuation**

Resolution, failure to objectively improve, or intolerance.

**Rationale**

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 (Madenci et al., 2012). 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**

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 FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**Not Recommended**

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**

There are no quality studies suggesting therapeutic touch is effective for treatment of CTS (Blankfield et al., 2001). 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**

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.

## 6.7.3.7. THERAPEUTIC ULTRASOUND

Ultrasound has been used to treat many MSDs including CTS (235,236,237,238,239).

### ULTRASOUND FOR ACUTE, SUBACUTE, OR CHRONIC CTS IN SELECT PATIENTS WHO FAIL SPLINT USE OR DECLINE INJECTION

**No Recommendation**

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**

The highest quality trial found ultrasound to be ineffective compared with sham ultrasound where both groups were treated with splinting (Yildiz et al., 2011). One moderate-quality study found modest efficacy comparing ultrasound with placebo (Ebenbichler et al., 1998). Another study had no placebo control and found ultrasound superior to low level laser therapy (Bakhtiary et al., 2004). One trial found ultrasound comparable to glucocorticosteroid injection (Bilgici et al., 2010). The remaining quality studies included co-interventions (Baysal et al., 2006, Davis et al., 1998) or had a lower quality rating and mostly suggested lack of efficacy (Oztas et al., 1998).

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**

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.

## 6.7.4. ELECTRICAL THERAPIES

Phonophoresis involves the use of ultrasound to deliver topically applied drugs and has been used to treat patients with CTS (240). 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 (240,241,242). 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.

### PHONOPHORESIS FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**Recommended**

Phonophoresis is recommended for treatment of acute, subacute, or chronic CTS.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**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/Dose/Duration**

The regimen in the highest quality study consisted of 5-15 sessions per week for 4-8 weeks with ketoprofen phonophoresis (PH) (Bakhtiary et al., 2013), US pulse mode (1:4) with 2.5% ketoprofen gel at 1 MHz frequency and 1 W/cm2 intensity (Yildiz et al., 2011). Dexamethasone has also been successfully used (Soyupek et al., 2012, Bakhtiary et al., 2013), with one trial suggesting the steroid is superior to NSAID (diclofenac) (Soyupek et al., 2012). Other NSAIDs and glucocorticoids are presumably equally efficacious (Yildiz et al., 2011).

**Indications for discontinuation**

Resolution, failure to objectively improve or intolerance.

**Rationale**

One high-quality comparative trial found ketoprofen phonophoresis plus splinting superior to ultrasound plus splinting (Yildiz et al., 2011). One moderate quality comparative trial found dexamethasone administered by phonophoresis superior to iontophoresis (Bakhtiary et al., 2013). One moderate quality comparative trial found phonophoresis with glucocorticoid superior to phonophoresis with diclofenac or splinting (Soyupek et al., 2012). 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**

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 FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**No Recommendation**

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)
**Level of confidence** Low

**Rationale**

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 (Amirjani et al., 2009). However, it was small in size (n = 20) and appears underpowered. The other moderate-quality study found injection to be superior (Gokoglu et al., 2005). 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 (Gokoglu et al., 2005). 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**

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.

## 6.7.5. HOT AND COLD THERAPIES

Ice has been rarely used to treat CTS. Various forms of heat treatment have sometimes been used to treat CTS (243). Diathermy is a type of heat treatment that has been used clinically to heat tissue (244,245). 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 (245,246).

## ICE FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CTS

**No Recommendation**

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**

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**

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 FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CTS

**No Recommendation**

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**

There are no quality studies suggesting heat is effective for treatment of CTS. There is one trial with paraffin as a cointervention (Horng et al., 2011). 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**

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 FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC CTS

**No Recommendation**

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**

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**

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.

## 6.7.6. 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.

Steroid injections of the carpal canal are frequently performed to treat CTS patients (189,201,247,248,240,242,249,250,251,252,253,254,255,256,257,258,259,260,261), 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 (262), steroid injections should be done by those experienced with administering these injections.

Intramuscular injections have been used to treat CTS (260). Treatment of CTS with carpal tunnel insulin injections has been attempted (192,263). Botulinum injections have been used to treat CTS (264,265).

## CARPAL TUNNEL INJECTIONS FOR TREATMENT OF SUBACUTE OR CHRONIC CTS

**Recommended**

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

**Strength of evidence** Strongly Recommended, Evidence (A)
**Level of confidence** High

**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.

**Frequency/Dose/Duration**

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 (Atroshi et al., 2013). 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, 60, 80 mg), betamethasone (6.0, 6.4 mg), triamcinolone hexacetonide (20, 40, 80 mg), and hydrocortisone (25, 100 mg) 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.

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 (Andreu et al., 2006). 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.

**Rationale**

There is strong consistent evidence that carpal tunnel injections are efficacious with superiority to placebo (Celiker et al., 2002, Ucan et al., 2006, Aygul et al., 2005, Gokoglu et al., 2005, Armstrong et

al., 2004, Dammers et al., 2006, Habib et al., 2006, Hui et al., 2005, Ozdogan et al., 1984, Atroshi et al., 2013). There also is evidence that injections are superior to oral glucocorticosteroids (Wong et al., 2001) and iontophoresis with glucocorticosteroids (Gokoglu et al., 2005). 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 (Eslamian F, 2017, Lee JY, 2014, Babaei-Ghazani A, 2018, Ustun et al., 2013)(Makhlouf T, 2014, Finnoff JT, 2015). 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 (Wang et al., 2003), 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 (Dammers et al., 2006). 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**

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 30articles considered for inclusion, 30 randomized trials and 0 systematic studies met the inclusion criteria.

## CARPAL TUNNEL INJECTIONS FOR TREATMENT OF ACUTE CTS WITHOUT FRACTURE

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**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.

**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.

**Rationale**

There is strong consistent evidence that carpal tunnel injections are efficacious with superiority to placebo (Celiker et al., 2002, Ucan et al., 2006, Aygul et al., 2005, Gokoglu et al., 2005, Armstrong et al., 2004, Dammers et al., 2006, Habib et al., 2006, Hui et al., 2005, Ozdogan et al., 1984, Atroshi et al., 2013). There also is evidence that injections are superior to oral glucocorticosteroids (Wong et al., 2001) and iontophoresis with glucocorticosteroids (Gokoglu et al., 2005). 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 (Eslamian F, 2017, Lee JY, 2014, Babaei-Ghazani A, 2018, Ustun et al., 2013)(Makhlouf T, 2014, Finnoff JT, 2015). 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 (Wang et al., 2003), 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 (Dammers et al., 2006). 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**

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 30articles considered for inclusion, 30 randomized trials and 0 systematic studies met the inclusion criteria.

## INTRAMUSCULAR INJECTIONS FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**Not Recommended**

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

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Moderate

**Rationale**

Intramuscular injections for CTS are not recommended as they have been found to be inferior to carpal tunnel injections (Ozdogan et al., 1984).

**Evidence**

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.

## INSULIN INJECTIONS FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**No Recommendation**

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**

There is one quality study which included CTS patients that suggests benefit from 7 weekly injections of insulin (Ozkul et al., 2001). A second moderate quality trial found a lack of benefits compared with physiotherapy (Ashraf et al., 2009). 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**

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.

### BOTULINUM INJECTIONS FOR ACUTE, SUBACUTE, OR CHRONIC CTS

**Not Recommended**

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

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Breuer et al., 2006). 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 (US Food and Drug Administration, 2009, Li et al., 2005), and are costly. They are not recommended for management of CTS.

**Evidence**

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.

## 6.7.7. SURGERY

### 6.7.7.1. OVERVIEW

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 (178,729,730,731,732,733,734,735,736,737,738,739,266,740,741,742,743,744,745,746,747,748,749,750,751,752,753,754). In the late 1980s, endoscopic releases were reported, gained prominence, utilized various equipment (745,746,755,756,757,582,758,759,463,577,760,761), and were initially reported as superior to open releases (582,577,762,579,763,764,583). 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 (765). 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 (757). More recently, the open technique has been revised towards a minimal incisional technique (766) and continues to be successfully performed with little apparent difference in outcome versus endoscopic releases (584,585,586,767). 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 (768,769,587,770,771,772,588,773,774,589,775,578,776,777,778,779).

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 (745,746,780,781). 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 (782), with self-employed patients incurring less lost work time (782). 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.

## FOLLOW-UP CARE

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 (783). Home exercise programs appear to be the most effective for regaining function (784).

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 section on Post-Operative Rehabilitation and Rehabilitation of Patients with Functional Deficits: CTS and Other Disorders.

## 6.7.7.2. CARPAL TUNNEL RELEASE

### SURGICAL RELEASE FOR TREATMENT OF SUBACUTE OR CHRONIC CTS

**Recommended**

Surgical release is strongly recommended for patients who fail non-operative treatment for subacute or chronic CTS (Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003). 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).

**Strength of evidence** Strongly Recommended, Evidence (A)
**Level of confidence** High

**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 (Bessette et al., 1997). 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.

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). 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 (Jugovac et al., 2002), 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 (Mackinnon et al., 1991).

Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## OPEN OR ENDOSCOPIC RELEASE FOR SUBACUTE OR CHRONIC CTS

**Recommended**

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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003).

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** Moderate

**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 (Bessette et al., 1997). 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.

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). 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 (Jugovac et al., 2002), 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 (Mackinnon et al., 1991).

Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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.

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**Evidence**

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.

## KNIFELIGHT FOR SUBACUTE OR CHRONIC CTS

**Recommended**

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

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**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 (Bessette et al., 1997). 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.

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). However, it is the surgeon's experience and comfort that are the determining factors in the selection of the procedure performed.

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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 (Mackinnon et al., 1991).

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**Evidence**

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## OTHER ADJUNCTIVE PROCEDURES OR TECHNIQUES FOR SUBACUTE OR CHRONIC CTS

**Not Recommended**

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.

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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.

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**Evidence**

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.

Anesthetic techniques for carpal tunnel release and other hand surgery have ranged from general anesthesia to axillary/regional blocks to local infiltration (266,267). Tourniquets have also been used (268).

### ANESTHESIA DURING CARPAL TUNNEL RELEASE

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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 (Rivera et al., 2008).

**Evidence**

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.

## 6.7.7.3. EPINEUROTOMY

### EPINEUROTOMY FOR SUBACUTE OR CHRONIC CTS

**Not Recommended**

Epineurotomy is moderately not recommended.

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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.

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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 (Jugovac et al., 2002), 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 (Mackinnon et al., 1991).

Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In

quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## 6.7.7.4. FLEXOR RETINACULAR LENGTHENING

### FLEXOR RETINACULAR LENGTHENING FOR SUBACUTE OR CHRONIC CTS

**Not Recommended**

Flexor retinacular lengthening is moderately not recommended.

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al.,

2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). 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 (Jugovac et al., 2002), 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 (Mackinnon et al., 1991).

Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## 6.7.7.5. FLEXOR TENOSYNOVECTOMY

### FLEXOR TENOSYNOVECTOMY FOR SUBACUTE OR CHRONIC CTS

**Not Recommended**

Flexor tenosynovectomy is not recommended.

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Moderate

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009).

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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). 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 (Jugovac et al., 2002), 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 (Mackinnon et al., 1991).

Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## BIOPSY OF ABNORMAL TENOSYNOVIUM FOR SUBACUTE OR CHRONIC CTS

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

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

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). 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 (Jugovac et al., 2002), 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 (Mackinnon et al., 1991).

Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## 6.7.7.6. NEUROLYSIS

### INTERNAL NEUROLYSIS FOR SUBACUTE OR CHRONIC CTS

**Not Recommended**

Internal neurolysis is strongly not recommended.

**Strength of evidence** Strongly Not Recommended, Evidence (A)
**Level of confidence** High

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6

studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). However, it is the surgeon's experience and comfort that are the determining factors in the selection of the procedure performed.

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Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## 6.7.7.7. ULNAR BURSAL PRESERVATION

### ULNAR BURSAL PRESERVATION FOR SUBACUTE OR CHRONIC CTS

**Not Recommended**

Ulnar bursal preservation is moderately not recommended.

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). 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 (Jugovac et al., 2002), 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 (Mackinnon et al., 1991).

Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## 6.7.7.8. INCISIONS

### ALTERING INCISION LOCATION FOR SUBACUTE OR CHRONIC CTS

**Not Recommended**

The mini palmar incision using the ring finger as a guide does not require any special changes in the location of the incision (Siegmeth et al., 2006). 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** Moderate

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). 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 (Jugovac et al., 2002), 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 (Mackinnon et al., 1991).

Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## ULNAR INCISIONAL APPROACH FOR SUBACUTE OR CHRONIC CTS

**Not Recommended**

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

**Rationale**

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 (Gerritsen et al., 2002, Ucan et al., 2006, Korthals-de Bos et al., 2006). Two of three studies suggest superiority of surgical release compared with injection (Ucan et al., 2006, Hui et al., 2005, Ly-Pen et al., 2005, Ly-Pen et al., 2005) over longer timeframes mostly of 1 year. One study suggested superiority compared with physical therapy (Jarvik et al., 2009). 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 (Dumontier et al., 1995, Sennwald et al., 1995, Agee et al., 1992, Brown et al., 1993, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012). Six of 11 studies reported since 2000 have failed to demonstrate better outcomes with endoscopic releases (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003, Ejiri et al., 2012, Kang et al., 2013, Larsen et al., 2013, Tarallo et al., 2014, Aslani et al., 2012), 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 (Atroshi et al., 2009). 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 (Atroshi et al., 2006, Ferdinand et al., 2002, MacDermid et al., 2003, Atroshi et al., 2009, Wong et al., 2003), of 6 studies (Saw et al., 2003, Trumble et al., 2002) showing a lack of superiority of the endoscopic release (Atroshi et al., 2006, Ferdinand et al., 2002, Jacobsen et al., 1996, Macdermid et al., 2012, Atroshi et al., 2009, Wong et al., 2003). However, it is the surgeon's experience and comfort that are the determining factors in the selection of the procedure performed.

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Recently, a Knifelight has been utilized for carpal tunnel releases (Bhattacharya et al., 2004, Helm et al., 2003). 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 (Bhattacharya et al., 2004, Helm et al., 2003), 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 (Menovsky et al., 2004) 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 (Blair et al., 1992, Borisch et al., 2003, Leinberry et al., 1997, Foulkes et al., 1994, Crnkovic et al., 2012), neurolysis (Lowry et al., 1988, Mackinnon et al., 1991), flexor tenosynovectomy (Shum et al., 2002), flexor retinacular lengthening (Crnkovic et al., 2012), nerve sparing incisions (Siegmeth et al., 2006), double-limited incisions (Zyluk et al., 2006), ulnar incisions (Citron et al., 1997), and ulnar bursal preservation (Forward et al., 2006). 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 (Shum et al., 2002). 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 (Korthals-de Bos et al., 2006). CTS is not different from other MSDs, with reportedly worse outcomes and greater delays in return to work among patients receiving workers' compensation (Agee et al., 1992, MacDermid et al., 2003). In quality studies, lost time ranged from 12 days for open releases in the Netherlands (Korthals-de Bos et al., 2006) to 88 days for endoscopically treated patients in Sweden (Atroshi et al., 2006), with most trials reporting these data between 12 and 40 days (Korthals-de Bos et al., 2006, Dumontier et al., 1995, Agee et al., 1992, Erdmann, 1994, Saw et al., 2003, Trumble et al., 2002, Ferdinand et al., 2002, Jacobsen et al., 1996, Bhattacharya et al., 2004, Helm et al., 2003, Provinciali et al., 2000). 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**

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.

## 6.7.7.9. 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.

## PERIOPERATIVE ANTIBIOTICS FOR PATIENTS UNDERGOING CARPAL TUNNEL RELEASE

**Recommended**

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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** 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.

**Rationale**

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 susceptibility 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**

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.

## ROUTINE USE OF ANTIBIOTICS FOR PATIENTS UNDERGOING CARPAL TUNNEL RELEASE

**Not Recommended**

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**

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 susceptibility 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**

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.

## 6.7.8. WORK RESTRICTIONS

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

### WORK RESTRICTIONS FOR CTS

**Recommended**

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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**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.

**Rationale**

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**

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.

## 6.8. FOLLOW-UP CARE

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 (672). These include the DASH (673,674,675,676,677,678,679,680,681,682,683,684,685,686,687,688,689, 690,691,692,693,694) and Boston Carpal Tunnel Questionnaire (701,628,694,697,137,706,705,699, 674,686,684,703,700,698,696,708,682,702,707,673,683,709,689,691,695,688,678,704,677,710,711, 712,713,714,715). Michigan Hand Outcomes Questionnaire (MHQ) has been used in many studies as a measurement outcome of CTS (685,693,697,716). The Short Form-36 (SF-36) (680,686,695), the Flinn Performance Screening Tool (FPST) (717), the Patient Evaluation Measure questionnaire (PEM) (679,694), the Amadio questionnaire (690), the Historical-objective-distribution based scale (Hi-Ob-Db) (698,710), and the Alderson-McGali hand function questionnaire (AMHFQ) (695) have been used to diagnose CTS. VAS symptoms and pain scores may also be used (680,684,695) even though many patients with CTS have no pain. Functional status scores (701,628,706,705, 686,696,708,673,711,690,713,717,718,719) and Global Symptom Scores (720) are also used, particularly in some research studies. Grip strength (679,684,695,702,703,708,715,721,722,723,724) and pinch strength measures (679,684,695,700,702,703,707,714,721,723) 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 (673,677,683,697,705,713,720,725,726,727,728).

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 (783). Home exercise programs appear to be the most effective for regaining function (784).

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 the Postoperative Rehabilitation recommendations.

# 7. CRUSH INJURIES AND COMPARTMENT SYNDROME

## 7.1. OVERVIEW

Crush injuries and compartment syndrome are usually surgical emergencies that require urgent evaluation (269,270). Patients have pain and may have paresthesia. 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 (270,271,272,273,274,275).

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. 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. 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.

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.

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.

## 7.2. DIAGNOSTIC RECOMMENDATIONS

### X-RAYS FOR EVALUATING CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

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**

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**

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.

## MAGNETIC RESONANCE IMAGING (MRI) FOR CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

Magnetic resonance imaging (MRI) 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**

Initial evaluation of crush injuries or compartment syndrome generally does not require MRI. However, some patients require MRI for evaluation of symptoms and extent of injury, so it is recommended in select cases.

**Evidence**

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.

## COMPUTED TOMOGRAPHY (CT) FOR CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

Computed tomography (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**

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

**Evidence**

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.

## 7.3. TREATMENT RECOMMENDATIONS

### 7.3.1. INITIAL CARE

Compartment pressure measurements are helpful and assist in determining the need for emergent surgery.

#### ELEVATION FOR ACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

Elevation is recommended for treatment of acute crush injuries or compartment syndrome.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

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.

**Evidence**

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.

#### RELATIVE REST FOR ACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

Relative rest is recommended for treatment of acute crush injuries or compartment syndrome.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

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.

**Evidence**

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.

## SPLINTING FOR SUBACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

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

**Rationale**

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**

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.

## SELF-APPLICATION OF ICE FOR ACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

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

**Rationale**

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**

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.

## SELF-APPLICATION OF HEAT FOR ACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Not Recommended**

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**

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**

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).

## 7.3.2. ACTIVITY MODIFICATION AND EXERCISE

### EXERCISE FOR CRUSH INJURIES OR COMPARTMENT SYNDROME

**Sometimes Recommended**

Exercise is generally not indicated acutely for crush injuries or compartment syndrome. However, exercise may be needed in the recovery or post-operative phases.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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 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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## 7.3.3. MEDICATIONS

Over-the-counter medications may be helpful, but most patients require prescription medications for pain, particularly for moderate to severe injuries. Mannitol has been reported as a treatment (276).

### NSAIDS FOR ACUTE OR SUBACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to acute or subacute crush injuries or compartment syndrome.

**Frequency/Dose/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.

**Rationale**

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 et al., 2005). 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**

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.

## ACETAMINOPHEN FOR ACUTE OR SUBACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

Acetaminophen is recommended to control pain associated with acute or subacute crush injuries or compartment syndrome.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to acute or subacute crush injuries or compartment syndrome.

**Frequency/Dose/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.

**Rationale**

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 diclofena (Woo et al., 2005). 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**

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 recommendations in Carpal Tunnel Syndrome section.

## ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 7.3.4. ALLIED HEALTH INTERVENTIONS

### HYPERBARIC OXYGEN FOR ACUTE OR SUBACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

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**

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 (Bouachour et al., 1996). HBO is non-invasive and generally safe, 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**

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.

## 7.3.5. SURGERY

### SURGERY FOR ACUTE OR SUBACUTE CRUSH INJURIES OR COMPARTMENT SYNDROME

**Recommended**

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**

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 (Naidu et al., 1994, Dellaero et al., 1996, Botte et al., 1998, Friedrich et al., 2007, Gelberman et al., 1978, Mubarak et al., 1989, Ortiz et al., 1998, Weinstein et al., 1992, Gourgiotis et al., 2007, Hayakawa et al., 2009, Kalyani et al., 2011, Wall et al., 2010). Other procedures may be required based on remediable defects such as fractures, ligament tears, or other injuries.

**Evidence**

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.

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.

# 8. DUPUYTREN'S DISEASE

## 8.1. OVERVIEW

Dupuytren's disease is a disorder of the hand involving the formation of fibrosis (scar tissue) in the palm and digits with subsequent contractures (277). It has strong age and inheritance patterns (278,279,280,281,282). There is insufficient evidence relating Dupuytren's disease to occupational activities (283,284). Purported risks include the use of alcohol, smoking, diabetes mellitus, and epilepsy (279). However, although there are no quality studies involving occupational factors, there are some reported associations with both heavy (285) and manual work (286). 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 (287). While surgery is currently the most effective treatment for Dupuytren's disease, the contracture often reoccurs with time.

## 8.2. TREATMENT RECOMMENDATIONS

### 8.2.1. RADIOTHERAPY

Radiotherapy has been used to attempt to slow or prevent the progression of Dupuytren's disease (288). Treatment involves irradiating the nodules and cords associated with Dupuytren's with x-rays or electrons.

#### RADIOTHERAPY FOR PREVENTION OF PROGRESSION OF DUPUYTREN'S DISEASE

**No Recommendation**

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**

One moderate-quality trial of radiotherapy found no differences between two types of radiotherapy treatment regimens (Seegenschmiedt et al., 2001). 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.

**Evidence**

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, dupuytrend 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.

### 8.2.2. MEDICATIONS

NSAIDs have been used to treat post-operative swelling from surgery for Dupuytren's disease and appear to be superior to acetaminophen (paracetamol) (289). Naproxen may also be useful as an analgesic during the immediate post-operative phase (289).

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 (285).

## NSAIDS TO TREAT POST-OPERATIVE SWELLING FROM SURGERY FOR DUPUYTREN'S DISEASE

**Recommended**

NSAIDs are moderately recommended to treat post-operative swelling from surgery for Dupuytren's disease.

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** High

**Indications**

Dupuytren's disease surgical patients.

**Frequency/Dose/Duration**

Naproxen 500mg BID. Trial utilized 3 days of treatment (Husby et al., 2001).

**Rationale**

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 (Husby et al., 2001). 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.

**Evidence**

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.

## ACETAMINOPHEN FOR DUPUYTREN'S SURGERY

**Recommended**

Acetaminophen is recommended for Dupuytren's surgery.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Moderate

**Frequency/Dose/Duration**

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) (U.S. Food and Drug Administration, 2009).

**Rationale**

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 (Husby et al., 2001). 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.

**Evidence**

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.

## 5-FLUOROURACIL FOR RECURRENCE OF DUPUYTREN'S DISEASE IN SURGICAL PATIENTS

**Not Recommended**

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**

There is one moderate-quality trial of 5-fluorouracil administered intraoperatively which showed no difference when compared with placebo (Bulstrode et al., 2004). 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.

**Evidence**

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.

## 8.2.3. INJECTION THERAPIES

Collagenase injections have been utilized for treatment of Dupuytren's disease to lyse and rupture the finger cords that are causing the joint contracture (290,291,292).

### COLLAGENASE INJECTIONS FOR TREATMENT OF DUPUYTREN'S DISEASE

**Recommended**

Collagenase injections are moderately recommended for treatment of Dupuytren's disease.

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** Moderate

**Indications**

Dupuytren's contractures sufficient to result in impairment, nearing impairment, or sufficient to result in significant cosmetic deformity.

**Frequency/Dose/Duration**

Clostridial collagenase 10,000 U injection; repeat injection(s) at 4- to 6-week intervals.

**Indications for discontinuation**

Resolution of contracture, sufficient reduction for patient to decline additional injection, adverse effects, or failure to respond to 3 injections.

**Rationale**

Quality studies evaluating the efficacy of clostridial collagenase show considerable benefits (Badalamente et al., 2007, Badalamente et al., 2002, Gilpin et al., 2010, Hurst et al., 2009). 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 (Mickelson et al., 2014).

**Evidence**

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.

## 8.2.4. SURGICAL CONSIDERATIONS

Surgical procedures have long been used to attempt to improve range of motion in patients with contracture from Dupuytren's disease (284). 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.

### SURGERY FOR TREATMENT OF DUPUYTREN'S CONTRACTURE

**Recommended**

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

**Rationale**

There are no quality studies comparing surgical results with non-surgical treatments or with no treatment (Ullah et al., 2009, van Rijssen et al., 2006, Citron et al., 2005). Considering the high propensity for Dupuytren's contracture to progress or reoccur (estimated at 27 to 80% after surgery) (van Rijssen et al., 2006, Citron et al., 2005, Mäkelä et al., 1991, Rodrigo et al., 1976, Tonkin et al., 1984), 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 (Ullah et al., 2009).

**Evidence**

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.

## PERCUTANEOUS NEEDLE FASCIOTOMY (NEEDLE APONEUROTOMY) FOR TREATMENT OF DUPUYTREN'S CONTRACTURE

**Not Recommended**

Percutaneous needle fasciotomy (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

**Rationale**

There are no quality studies comparing surgical results with non-surgical treatments or with no treatment (Ullah et al., 2009, van Rijssen et al., 2006, Citron et al., 2005). Considering the high propensity for Dupuytren's contracture to progress or reoccur (estimated at 27 to 80% after surgery) (van Rijssen et al., 2006, Citron et al., 2005, Mäkelä et al., 1991, Rodrigo et al., 1976, Tonkin et al., 1984), 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 (Ullah et al., 2009).

**Evidence**

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.

## "FIREBREAK" FULL-THICKNESS SKIN GRAFT FOR TREATMENT OF DUPUYTREN'S CONTRACTURE

**Not Recommended**

"Firebreak" full-thickness skin graft is not recommended for routine Dupuytren's contracture surgery.

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

There are no quality studies comparing surgical results with non-surgical treatments or with no treatment (Ullah et al., 2009, van Rijssen et al., 2006, Citron et al., 2005). Considering the high propensity for Dupuytren's contracture to progress or reoccur (estimated at 27 to 80% after surgery) (van Rijssen et al., 2006, Citron et al., 2005, Mäkelä et al., 1991, Rodrigo et al., 1976, Tonkin et al., 1984), 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 (Ullah et al., 2009).

**Evidence**

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.

## EXTENSIVE FASCIECTOMY FOR TREATMENT OF DUPUYTREN'S CONTRACTURE

**Not Recommended**

Extensive fasciectomy is not recommended for routine Dupuytren's contracture surgery.

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

There are no quality studies comparing surgical results with non-surgical treatments or with no treatment (Ullah et al., 2009, van Rijssen et al., 2006, Citron et al., 2005). Considering the high propensity for Dupuytren's contracture to progress or reoccur (estimated at 27 to 80% after surgery) (van Rijssen et al., 2006, Citron et al., 2005, Mäkelä et al., 1991, Rodrigo et al., 1976, Tonkin et al., 1984), 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 (Ullah et al., 2009).

**Evidence**

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.

## DERMOFASCIECTOMY FOR TREATMENT OF DUPUYTREN'S CONTRACTURE

**Not Recommended**

Dermofasciectomy is not recommended for routine Dupuytren's contracture surgery.

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

There are no quality studies comparing surgical results with non-surgical treatments or with no treatment (Ullah et al., 2009, van Rijssen et al., 2006, Citron et al., 2005). Considering the high propensity for Dupuytren's contracture to progress or reoccur (estimated at 27 to 80% after surgery) (van Rijssen et al., 2006, Citron et al., 2005, Mäkelä et al., 1991, Rodrigo et al., 1976, Tonkin et al., 1984), 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 (Ullah et al., 2009).

**Evidence**

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.

# 9. EXTENSOR COMPARTMENT TENOSYNOVITIS

## 9.1. OVERVIEW

De Quervain's stenosing tenosynovitis involves hypertrophy of the extensor retinaculum of the first extensor compartment involving the abductor pollicis longus and extensor pollicis brevis tendons with signs of tenosynovial and retinacular fibrosis usually present (293,294). Extensor tendon entrapment generally presents as a relatively simple clinical presentation. Some occur after acute injury, but most occur without specific inciting event.

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.

Patients present with wrist pain that is augmented by movement and generally non-radiating (294), although occasionally pain may spread along the course of the affected tendon sheath (293,294). Patients rarely have paresthesias unless there is an accompanying swelling or other mechanism to affect the superficial radial nerve or other digital nerves (293). Some repeated hand postures with thumb pinching may be associated with de Quervain's disease (295). 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 (296).

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 (293), 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) (294). Triggering may be demonstrated on rare occasions.

Follow-up visits are generally required every 1 or 2 weeks to evaluate efficacy of interventions until resolution of the condition.

The condition may be occupational when jobs require repeated forceful gripping or sustained wrist extension. Job modifications are thought to be needed in most of these work-related cases to facilitate recovery (294).

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 (297) and is somewhat controversial regarding the actual site of entrapment of the dorsal compartment (298,299,300) with the principal site appearing to involve the musculotendinous junction of the first extensor compartment and the tendons of the 2nd extensor compartment (301).

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 (293,302,303). 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.

Work-relatedness is thought to be present in a significant proportion of cases (304,305,306), although more recent studies have suggested less work-relatedness (19). Risk factors have not been confirmed

in cohort studies, but are thought to particularly involve combinations of force, repetition and posture (293,304,307,305,306,308). Direct trauma over the affected extensor compartment is reported in a minority of cases (293). 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 (309,310). Work tasks reported to be risks appear similar with intensive agricultural workers (threshing, planting, hammering, hand washing, spraying, cementing) (297) and recent job change to supermarket cashiering being examples of reported risks (311). Discontinuation of the high force, unaccustomed activity has been frequently reported to resolve intersection syndrome (297,299,312,313). Increasing hours of computer work has been associated with extensor compartment tenosynovitis, de Quervain's disease, and non-specific wrist and forearm pain (307,314). 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 (315,316).

## 9.2. DIAGNOSTIC RECOMMENDATIONS

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 FOR EXTENSOR COMPARTMENT TENOSYNOVITIS

**No Recommendation**

There is no recommendation for or against special studies to diagnose extensor compartment tenosynovitis.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no special tests that are typically performed for extensor compartment tenosynovitis. X-rays are usually not helpful, although one study suggested minor x-ray changes may be present (Chien et al., 2001). 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 (Costa et al., 2003, de Lima et al., 2004, Lee et al., 2009); however, the utility of MRI has not been demonstrated in quality studies. The condition should be distinguished from de Quervain's.

**Evidence**

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.

### MRI TO DIAGNOSE EXTENSOR COMPARTMENT TENOSYNOVITIS

**Recommended**

MRI is recommended to diagnose extensor compartment tenosynovitis.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are two moderate-quality articles (Nieuwenhuis et al., 2015, Parellada et al., 2007) 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 injections.

**Evidence**

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.

## 9.3. TREATMENT RECOMMENDATIONS

### 9.3.1. INITIAL CARE

Initial care usually involves limitation of the physical factors thought to be contributing (294). Thumb spica splints for de Quervain's and wrist braces for the other compartment tendinoses are generally believed to be helpful (294). 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 (294,297,299,312,317). NSAIDs are often prescribed for initial treatment (294). 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.

#### THUMB SPICA AND WRIST SPLINTS FOR ACUTE AND SUBACUTE THUMB EXTENSOR COMPARTMENT TENOSYNOVITIS

**Recommended**

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 are recommended.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Patients with extensor compartment tendinoses (Piligian et al., 2000)

**Frequency/Dose/Duration**

Generally recommended to be worn while awake.

**Indications for discontinuation**

Failure to respond or resolution.

**Rationale**

There is one moderate-quality RCT evaluating wrist splints for extensor compartment tenosynovitis with full-time compared with PRN use and found no differences (Menendez et al., 2015). Wrist splints are not invasive, have few adverse effects, and are not costly; thus, they are recommended.

**Evidence**

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.

## 9.3.2. ACTIVITY MODIFICATION AND EXERCISE

### MODIFICATION OF WORK ACTIVITIES FOR EXTENSOR COMPARTMENT TENOSYNOVITIS

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**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.

**Rationale**

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 (Pantukosit et al., 2001, Idler et al., 1990)(Hanlon et al., 1999).

### EXERCISE FOR EXTENSOR TENDON ENTRAPMENT

**No Recommendation**

Exercise is not generally indicated acutely and most patients with extensor tendon entrapment do not require an exercise program. For patients with residual deficits, particularly postoperatively, see the recommendations for carpal tunnel syndrome.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/Duration**

In the event it is needed for recovery or post-operatively, 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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## 9.3.3. 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 FOR ACUTE, SUBACUTE, OR CHRONIC EXTENSOR COMPARTMENT TENOSYNOVITIS

**Recommended**

NSAIDs (oral or topical) are recommended to control pain associated with acute, subacute, or chronic extensor compartment tenosynovitides.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

Patients with wrist compartment tendinoses.

**Frequency/Dose/Duration**

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.

**Rationale**

NSAIDs are often used to treat pain associated with wrist compartment tendinoses (Piligian et al., 2000, Pantukosit et al., 2001, Idler et al., 1990, Hanlon et al., 1999, Steinberg, 2008, Jirarattanaphochai et al., 2004, Mazieres et al., 2005). There is one quality study demonstrating efficacy of a ketoprofen patch versus placebo (Mazieres et al., 2005). However, another study failed to demonstrate efficacy of injectable nimesulide as an adjuvant treatment to triamcinolone acetonide 10mg injection (Jirarattanaphochai et al., 2004) and another study of diclofenac gel for treating marathon kayakers prior to racing also was negative (May et al., 2007), 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**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 9.3.4. ALLIED HEALTH INTERVENTIONS

### IONTOPHORESIS FOR ACUTE AND SUBACUTE EXTENSOR COMPARTMENT TENOSYNOVITIS

**Sometimes Recommended**

Iontophoresis treatments using glucocorticosteroids and sometimes NSAIDs are recommended for extensor compartment tenosynovitis.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Patients with wrist compartment tendinoses. Generally those who either fail to respond adequately to NSAIDs, splints, and activity modifications or decline injection.

**Frequency/Dose/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. 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.

**Indications for discontinuation**

Failure to respond, development of adverse effects, resolution.

**Rationale**

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**

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 FOR ACUTE, SUBACUTE, OR CHRONIC EXTENSOR COMPARTMENT TENOSYNOVITIS

**No Recommendation**

There is no recommendation for or against the use of other non-operative interventions (e.g., 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**

There are no quality studies evaluating other non-operative interventions for extensor compartment tenosynovitis. Manual therapy has been attempted (Anderson et al., 1994); however, there are no quality studies available to assess its efficacy. Deep friction massage has been used and does not appear successful (Brosseau et al., 2002).

**Evidence**

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.

## 9.3.5. INJECTION THERAPIES

Glucocorticosteroid injections are frequently used for the wrist compartment tendinoses (317,297,299,312,318,319,320,321,322,323,324,325,326,327). Techniques vary slightly (324,318) and have included attempted selective injection of the extensor pollicis brevis tendon (328), 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% (323,324,318,328,329,330,331,332).

### GLUCOCORTICOSTEROID INJECTIONS FOR ACUTE, SUBACUTE, OR CHRONIC DE QUERVAIN'S OR OTHER WRIST COMPARTMENT TENDINOSIS

**Recommended**

Glucocorticosteroid injections are recommended for treatment of acute, subacute, or chronic de Quervain's or other wrist compartment tendinosis.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** High

**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 (Peters-Veluthamaningal et al., 2009, Anderson et al., 1991, Sakai, 2002).

**Frequency/Dose/Duration**

Optimal dose is unknown. Studies have utilized methylprednisolone acetate 40mg (Goldfarb et al., 2007, Anderson et al., 1991, Witt et al., 1991) and triamcinolone acetonide 10mg (Peters-Veluthamaningal et al., 2009, Sakai, 2002). An adjuvant injectable anesthetic is typically used (Jirarattanaphochai et al., 2004, Anderson et al., 1991, Sakai, 2002). 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 (Kosuwon, 1996, Weiss et al., 1994).

It is recommended that a single injection be scheduled and the results evaluated to document improvement (Peters-Veluthamaningal et al., 2009).(1126) Failure of a response within 1 or 2 weeks should result in reanalysis of the diagnosis and consideration of repeat injection (Peters-Veluthamaningal et al., 2009). Recurrence of symptoms months later should result in consideration of re-injection (Lapidus et al., 1972, Anderson et al., 1991). 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 (Witt et al., 1991).

**Indications for discontinuation**

If a partial response, consideration should be given to repeating the injection, typically at a modestly higher dose.

**Rationale**

There is 1 moderate-quality study comparing glucocorticosteroid injections with placebo for treatment of de Quervain's stenosing tenosynovitis (Peters-Veluthamaningal et al., 2009). 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 (Hadianfard et al., 2014). Ultrasound-guidance has been suggested to be moderately superior (Kume et al., 2012). Two trials have found inconclusive evidence regarding whether splint use is required in addition to steroid injection (Mardani-Kivi et al., 2014, Mehdinasab et al., 2010) A high-quality trial found the steroid flare was unrelated to pH (Goldfarb et al., 2007); 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 it did not assess reductions in pain immediately after injection; thus, it appears to have no bearing on use of NSAIDs for those purposes (Jirarattanaphochai et al., 2004). A low-quality trial found glucocorticosteroid injection superior to splinting in pregnant and lactating females (Avci et al., 2002).

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**

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 75 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 2 from other sources. Of the 75 articles considered for inclusion, 7 randomized trials and 0 systematic studies met the inclusion criteria.

## 9.3.6. SURGICAL CONSIDERATIONS

### SURGICAL RELEASE FOR SUBACUTE OR CHRONIC EXTENSOR COMPARTMENT TENOSYNOVITIS

**Recommended**

Surgical release is recommended for patients with subacute or chronic extensor compartment tenosynovitis who fail to respond to injection.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Wrist compartment tenosynovitis that fails to respond to non-operative interventions generally including at least 2 glucocorticosteroid injections (Lapidus et al., 1972)

**Rationale**

There are no quality studies evaluating the use of surgical release for extensor compartment tenosynovitis (Servi et al., 1997, Williams, 1977). 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**

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.

# 10. FLEXOR TENDON ENTRAPMENT

## 10.1. OVERVIEW

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 (785,786,787,788,789,790). While some cases are thought to be occupational (26) 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, osteoarthrosis, amyloidosis, hypothyroidism, heredity, and partial tendon laceration (791,792,793,794,795,796). There also is evidence these may be connective tissue disorders (797,798). Diabetes mellitus reportedly portends a worse prognosis for glucocorticosteroid injection (799,800).

The disorder includes a spectrum from localized pain in the flexor compartment to triggering to locking of a digit (801). The most common abnormality is thickening at or of the A1 pulley (801). Less common

pathophysiologic abnormalities include metacarpal-phalangeal joint abnormalities, disorders at the level of the carpal tunnel, and other pulley anomalies (801).

Flexor tendon entrapment generally presents as a relatively simple clinical presentation. Some occur after acute injury, but most occur without specific inciting event (801,802,803,804,805). Symptoms are variable and may include pain, stiffness, clicking, snapping, and locking (790,796,804,806,807,808,809,810,811). Pain is generally in the volar digit and/or metacarpophalangeal joint area (807,808,809,810). Certain patients report worse symptoms in the morning or after lack of use (801).

Patients without triggering will typically have tenderness localized over the A1 pulley (812). 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 (792,794,795,796,801,802,803,804,10,813,814,811,815,816,817,818,819,820,821,822,823,824,825,304,826,827,828,829,830).

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.

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.

As the epidemiological evidence is weak, the etiological fraction for occupational tasks is unknown (798). Thus, work-relatedness is somewhat unclear (19). The available biomechanical evidence suggests pinch force may be a risk factor (796,801,802,804,806,831,832,813,833,834,835,836,814,837,807,838). The mechanism of injury for many appears to be typically idiopathic (801,802,804,839) or as a complication of medical conditions (especially diabetes mellitus and rheumatoid arthritis) (794). However, available epidemiological and biomechanical evidence suggests that the disorder may also occur as a complication of repeated forceful use of a digit (796,801,802,804,806,831,832,813,833,834,835,836,814,837,807), or unaccustomed use (796,801), thus many cases may be work-related (26,801,838). A careful history of occupational tasks as well as non-occupational exposures is recommended.

## 10.2. DIAGNOSTIC RECOMMENDATIONS

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.

### DIAGNOSTIC STUDIES FOR FLEXOR TENDON ENTRAPMENT

**No Recommendation**

There are no special tests that are typically performed for flexor tendon entrapment. 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 (Saldana, 2001, Moore, 2000).

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## 10.3. TREATMENT RECOMMENDATIONS

## 10.3.1. EXERCISE

### EXERCISE FOR FLEXOR TENDON ENTRAPMENT

**No Recommendation**

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 postoperatively, see the recommendations for carpal tunnel syndrome.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/Duration**

In the event it is needed for recovery or post-operatively, 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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## 10.3.2. MEDICATIONS

### MEDICATIONS FOR FLEXOR TENDON ENTRAPMENT

**No Recommendation**

Medications are generally not required for flexor tendon entrapment because the condition is generally not substantially painful. There are no quality studies on use of medications for flexor tendor entrapment, although some studies have recommended NSAIDs (Saldana, 2001). 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.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## 10.3.3. DEVICES

### SPLINTS FOR SELECT CASES OF ACUTE, SUBACUTE, OR CHRONIC FLEXOR TENDON ENTRAPMENT

**Recommended**

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**

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 (Tarbhai et al., 2012). Historically splints were widely used for treatment of trigger digits (Ryzewicz et al., 2006,

Saldana, 2001, Moore, 2000, Akhtar et al., 2005, Colbourn et al., 2008); 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 (Ryzewicz et al., 2006, Saldana, 2001) 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**

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.

## 10.3.4. INJECTION THERAPIES

### GLUCOCORTICOSTEROID INJECTIONS FOR ACUTE, SUBACUTE, OR CHRONIC FLEXOR TENDON ENTRAPMENT

**Recommended**

Glucocorticosteroid injections are strongly recommended for treatment of acute, subacute, or chronic flexor tendon entrapment.

**Strength of evidence** Strongly Recommended, Evidence (A)
**Level of confidence** High

**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 (Nimigan et al., 2006).

**Frequency/Dose/Duration**

Optimal dose is unknown. Quality studies have included betamethasone 6mg (Baumgarten et al., 2007, Warren et al., 1988), depot preparation of methylprednisolone 20mg (Hong, 2005); and triamcinolone 1mL (Smit et al., 2010) 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 (Betts-Symonds et al., 1982). A single injection and results evaluated to document improvement. Ultrasound-guidance is not shown to be helpful (Goldfarb et al., 2007, Cecen et al., 2015).

**Indications for discontinuation**

If a partial response, consideration should be given to repeating the injection, typically at a modestly higher dose.

**Rationale**

There are 2 high-quality and 2 moderate-quality studies incorporated into this analysis (Baumgarten et al., 2007, Akhtar et al., 2006, Benson et al., 1997, Clark et al., 1973). Glucocorticosteroid injection(s) are the most commonly used intervention for trigger digits (Nimigan et al., 2006, Moore, 2000). 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 (Fleisch et al., 2007) and a low-quality study performed subcutaneous injections that were efficacious (Marks et al., 1989). Further, ultrasound guidance has not been found to improve the results (Cecen et al., 2015). It has been suggested that many injections are performed along, rather than within the sheaths (Newport et al., 1990) 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% (Rhoades et al., 1984, Baumgarten et al., 2007, Akhtar et al., 2006, Benson et al., 1997, Clark et al., 1973, Sato et al., 2012, Zyluk et al., 2011, Callegari et al., 2011, Pataradool et al., 2011, Ring et al., 2008, Shakeel et al., 2012, Taras et al., 1998, Cecen et al., 2015, Jianmongkol et al., 2007). Two studies compared injection with surgery, but the recurrence rates while lower with surgery still showed strong efficacy of injection (0% vs. 11% recurrence (Jianmongkol et al., 2007) and 0% vs. 14% (Cecen et al., 2015)). They are less effective in diabetics, although still are effective (Baumgarten et al., 2007) and there is weak evidence that patients failing other medical treatments may respond at lower rates of approximately 60% (Anderson et al., 1991). 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**

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.

## 10.3.5. SURGICAL CONSIDERATIONS

### SURGERY FOR PERSISTENT OR CHRONIC FLEXOR TENDON ENTRAPMENT

**Recommended**

Open release for persistent or chronic flexor tendon entrapment is moderately recommended. Percutaneous release is also a reasonable option (Kamhin et al., 1983).

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** High

**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 (Akhtar et al., 2006).

**Rationale**

Both open (with a scalpel) and percutaneous (with a needle through the skin) releases are performed with evidence both are effective (Topper et al., 1997). Evidence is strong that percutaneous release is as effective, if not more effective than as open release (Eastwood et al., 1992, Cecen et al., 2015, Jianmongkol et al., 2007, Gilberts et al., 2001, Bamroongshawgasame, 2010, Fu et al., 2006, Yiannakopoulos et al., 2006, Chao et al., 2009, Pegoli et al., 2008, Costa et al., 2003, de Lima et al., 2004), is faster to perform, requires fewer resources (Bamroongshawgasame, 2010, Costa et al., 2003), involves less pain, and results in faster recovery (Bamroongshawgasame, 2010). Failures are believed to be due to incomplete release of the A-1 pulley (Lee et al., 2009). 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 (Lee et al., 2009). A low-quality case series suggested repeat percutaneous release was reasonable for treatment of incomplete releases (Chien et al., 2001), 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 (Cebesoy et al., 2007), although the success rates were both lower than other reports. Surgical release is invasive (though less invasive with percutaneous release) (Nieuwenhuis et al., 2015), has low adverse effects, but is costly. For those patients failing glucocorticosteroid injection(s), surgery is recommended.

**Evidence**

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.

# 11. FRACTURES

## 11.1. FRACTURE CLASSIFICATION

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 (333,334). 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 (335). Stable fractures are most often defined as dorsal angulation of less than 10°, radial shortening of 2mm maximum, and no radial shift (336). 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 (337,338). 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 (339,340,341,342).

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.

## 11.2. DISTAL FOREARM FRACTURES

### 11.2.1. OVERVIEW

Fractures of the distal forearm make up a significant proportion of injuries and fractures treated in the emergency room (343), 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 (344,345). 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 (344,346,347), as well as a high incidence of triangular fibrocartilage complex (TFCC) disruption (348). 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 (349). 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 (350).

Wrist injuries associated with significant pain, swelling, ecchymosis, crepitance, 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.

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.

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 stylus (344,346,347). 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 (351). 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 (352), 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 (353).

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 (354), and in allowing for pronation and supination of the hand (355). 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.

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.

## 11.2.2. DIAGNOSTIC RECOMMENDATIONS

### X-RAY FOR SUSPECTED DISTAL FOREARM FRACTURES

**Recommended**

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**

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**

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 FOR DIAGNOSING DISTAL FOREARM FRACTURES

**Recommended**

MRI is recommended to diagnose suspected soft-tissue trauma after x-ray images confirm a complex displaced, unstable, or comminuted distal forearm fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Bombaci et al., 2008, Metz et al., 1993, Spence et al., 1998).

**Evidence**

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 FOR DIAGNOSIS AND CLASSIFICATION OF OCCULT AND COMPLEX DISTAL FOREARM FRACTURES

**Recommended**

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 (Harness et al., 2006).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Negative x-rays with occult fracture strongly suspected.

**Rationale**

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 (Harness et al., 2006, Catalano et al., 2004). 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 (Katz et al., 2001).

**Evidence**

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.

## 11.2.3. TREATMENT RECOMMENDATIONS

## 11.2.3.1. INITIAL CARE

### IMMOBILIZATION PERIOD OF THREE OR LESS WEEKS (EARLY MOBILIZATION) FOR NON-DISPLACED OR MINIMALLY DISPLACED DISTAL RADIUS FRACTURES

**Recommended**

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**

Six moderate-quality studies (Christensen et al., 1995, Davis et al., 1987, Dias et al., 1987, McAuliffe et al., 1987, Millett et al., 1995, Vang Hansen et al., 1998) 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 (Davis et al., 1987, Earnshaw et al., 2002, Lagerstrom et al., 1999, Lagerstrom et al., 1999, Stoffelen et al., 1998).

In each study comparing immobilization of 3 or 5 weeks, patients demonstrated either improved functional measures such as pain scores (Davis et al., 1987), 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 (Christensen et al., 1995, Dias et al., 1987) 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) (Stoffelen et al., 1998), there is insufficient evidence to support 1-week immobilization.

**Evidence**

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.

## USE OF FUNCTIONAL BRACE OR SPLINT OVER TRADITIONAL CASTING FOR NON-DISPLACED OR MINIMALLY DISPLACED DISTAL RADIUS FRACTURES

**Recommended**

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**

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 (Davis et al., 1987, Dias et al., 1987, Abbaszadegan et al., 1989, Ledingham et al., 1991, Moir et al., 1995, O'Connor et al., 2003). 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 (O'Connor et al., 2003), posterior splint with tubigrip (Davis et al., 1987), crépe bandage (Dias et al., 1987), elastic bandage (Abbaszadegan et al., 1989), triple point loading brace with adjustable Velcro straps (Moir et al., 1995), and 3-point loading functional plaster brace (Ledingham et al., 1991).
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.

**Evidence**

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/BRACING NON-DISPLACED OR MINIMALLY DISPLACED COLLES' FRACTURES IN PRONATION OR SUPINATION

**No Recommendation**

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**

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 (Stewart et al., 1984); the other found forearm casting in pronation superior to above-elbow supination (Wilson et al., 1984). 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**

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.

## 11.2.3.2. MEDICATIONS

### NSAIDS FOR ACUTE COLLES' FRACTURE (DISTAL FOREARM FRACTURE) ANALGESIA

**Recommended**

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.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Moderate

**Indications**

Bone pain associated with Colles' fracture.

**Frequency/Dose/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.

**Rationale**

There are three moderate-quality studies that show NSAIDs are effective for pain relief of distal forearm fracture (Adolphson et al., 1993, Barrington, 1980, Davis et al., 1988). Flurbiprofen was more effective than placebo in conjunction with bier block manipulation and for post manipulation pain (Davis et al., 1988). Piroxicam was more effective than paracetamol (Adolphson et al., 1993), and diflunisal was equally effective as mefenamic acid. No changes in Gartland and Werley functional assessment scores (Davis et al., 1988) or functional recovery in post menopausal women (Adolphson et al., 1993) were found, indicating there is no significant benefit other than pain relief from the use of NSAIDS.

**Evidence**

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.

## 11.2.3.3. PHYSICAL METHODS/REHABILITATION

### USE OF LOW-FREQUENCY ELECTROMAGNETIC FIELDS TO STIMULATE BONE HEALING OF DISTAL RADIAL FRACTURES

**Not Recommended**

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**

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 (Wahlstrom, 1984).

**Evidence**

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 theapy, 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.

## EDUCATION AFTER CAST REMOVAL FOR ACUTE COLLES' FRACTURE

**Recommended**

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

**Rationale**

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**

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.

## USE OF PHYSICAL OR OCCUPATIONAL THERAPY AFTER CAST REMOVAL FOR ACUTE COLLES' FRACTURE FOR PATIENTS WITH FUNCTIONAL DEFICITS UNABLE TO RETURN TO WORK

**Recommended**

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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Frequency/Dose/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. 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.

**Indications for discontinuation**

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 (Christensen et al., 2001). 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 (Watt et al., 2000). One low-quality study (Pasila et al., 1974) and one case series (Oskarsson, 1997) 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**

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.

## ROUTINE REFERRAL FOR PHYSICAL OR OCCUPATIONAL THERAPY AFTER CAST REMOVAL FOR COLLES' FRACTURE FOR PATIENTS ABLE TO RETURN TO WORK

**Not Recommended**

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.

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Moderate

**Rationale**

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 (Christensen et al., 2001). 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 (Watt et al., 2000). One low-quality study (Pasila et al., 1974) and one case series (Oskarsson, 1997) 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**

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.

## 11.2.3.4. SURGERY

### CLOSED REDUCTION OR EXTERNAL FIXATION FOR SEVERELY DISPLACED EXTRA-ARTICULAR FRACTURES, COMMINUTED, OR DISPLACED INTRAARTICULAR FRACTURES OF THE DISTAL FOREARM

**Recommended**

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

**Rationale**

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 (Pring et al., 1988, Young et al., 2003, Kreder et al., 2006, McQueen et al., 1996, Merchan et al., 1992). 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 (Lagerstrom et al., 1999). 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 (Howard et al., 1989, Jenkins et al., 1988, Jenkins et al., 1987, Kapoor et al., 2000, Stein et al., 1990, Abbaszadegan et al., 1990). 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 (Roumen et al., 1991). 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 (Ludvigsen et al., 1997, Pritchett, 1995), 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 (Kapoor et al., 2000). If pinning is selected, there does not seem to be any difference in technique comparing Kapandji and Willinegger procedures (Strohm et al., 2004), nor in the length of post-operative cast immobilization comparing 1 vs. 6 weeks (Allain et al., 1999). 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 (Sanchez-Sotelo et al., 2000, Schmalholz, 1989) and external fixation (Kopylov et al., 1999, Schmalholz, 1990) and reducing immobilization time (Kopylov et al., 2001). There is only one moderate-quality study on the repair of triangular fibrocartilage complex (TFCC) with distal radial fractures (Ekenstam et al., 1989). 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 (Hahnloser et al., 1999). Thus, with insufficient evidence for comparison, there are no recommendations for internal fixation techniques.

**Evidence**

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.

## CAST IMMOBILIZATION OR EXTERNAL FIXATION FOR MODERATELY DISPLACED EXTRA-ARTICULAR FRACTURES, NON-COMMINUTED OR NON-DISPLACED INTRA-ARTICULAR FRACTURES OF THE DISTAL FOREARM

**Recommended**

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

**Rationale**

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 (Pring et al., 1988, Young et al., 2003, Kreder et al., 2006, McQueen et al., 1996, Merchan et al., 1992). 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 (Lagerstrom et al., 1999). 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 (Howard et al., 1989, Jenkins et al., 1988, Jenkins et al., 1987, Kapoor et al., 2000, Stein et al., 1990, Abbaszadegan et al., 1990). 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 (Roumen et al., 1991). 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 (Ludvigsen et al., 1997, Pritchett, 1995), 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 (Kapoor et al., 2000). If pinning is selected, there does not seem to be any difference in technique comparing Kapandji and Willinegger procedures (Strohm et al., 2004), nor in the length of post-operative cast immobilization comparing 1 vs. 6 weeks (Allain et al., 1999). 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 (Sanchez-Sotelo et al., 2000, Schmalholz, 1989) and external fixation (Kopylov et al., 1999, Schmalholz, 1990) and reducing immobilization time (Kopylov et al., 2001). There is only one moderate-quality study on the repair of triangular fibrocartilage complex (TFCC) with distal radial fractures (Ekenstam et al., 1989). 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 (Hahnloser et al., 1999). Thus, with insufficient evidence for comparison, there are no recommendations for internal fixation techniques.

**Evidence**

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.

## MEDULLARY PINNING AS AN ALTERNATIVE TO EXTERNAL FIXATION

**Recommended**

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

**Rationale**

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 (Pring et al., 1988, Young et al., 2003, Kreder et al., 2006, McQueen et al., 1996, Merchan et al., 1992). 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 (Lagerstrom et al., 1999). 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 (Howard et al., 1989, Jenkins et al., 1988, Jenkins et al., 1987, Kapoor et al., 2000, Stein et al., 1990, Abbaszadegan et al., 1990). 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 (Roumen et al., 1991). 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 (Ludvigsen et al., 1997, Pritchett, 1995), 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 (Kapoor et al., 2000). If pinning is selected, there does not seem to be any difference in technique comparing Kapandji and Willinegger procedures (Strohm et al., 2004), nor in the length of post-operative cast immobilization comparing 1 vs. 6 weeks (Allain et al., 1999). 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 (Sanchez-Sotelo et al., 2000, Schmalholz, 1989) and external fixation (Kopylov et al., 1999, Schmalholz, 1990) and reducing immobilization time (Kopylov et al., 2001). There is only one moderate-quality study on the repair of triangular fibrocartilage complex (TFCC) with distal radial fractures (Ekenstam et al., 1989). 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 (Hahnloser et al., 1999). Thus, with insufficient evidence for comparison, there are no recommendations for internal fixation techniques.

**Evidence**

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.

## BONE CEMENT AS AN ALTERNATIVE TO EXTERNAL FIXATION

**Recommended**

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

**Rationale**

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 (Pring et al., 1988, Young et al., 2003, Kreder et al., 2006, McQueen et al., 1996, Merchan et al., 1992). 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 (Lagerstrom et al., 1999). 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 (Howard et al., 1989, Jenkins et al., 1988, Jenkins et al., 1987, Kapoor et al., 2000, Stein et al., 1990, Abbaszadegan et al., 1990). 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 (Roumen et al., 1991). 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 (Ludvigsen et al., 1997, Pritchett, 1995), 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 (Kapoor et al., 2000). If pinning is selected, there does not seem to be any difference in technique comparing Kapandji and Willinegger procedures (Strohm et al., 2004), nor in the length of post-operative cast immobilization comparing 1 vs. 6 weeks (Allain et al., 1999). 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 (Sanchez-Sotelo et al., 2000, Schmalholz, 1989) and external fixation (Kopylov et al., 1999, Schmalholz, 1990) and reducing immobilization time (Kopylov et al., 2001). There is only one moderate-quality study on the repair of triangular fibrocartilage complex (TFCC) with distal radial fractures (Ekenstam et al., 1989). 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 (Hahnloser et al., 1999). Thus, with insufficient evidence for comparison, there are no recommendations for internal fixation techniques.

**Evidence**

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.

## OPEN REDUCTION AND INTERNAL FIXATION VIA DORSAL OR VOLAR PLATING

**Recommended**

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

**Rationale**

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 (Pring et al., 1988, Young et al., 2003, Kreder et al., 2006, McQueen et al., 1996, Merchan et al., 1992). 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 (Lagerstrom et al., 1999). 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 (Howard et al., 1989, Jenkins et al., 1988, Jenkins et al., 1987, Kapoor et al., 2000, Stein et al., 1990, Abbaszadegan et al., 1990). 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 (Roumen et al., 1991). 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 (Ludvigsen et al., 1997, Pritchett, 1995), 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 (Kapoor et al., 2000). If pinning is selected, there does not seem to be any difference in technique comparing Kapandji and Willinegger procedures (Strohm et al., 2004), nor in the length of post-operative cast immobilization

comparing 1 vs. 6 weeks (Allain et al., 1999). 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 (Sanchez-Sotelo et al., 2000, Schmalholz, 1989) and external fixation (Kopylov et al., 1999, Schmalholz, 1990) and reducing immobilization time (Kopylov et al., 2001). There is only one moderate-quality study on the repair of triangular fibrocartilage complex (TFCC) with distal radial fractures (Ekenstam et al., 1989). 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 (Hahnloser et al., 1999). Thus, with insufficient evidence for comparison, there are no recommendations for internal fixation techniques.

**Evidence**

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.

## TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) REPAIR FOR DISTAL RADIAL FRACTURES

**No Recommendation**

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**

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 (Pring et al., 1988, Young et al., 2003, Kreder et al., 2006, McQueen et al., 1996, Merchan et al., 1992). 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 (Lagerstrom et al., 1999). 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 (Howard et al., 1989, Jenkins et al., 1988, Jenkins et al., 1987, Kapoor et al., 2000, Stein et al., 1990, Abbaszadegan et al., 1990). 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 (Roumen et al., 1991). 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 (Ludvigsen et al., 1997, Pritchett, 1995), 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 (Kapoor et al., 2000). If pinning is selected, there does not seem to be any difference in technique comparing Kapandji and Willinegger procedures (Strohm et al., 2004), nor in the length of post-operative cast immobilization comparing 1 vs. 6 weeks (Allain et al., 1999). 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 (Sanchez-Sotelo et al., 2000, Schmalholz, 1989) and external fixation (Kopylov et al., 1999, Schmalholz, 1990) and reducing immobilization time (Kopylov et al., 2001). There is only one moderate-quality study on the repair of triangular fibrocartilage complex (TFCC) with distal radial fractures (Ekenstam et al., 1989). 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 (Hahnloser et al., 1999). Thus, with insufficient evidence for comparison, there are no recommendations for internal fixation techniques.

**Evidence**

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.

## 11.2.3.5. 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 (337,338).

### CLOSED REDUCTION TECHNIQUE FOR DISPLACED DISTAL RADIAL FRACTURES

**Recommended**

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 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 (Earnshaw et al., 2002, Kongsholm et al., 1987, Kongsholm et al., 1987). 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 (Kelly et al., 1997).

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 (Kongsholm et al., 1987, Kongsholm et al., 1987). These studies suggest 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**

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.

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.

## USE OF FUNCTIONAL BRACE OR SPLINT OVER TRADITIONAL CASTING FOR DISPLACED DISTAL RADIAL FRACTURE

**No Recommendation**

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**

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) (Millett et al., 1995, Bunger et al., 1984, Gupta, 1991, Rosetzsky, 1982, Sarmiento et al., 1980, Tumia et al., 2003, Wahlstrom, 1982). One moderate-quality study of 339 patients with non-specific displaced fractures showed no difference in casting versus functional bracing (Tumia et al., 2003). Two moderate quality studies found bracing in the supine position may have advantages for intra-articular fractures (Bunger et al., 1984, Sarmiento et al., 1980), whereas bracing in pronation may provide advantage for extra-articular fracture (Gupta, 1991). However, another moderate-quality study with 250 participants found no differences between hand and ulnar positioning (van der Linden, 1981). 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**

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, 110 randomized trials and 1 systematic studies met the inclusion criteria.

## BIER BLOCK ANALGESIA FOR MANIPULATION OF ACUTE DISPLACED DISTAL FOREARM FRACTURES

**Recommended**

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

**Rationale**

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 (Cobb et al., 1985, Kendall et al., 1997, Abbaszadegan et al., 1990) In addition, those manipulated under Bier block were found to have better anatomic outcomes (Kendall et al., 1997, Abbaszadegan et al., 1990), lower remanipulation rates (Kendall et al., 1997), and better grip strength at 6 months (Abbaszadegan et al., 1990). 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 (Cobb et al., 1985). 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.

**Evidence**

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.

## HEMATOMA BLOCK ANALGESIA FOR MANIPULATION OF ACUTE DISPLACED DISTAL FOREARM FRACTURES

**Recommended**

Hematoma block analgesia is recommended for manipulation of acute displaced distal forearm fractures.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

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 (Cobb et al., 1985, Kendall et al., 1997, Abbaszadegan et al., 1990) In addition, those manipulated under Bier block were found to have better anatomic outcomes (Kendall et al., 1997, Abbaszadegan et al., 1990), lower remanipulation rates (Kendall et al., 1997), and better grip strength at 6 months (Abbaszadegan et al., 1990). 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 (Cobb et al., 1985). 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.

**Evidence**

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.

## DYNAMIC REDUCTION FOR ACUTE DISTAL FOREARM FRACTURES

**Recommended**

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**

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 (Kongsholm et al., 1987). 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 (Kongsholm et al., 1987). Hematoma infiltration provided lower pain scores during reduction and quicker onset of

analgesia than patients receiving IV pentazocine (Talwin®) and diazepam (Valium®) (Singh et al., 1992). Finally, in one moderate-quality study, hematoma block showed no difference with cubital block, and both were judged to be substandard (Haasio, 1990).

**Evidence**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 11.3. DISTAL PHALANX FRACTURES AND SUBUNGUAL HEMATOMAS

### 11.3.1. OVERVIEW

Fingertip or distal phalangeal fractures are frequently cited as the most common fractures of the hand, with the tuft being the most common (356). 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 (357,358). Tuft fractures are most often usually due to a crush injury of the fingertip (359), resulting in comminuted or transverse fractures and are a common occupational injury. Often, they are accompanied with nail bed laceration and subungual hematoma (360,361). Tuft fractures are generally stable and heal uneventfully because of the soft tissue support of the fibrous septae and nail plate (362,363). Crush fractures or avulsion fractures involving the proximal base of the distal phalanx may also involve flexor or extensor tendons and may require surgical intervention (363).

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.

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 (360). The DIP joint should be evaluated for flexion and extension range of motion.

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.

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 (364).

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 (363).

## 11.3.2. DIAGNOSTIC RECOMMENDATIONS

Diagnosis is evident from clinical suspicion, physical examination findings, and x-ray confirmation.

### X-RAYS FOR DIAGNOSING TUFT FRACTURES

**Recommended**

X-rays are recommended to diagnose tuft fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

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/Dose/Duration**

Obtaining x-rays once is generally sufficient. Follow-up x-rays are rarely indicated aside from complicated healing.

**Rationale**

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**

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.

## MAGNETIC RESONANCE IMAGING (MRI) FOR DIAGNOSING TUFT FRACTURES

**Not Recommended**

Magnetic resonance imaging (MRI) is not recommended for diagnosing tuft fractures.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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**

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.

## COMPUTED TOMOGRAPHY (CT) FOR DIAGNOSING TUFT FRACTURES

**Not Recommended**

Computed tomography (CT) is not recommended for diagnosing tuft fractures.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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**

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.

## ULTRASOUND FOR DIAGNOSING TUFT FRACTURES

**Not Recommended**

Ultrasound is not recommended for diagnosing tuft fractures.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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**

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.

## BONE SCANNING FOR DIAGNOSING TUFT FRACTURES

**Not Recommended**

Bone scanning is not recommended for diagnosing tuft fractures.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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**

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.

## 11.3.3. TREATMENT RECOMMENDATIONS

### 11.3.3.1. SUBUNGUAL HEMATOMA

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 (365,366,367,368,369,370,360,371,372,373,374,361,375). 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 (361). The primary concern for this procedure is the potential to convert an underlying fracture into an open fracture (365,366,367,368,369,370,360,371,372,373,374,361,375).

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 (375). 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.

#### TREPHINATION FOR MANAGEMENT OF SUBUNGUAL HEMATOMA

**Recommended**

Trephination is recommended for management of subungual hematoma.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

There are no quality studies regarding trephination or nail removal/laceration repair to manage subungual hematoma (Seaberg et al., 1991, Simon et al., 1987, Batrick et al., 2003, Bonisteel, 2008, Brown, 2002, Farrington, 1964, Hart et al., 1993, Meek et al., 1998, Newmeyer et al., 1977, Palamarchuk et al., 1989, Roser et al., 1999, Salter et al., 2006, Wang et al., 2001, Dean et al., 2012, Ciocon et al., 2006). 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 (Simon et al., 1987). 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 (Roser et al., 1999). 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 (Kaya et al., 2003), as well as fine point scalpel blade, surgical drill and laser have also been reported (Bonisteel, 2008) Trephining gives good cosmetic and functional results (Batrick et al., 2003).

**Evidence**

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, 01 randomized trials and 2 systematic studies met the inclusion criteria.

## NAIL REMOVAL OR LACERATION REPAIR FOR MANAGEMENT OF SUBUNGUAL HEMATOMA

**Not Recommended**

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**

There are no quality studies regarding trephination or nail removal/laceration repair to manage subungual hematoma (Seaberg et al., 1991, Simon et al., 1987, Batrick et al., 2003, Bonisteel, 2008, Brown, 2002, Farrington, 1964, Hart et al., 1993, Meek et al., 1998, Newmeyer et al., 1977, Palamarchuk et al., 1989, Roser et al., 1999, Salter et al., 2006, Wang et al., 2001, Dean et al., 2012, Ciocon et al., 2006). 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 (Simon et al., 1987). 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 (Roser et al., 1999). 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 (Kaya et al., 2003), as well as fine point scalpel blade, surgical drill and laser have also been reported (Bonisteel, 2008) Trephining gives good cosmetic and functional results (Batrick et al., 2003).

**Evidence**

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, 01 randomized trials and 2 systematic studies met the inclusion criteria.

## 11.3.3.2. 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 (362).

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 (376).

### TIGHT CIRCUMFERENTIAL TAPING FOR TUFT FRACTURES

**Not Recommended**

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**

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 (Chalmer et al., 2013, Leggit et al., 2006). 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**

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.

## PROTECTIVE SPLINTING OF DISTAL PHALANX FOR FRACTURES

**Recommended**

Protective splinting of the distal phalanx to the PIP is recommended for fractures (Bowman et al., 1993, Lee et al., 2000, Hardy, 2004).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Frequency/Dose/Duration**

Approximately 3 weeks.

**Rationale**

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 (Chalmer et al., 2013, Leggit et al., 2006). 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**

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.

## ROUTINE USE OF PHYSICAL OR OCCUPATIONAL THERAPY FOR TUFT FRACTURES

**No Recommendation**

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**

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**

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.

## 11.3.3.3. MEDICATIONS

Some patients may require pain medication, especially nocturnally, for the first few days.

### NSAIDS FOR TUFT FRACTURES

**Recommended**

NSAIDs are recommended to control pain associated with tuft fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Pain due to tuft fracture.

**Frequency/Dose/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.

**Rationale**

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, and are low cost. Thus, they are recommended.

**Evidence**

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.

## ACETAMINOPHEN FOR TUFT FRACTURES

**Recommended**

Acetaminophen is recommended to control pain associated with tuft fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Pain due to tuft fracture.

**Frequency/Dose/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.

**Rationale**

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, and are low cost. Thus, they are recommended.

**Evidence**

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.

## POST-TREPHINATION ANTIBIOTIC PROPHYLAXIS FOR OPEN FRACTURES

**No Recommendation**

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**

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 (Suprock et al., 1990). 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**

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 STATUS FOR OPEN FRACTURES

**Recommended**

For open fractures, it is recommended that tetanus immunization status to be updated as necessary.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Indications**

Wounds that are not clean or burns if more than 5 years have elapsed since last tetanus immunization (Centers for Disease Control and Prevention, 2009).

**Rationale**

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 (Centers for Disease Control and Prevention, 2009). Patients without a completed immunization series of 3 injections should receive tetanus immune globulin along with immunization.

**Evidence**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 11.3.3.4. SURGICAL CONSIDERATIONS

### SURGERY FOR TUFT FRACTURES

**No Recommendation**

Distal phalangeal diaphyseal fractures rarely require operative fixation, except those that are extremely displaced, unable to be reduced or are unstable. Retrograde percutaneous Kirschner-wire fixation is the preferred internal fixation technique .

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

### EXERCISE FOR TUFT FRACTURES

**Not Recommended**

Exercise is not indicated acutely. Few patients require exercise after recovery. For patients with residual deficits, particularly post-operatively, see recommendations for carpal tunnel syndrome.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: controlled clinical trial, controlled 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 0 systematic studies met the inclusion criteria.

## 11.4. MIDDLE AND PROXIMAL PHALANGEAL AND METACARPAL FRACTURES

### 11.4.1. OVERVIEW

Fractures of the proximal and middle phalanges represent approximately 46% of fractures of the hand and wrist (356,377). The more severe fractures are among the most challenging injuries that hand surgeons and therapists treat (378). Fortunately, most are uncomplicated and are non-surgical cases (379,380,381). 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 (362), 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 (382).

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 (377,383), and fractures of the thumb constituting another 25% (384). 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.

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. 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 (363).

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 (362). 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.

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. Motion and other hand exercises should be started at the earliest date the fracture becomes stable**.**

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 (385). Fifth metacarpal fractures usually displace at a volar angle because of the action of the interosseous muscles (386). Other metacarpal fractures tend to angulate dorsally owing to the unbalanced pull of the interosseous muscles and extrinsic finger flexors on the distal fragment (387). 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.

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

## 11.4.2. DIAGNOSTIC RECOMMENDATIONS

Diagnosis is determined by clinical suspicion evident from history, physical examination findings and x-ray confirmation.

### X-RAYS FOR DIAGNOSING PHALANGEAL OR METACARPAL FRACTURES

**Recommended**

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**

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**

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.

## MAGNETIC RESONANCE IMAGING (MRI) FOR DIAGNOSING PHALANGEAL OR METACARPAL FRACTURES

**Not Recommended**

Magnetic resonance imaging (MRI) is not recommended for diagnosing phalangeal or metacarpal fractures.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

There are no quality studies evaluating MRI 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. Therefore, MRI is not recommended for diagnosing phalangeal or metacarpal fractures.

**Evidence**

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

## COMPUTED TOMOGRAPHY (CT) FOR DIAGNOSING PHALANGEAL OR METACARPAL FRACTURES

**Not Recommended**

Computed tomography (CT) is not recommended for diagnosing phalangeal or metacarpal fractures.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

There are no quality studies evaluating CT 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 (Lee et al., 2000). Therefore, CT is not recommended for diagnosing phalangeal or metacarpal fractures.

**Evidence**

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

## ULTRASOUND FOR DIAGNOSING PHALANGEAL OR METACARPAL FRACTURES

**Not Recommended**

Ultrasound is not recommended for diagnosing phalangeal or metacarpal fractures.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

There are no quality studies evaluating ultrasound 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. Therefore, ultrasound is not recommended for diagnosing phalangeal or metacarpal fractures.

**Evidence**

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

## BONE SCANNING FOR DIAGNOSING PHALANGEAL OR METACARPAL FRACTURES

**Not Recommended**

Bone scanning is not recommended for diagnosing phalangeal or metacarpal fractures.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

There are no quality studies evaluating 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. Therefore, bone scanning is not recommended for diagnosing phalangeal or metacarpal fractures.

**Evidence**

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.

## ROUTINE X-RAYS IN FOLLOW-UP OF FIFTH METACARPAL NECK FRACTURES

**Not Recommended**

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**

Routine radiographs in follow-up of non-operative treatment for 5th metacarpal neck fracture were not found to be of clinical utility (Braakman et al., 1996), 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.

**Evidence**

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.

## 11.4.3. TREATMENT RECOMMENDATIONS

### 11.4.3.1. INITIAL CARE

Initial management should include treatment of soft tissue injuries (388) 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 – TRADITIONAL (RING) BLOCK TECHNIQUE, PALMAR SUBCUTANEOUS BLOCK

**Recommended**

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 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 (Knoop et al., 1994, Williams et al., 2006, Yin et al., 2006) and transthecal block (Cummings et al., 2004, Hill et al., 1995, Keramidas et al., 2004). There is no clear difference in the primary anesthesia outcomes between transthecal and palmar techniques (Low et al., 1997, Low et al., 1997, Hung et al., 2005), 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**

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.

## NSAIDS FOR PHALANGEAL OR METACARPAL FRACTURES

**Recommended**

NSAIDs are recommended to control pain from phalangeal or metacarpal fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to phalangeal or metacarpal fracture.

**Frequency/Dose/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.

**Rationale**

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**

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 FOR OPEN PHALANGEAL FRACTURES

**No Recommendation**

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**

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 (Suprock et al., 1990). However, the study may have been underpowered for these infrequent complications.

**Evidence**

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 STATUS FOR OPEN FRACTURES

**Recommended**

For open fractures, it is recommended that tetanus immunization status to be updated as necessary.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Indications**

Wounds that are not clean or burns if more than 5 years have elapsed since last tetanus immunization (Centers for Disease Control and Prevention, 2009).

**Rationale**

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 (Centers for Disease Control and Prevention, 2009). Patients without a completed immunization series of 3 injections should receive tetanus immune globulin along with immunization.

**Evidence**

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.

## 11.4.3.2. MIDDLE AND PROXIMAL PHALANX FRACTURES

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 (381,389). Non-operative management techniques include padded aluminum splints, buddy tape, functional splinting, and gutter casting.

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.

### IMMOBILIZATION FOR MIDDLE AND PROXIMAL PHALANX FRACTURES

**Recommended**

Immobilization is recommended for treatment of middle and proximal phalanx fractures (Reyes et al., 1987, Maitra et al., 1992).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Frequency/Dose/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.

**Rationale**

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.

**Evidence**

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.

## IMMOBILIZATION FOR NON-DISPLACED AND STABLE TRANSVERSE DIAPHYSEAL FRACTURES OF THE MIDDLE AND PROXIMAL PHALANGES

**Recommended**

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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Frequency/Dose/Duration**

Immobilization of the affected digit with neighboring digit in 70 to 90° of MCP flexion for 1 to 3 weeks.

**Rationale**

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 (Klein et al., 2000, Kozin et al., 2000).

**Evidence**

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

## NON-OPERATIVE MANAGEMENT OF NON-DISPLACED OBLIQUE FRACTURES OF THE MIDDLE AND PROXIMAL PHALANGES

**Recommended**

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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Frequency/Dose/Duration**

Examinations weekly for the first 3 weeks.

**Rationale**

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 (Lee et al., 2000, Kozin et al., 2000) or with intramedullary wires (Freeland et al., 2006).

**Evidence**

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.

## CLOSED REDUCTION WITH SPLINTING FOR BASE PHALANX FRACTURES

**Recommended**

Closed reduction with splinting is recommended for base phalanx fractures (Baratz et al., 1997).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Involvement of less than 40% of the middle phalanx base.

**Rationale**

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 (Baratz et al., 1997) 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 (Baratz et al., 1997).

**Evidence**

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.

## SURGICAL MANAGEMENT OF CONDYLAR FRACTURES

**Recommended**

Surgical management of condylar fractures is recommended as these fractures are unstable.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

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 (Lee et al., 2000, Baratz et al., 1997).

**Evidence**

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.

### SURGICAL MANAGEMENT FOR MALROTATED PHALANGEAL FRACTURES

**Recommended**

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**

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 5th metacarpal (Klein et al., 2000). 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 (McNemar et al., 2003).

**Evidence**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 11.4.3.3. PHALANGEAL OR 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.

## NON-OPERATIVE TREATMENT OF DISTAL METACARPAL HEAD FRACTURE

**Recommended**

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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Fractures with less than 20% of joint involvement.

**Rationale**

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 (McNemar et al., 2003).

**Evidence**

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.

## NON-OPERATIVE TREATMENT OF DISTAL METACARPAL HEAD FRACTURE WITH ACCEPTABLE ANGULATION

**Recommended**

Non-operative treatment of distal metacarpal head fracture using angulation is recommended.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Degree of angulation 15° in the ring finger and 10° in the index and long fingers.

**Frequency/Dose/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 (McNemar et al., 2003).

**Rationale**

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 metacarpohamate joint osteoarthrosis (Papaloizos et al., 2000), although it may result in slightly more cosmetic deformity (McKerrell et al., 1987).

**Evidence**

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.

## NON-OPERATIVE TREATMENT OF FIFTH METACARPAL NECK FRACTURES (BOXER'S FRACTURE)

**Recommended**

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

**Rationale**

There are 11 moderate-quality studies available comparing the effectiveness of different non-operative measures and no clear evidence of superiority of one approach over another (Braakman et al., 1998, Harding et al., 2001, Kuokkanen et al., 1999, Statius Muller et al., 2003, Hofmeister et al., 2008, Kim et al., 2015, Konradsen et al., 1990, Krukhaug et al., 2009, McMahon et al., 1994, Randall et al., 1992, Winter et al., 2007). 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 (Poolman et al., 2005). 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 (Braakman et al., 1998), 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 (Kuokkanen et al., 1999). 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 (Harding et al., 2001).

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 (Statius Muller et al., 2003). Several non-randomized prospective and retrospective trials with long-term follow up (up to 4 years) of patients treated without immobilization support these findings (Arafa et al., 1986, Breddam et al., 1995, Ford et al., 1989). Other methods described in the literature for non-operative management with reported efficacy include fracture brace (Jones, 1995), modified Thomine brace (Trabelsi et al., 2001), and a glove cast (Toronto et al., 1996). 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 (Kanatli et al., 2002) followed for a mean of 20 months, and 60° and 70° in early mobilization trials (Kuokkanen et al., 1999, Statius Muller et al., 2003). 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 (Kjaer-Petersen et al., 1992).

**Evidence**

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.

## USE OF FUNCTIONAL THERAPIES RATHER THAN CASTING OR SPLINTING FOR FIFTH METACARPAL NECK FRACTURES

**Recommended**

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**

There are 11 moderate-quality studies available comparing the effectiveness of different non-operative measures and no clear evidence of superiority of one approach over another (Braakman et al., 1998, Harding et al., 2001, Kuokkanen et al., 1999, Statius Muller et al., 2003, Hofmeister et al., 2008, Kim et al., 2015, Konradsen et al., 1990, Krukhaug et al., 2009, McMahon et al., 1994, Randall et al., 1992, Winter et al., 2007). 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 (Poolman et al., 2005). 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 (Braakman et al., 1998), 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 (Kuokkanen et al., 1999). 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 (Harding et al., 2001). 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 (Statius Muller et al., 2003). Several non-randomized prospective and retrospective trials with long-term follow up (up to 4 years) of patients treated without immobilization support these findings (Arafa et al., 1986, Breddam et al., 1995, Ford et al., 1989). Other methods described in the literature for non-operative management with reported efficacy include fracture brace (Jones, 1995), modified Thomine brace (Trabelsi et al., 2001), and a glove cast (Toronto et al., 1996). 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 (Kanatli et al., 2002) followed for a mean of 20 months, and 60° and 70° in early mobilization trials (Kuokkanen et al., 1999, Statius Muller et al., 2003). 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 (Kjaer-Petersen et al., 1992).

**Evidence**

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.

### ROUTINE X-RAYS IN FOLLOW-UP OF FIFTH METACARPAL NECK FRACTURES

**Not Recommended**

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**

Routine radiographs in follow-up of non-operative treatment for 5th metacarpal neck fracture were not found to be of clinical utility, except in only one case from two retrospective studies of 307 patients and 288 patients (Braakman et al., 1996). Follow-up radiographs are indicated if physical examination suggests loss of reduction or instability within 1 week of the fracture.

## 11.4.3.4. 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.

### NON-OPERATIVE MANAGEMENT OF METACARPAL SHAFT FRACTURES

**No Recommendation**

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

**Rationale**

There are no quality studies and there are conflicting opinions regarding whether any angulation of the middle and index finger is acceptable (McNemar et al., 2003), versus whether up to 15° of dorsal angulation of the middle and index finger (Freeland et al., 2006) can be tolerated. The ring finger is thought to tolerate 20° (McNemar et al., 2003). 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 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) (Freeland et al., 2006) 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).

**Evidence**

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.

## SURGICAL MANAGEMENT FOR BASE FRACTURES OF THE PROXIMAL METACARPAL

**Recommended**

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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**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 (McNemar et al., 2003).

**Rationale**

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 5th metacarpal (Klein et al., 2000). 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 (McNemar et al., 2003).

**Evidence**

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.

## OPERATIVE FIXATION FOR BENNETT'S FRACTURE AND ROLANDO'S FRACTURE

**Recommended**

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

**Rationale**

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 5th metacarpal (Klein et al., 2000). 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 (McNemar et al., 2003).

**Evidence**

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.

## SURGICAL MANAGEMENT FOR MALROTATED PHALANGEAL FRACTURES

**Recommended**

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**

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 5th metacarpal (Klein et al., 2000). 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 (McNemar et al., 2003).

**Evidence**

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.

## FOLLOW-UP VISITS FOR METACARPAL FRACTURES AT RISK FOR DISPLACEMENT

**Recommended**

Follow-up visits are recommended for metacarpal fractures at risk for displacement.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Motion and other hand exercises should be started at the earliest date the fracture becomes stable.

**Rationale**

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.

## ICE FOR ACUTE METACARPAL FRACTURES

**Recommended**

Ice is recommended for controlling edema related to acute metacarpal fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Saunders, 1989). 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% (Hardy, 2004).

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 (Freeland, 2000). Ice, compression, and elevation should be emphasized, with particular emphasis on hand elevation overnight (Eccles, 1956).

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 (Freeland, 2000). Tendon gliding range of motion exercises should be initiated as soon as possible based on the fracture immobilization method.

**Evidence**

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.

## COMPRESSION FOR ACUTE METACARPAL FRACTURES

**Recommended**

Compression is recommended for controlling edema related to acute metacarpal fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Saunders, 1989). 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% (Hardy, 2004).

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 (Freeland, 2000). Ice, compression, and elevation should be emphasized, with particular emphasis on hand elevation overnight (Eccles, 1956).

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 (Freeland, 2000). Tendon gliding range of motion exercises should be initiated as soon as possible based on the fracture immobilization method.

**Evidence**

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.

## ELEVATION FOR ACUTE METACARPAL FRACTURES

**Recommended**

Elevation is recommended for controlling edema related to acute metacarpal fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Saunders, 1989). 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% (Hardy, 2004).

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 (Freeland, 2000). Ice, compression, and elevation should be emphasized, with particular emphasis on hand elevation overnight (Eccles, 1956).

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 (Freeland, 2000). Tendon gliding range of motion exercises should be initiated as soon as possible based on the fracture immobilization method.

**Evidence**

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.

## EARLY MOBILIZATION FOR ACUTE METACARPAL FRACTURES

**Recommended**

Early mobilization of acute metacarpal fracture (before 21 days) is recommended.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Saunders, 1989). 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% (Hardy, 2004). 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 (Freeland, 2000). Ice, compression, and elevation should be emphasized, with particular emphasis on hand elevation overnight (Eccles, 1956). 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 (Freeland, 2000). Tendon gliding range of motion exercises should be initiated as soon as possible based on the fracture immobilization method.

**Evidence**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 11.5. SCAPHOID FRACTURES

### 11.5.1. OVERVIEW

Scaphoid fractures, also known as wrist navicular fractures, are among the most common fractures of the carpal bones (390), 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 (391). 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 (392). 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 (393). A history of fracture, as well as non-union both increase risk for development of osteoarthrosis. 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.

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.

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.

Physical examination findings include antalgic behavior with avoidance of use of the hand, and tenderness over the scaphoid tubercle (394,395,396). 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 (397,398,399), and scaphoid pain on axial loading of the thumb ("scaphoid compression test") (395,400). 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 (393,396,401).

Duration of immobilization is typically 6 to 8 weeks to develop resolution of tenderness and for imaging evidence of healing (402,403). 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 (404).

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 triquestrum, carpal instability, distal ulna subluxation, de Quervain's tenosynovitis, radioscaphoid arthrosis, scapholunate dislocation, and tri-scaphoid arthrosis.

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 (404), 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 (404). 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).

## 11.5.2. DIAGNOSTIC RECOMMENDATIONS

### X-RAYS FOR DIAGNOSING SCAPHOID FRACTURES

**Recommended**

X-rays are recommended for diagnostic purposes that include at least 3 to 4 views including a "scaphoid view." (Schubert, 2000)

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: x-ray, scaphoid fracture, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and reviewed 2 articles in PubMed, 934 in Scopus, 2 in CINAHL, 9 Cochrane Library, and 0 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 3 articles considered for inclusion 3 diagnostic studies met the inclusion criteria.

### FOLLOW-UP X-RAYS FOR SCAPHOID FRACTURES

**Recommended**

Follow-up x-rays in 2 weeks are recommended for evaluation of potential scaphoid fractures (Leslie et al., 1981), 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**

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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: x-ray, scaphoid fracture, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, efficiency, diagnostic, diagnosis, sensitivity, specificity, positive predictive value, negative predictive value, and predictive value of tests, efficacy, and efficiency. We found and

reviewed 2 articles in PubMed, 934 in Scopus, 2 in CINAHL, 9 Cochrane Library, and 0 from Google Scholar. We considered for inclusion 0 from PubMed, 0 from Scopus, 1 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 3 articles considered for inclusion 3 diagnostic studies met the inclusion criteria.

## MAGNETIC RESONANCE IMAGING FOR DIAGNOSING SCAPHOID FRACTURES

**Recommended**

MRI is moderately recommended for diagnosis of occult scaphoid fractures when clinical suspicion remains high despite negative x-rays (Tiel-van Buul et al., 1993, Mallee et al., 2011, Ganel et al., 1979, Murphy et al., 1995, Tiel-van Buul et al., 1993, Brismar, 1988).

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** Low

**Indications**

Clinical suspicion of scaphoid fracture but negative x-rays.

**Rationale**

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 (Brooks et al., 2005). Two moderate quality studies have suggested comparable results between CT and MRI (Mallee et al., 2011, Fotiadou et al., 2011), although two other studies suggested CT was better to evaluate cortical involvement (Ilica et al., 2011, Memarsadeghi et al., 2006). Thus, as there is evidence to support its use among these select patients, MRI is recommended.

**Evidence**

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 FOR DIAGNOSING SCAPHOID FRACTURES

**Recommended**

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**

There are a few quality studies regarding the use of high-spatial resolution sonography to diagnose scaphoid fractures, with data suggesting reasonable reliability (Fusetti et al., 2005).

**Evidence**

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.

## COMPUTED TOMOGRAPHY (CT) IMAGING FOR DIAGNOSING SCAPHOID FRACTURES

**Recommended**

CT imaging is moderately recommended to diagnose occult scaphoid fractures when clinical suspicion remains high despite negative x-rays. Quality studies include multiplanar reconstructive CT (Hannemann et al., 2013).

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

There are some quality studies regarding the use of CT to diagnose scaphoid fractures, although false positives occur (Adey et al., 2007). One comparative trial was unable to confirm CT as superior to bone scan (Rhemrev et al., 2010). 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 (Nguyen et al., 2008). 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 (Mallee et al., 2011, Fotiadou et al., 2011) although two other studies suggested CT was better to evaluate cortical involvement (Ilica et al., 2011, Memarsadeghi et al., 2006) 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 (Biondetti et al., 1987, Pennes et al., 1989). Therefore, CT imaging for those with clinical impression of fracture but negative x-rays is recommended.

**Evidence**

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 SCANNING FOR DIAGNOSING SCAPHOID FRACTURES

**Recommended**

Bone scanning 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

**Indications**

At least 48 hours after the injury with continuing clinic suspicion of scaphoid fracture (Rolfe et al., 1981).

**Rationale**

There are few quality studies on bone scanning for scaphoid fracture and suggesting utility (Stordahl et al., 1984, Rolfe et al., 1981, Nielsen et al., 1983, O'Carroll et al., 1982). 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**

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.

## 11.5.3. TREATMENT RECOMMENDATIONS

## 11.5.3.1. INITIAL CARE

Casting has been long been traditionally used as a primary intervention, with successful union being achieved 88 to 95% of the time (405,406). 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 (402,407,408). 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.

Duration of immobilization is typically 6 to 8 weeks to develop resolution of tenderness and for imaging evidence of healing. 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, with all expected to heal in 6 months.

## WRIST SPLINTING FOR SCAPHOID TUBERCLE FRACTURES

**Recommended**

Wrist splinting is recommended for treatment of scaphoid tubercle fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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 (Symes et al., 2011). Splinting is not invasive, has few adverse effects, is low cost, and thus is recommended.

**Evidence**

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.

## WRIST CASTING FOR STABLE SCAPHOID FRACTURES

**Recommended**

Immobilization of the wrist with casting is moderately recommended for treatment of documented stable scaphoid fractures which are displaced less than 1 mm, are non-oblique, and do not include the proximal third of the scaphoid.

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** High

**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 third of the scaphoid.

**Frequency/Dose/Duration**

Casting should be performed for 6 to 8 weeks, and then with the cast removed, imaging taken to assess healing (Vinnars et al., 2008, Leslie et al., 1981).

**Rationale**

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 (McQueen et al., 2008, Vinnars et al., 2008, Dias et al., 2005, Clay et al., 1991, Gellman et al., 1989, Saeden et al., 2001). 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 osteoarthrosis than operative fixation (Skirven et al., 1994). Thus, casting is recommended for treatment of stable scaphoid fractures.

**Evidence**

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.

## USE OF THUMB IMMOBILIZATION WITH CASTING FOR SCAPHOID FRACTURES

**No Recommendation**

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**

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 (Clay et al., 1991). Another study included thumb immobilization in both groups when comparing long and short arm casts to evaluate the effect of pronation and supination (Gellman et al., 1989). 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 (Schramm et al., 2008), 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 (Brooks et al., 2005, Clay et al., 1991, Cohen et al., 2001, London, 1961).

**Evidence**

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.

## COLLES' CASTING OR SUPPORTIVE BANDAGING FOR SUSPECTED BUT RADIOGRAPHICALLY NEGATIVE SCAPHOID FRACTURE

**Recommended**

Colles' casting or supportive bandaging is recommended for patients with suspicion of scaphoid fracture, but with negative x-rays.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/Duration**

2 weeks, followed by cast removal, clinical examination, and re-x-ray (Leslie et al., 1981, Gumucio et al., 1989).

**Rationale**

The prognosis of occult fractures is thought to be very good as the fragments are by definition, well approximated (McLaughlin et al., 1969, Leslie et al., 1981, Christodoulou et al., 1986). For patients with suspicion of fractures, but negative x-rays, either Colles' casting or supportive bandaging (Sjolin et al., 1988) is recommended for 2 weeks, followed by cast removal, clinical examination, and repeat x-ray (Gumucio et al., 1989, Leslie et al., 1981). 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.

**Evidence**

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.

## CASTING FOR HIGH-RISK SCAPHOID FRACTURES

**Recommended**

Long-arm casting at 90° of elbow flexion is recommended for high-risk scaphoid fractures that are displaced 1mm or more (Cooney et al., 1980, Szabo et al., 1988), or fractures of the proximal 1/3 of

the scaphoid and oblique fractures (Leslie et al., 1981, Gumucio et al., 1989). 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**

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 osteoarthrosis is lower.

**Evidence**

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.

## 11.5.3.2. MEDICATIONS

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

### NSAIDS FOR SCAPHOID FRACTURES

**Recommended**

NSAIDs are recommended to control pain associated with scaphoid fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to a scaphoid fracture.

**Frequency/Dose/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.

**Rationale**

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 section).

**Evidence**

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.

## ACETAMINOPHEN FOR SCAPHOID FRACTURES

**Recommended**

Acetaminophen is recommended to control pain associated with scaphoid fractures.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to a scaphoid fracture.

**Frequency/Dose/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.

**Rationale**

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 section).

**Evidence**

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.

## 11.5.3.3. REHABILITATION

### EDUCATION AFTER CAST REMOVAL FOR SCAPHOID FRACTURES

**Recommended**

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

**Rationale**

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: Carpal Tunnel Syndrome 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.

### PHYSICAL OR OCCUPATIONAL THERAPY AFTER CAST REMOVAL FOR SCAPHOID FRACTURES FOR PATIENTS WITH FUNCTIONAL DEBILITIES

**Recommended**

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

**Rationale**

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: Carpal Tunnel Syndrome 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**

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.

## PHYSICAL OR OCCUPATIONAL THERAPY AFTER CAST REMOVAL FOR SCAPHOID FRACTURES FOR ALL OTHER PATIENTS

**Not Recommended**

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**

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: Carpal Tunnel Syndrome 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**

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.

## 11.5.3.4. SURGICAL CONSIDERATIONS

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 (402,406,409,410,411,412,413). These studies generally indicate earlier, short-term functional recovery is achieved by surgery compared with prolonged casting (404,409,410,411,412). A Swedish study also found higher costs among manual workers treated with casts due to longer periods of lost time (413). 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 (402,409). Another study noted a significant potential for overtreatment of these patients with surgery (412).

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 osteoarthrosis.

### SURGICAL FIXATION OF DISPLACED SCAPHOID FRACTURES

**Recommended**

Surgical fixation of displaced scaphoid fractures is recommended.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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 (Vinnars et al., 2008, Alshryda et al., 2012, Saeden et al., 2001, Adolfsson et al., 2001, Bond et al., 2001, Dias et al., 2005, Toby et al., 1997, Vinnars et al., 2007). These studies generally indicate earlier, short-term functional recovery is achieved by surgery compared with prolonged casting

(Vinnars et al., 2008, Saeden et al., 2001, Adolfsson et al., 2001, Bond et al., 2001, Dias et al., 2005). A Swedish study also found higher costs among manual workers treated with casts due to longer periods of lost time (Vinnars et al., 2007). 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(Vinnars et al., 2008, Saeden et al., 2001). Another study noted a significant potential for overtreatment of these patients with surgery (Dias et al., 2005).

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 osteoarthrosis.

**Evidence**

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.

## SURGICAL INTERVENTION OF NON-DISPLACED OR MINIMALLY DISPLACED SCAPHOID FRACTURES FOR PATIENTS REQUIRING EARLY RECOVERY

**Recommended**

Surgical intervention of treatment of non-displaced or minimally displaced scaphoid fractures is recommended for patients requiring earlier functional recovery.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**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 osteoarthrosis 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 (Braga-Silva et al., 2008, Caporrino et al., 2014, Garg et al., 2013, Raju et al., 2011, Ribak et al., 2010).

**Rationale**

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 (Vinnars et al., 2008, Alshryda et al., 2012, Saeden et al., 2001, Adolfsson et al., 2001, Bond et al., 2001, Dias et al., 2005, Toby et al., 1997, Vinnars et al., 2007). These studies generally indicate earlier, short-term functional recovery is achieved by surgery compared with prolonged casting (Vinnars et al., 2008, Saeden et al., 2001, Adolfsson et al., 2001, Bond et al., 2001, Dias et al., 2005). A Swedish study also found higher costs among manual workers treated with casts due to longer periods of lost time (Vinnars et al., 2007). 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(Vinnars et al., 2008, Saeden et al., 2001). Another study noted a significant potential for overtreatment of these patients with surgery (Dias et al., 2005). 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 osteoarthrosis.

**Evidence**

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.

## SURGICAL INTERVENTION OF NON-DISPLACED OR MINIMALLY DISPLACED SCAPHOID FRACTURES FOR ALL OTHER PATIENTS

**Not Recommended**

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**

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 (Vinnars et al., 2008, Alshryda et al., 2012, Saeden et al., 2001, Adolfsson et al., 2001, Bond et

al., 2001, Dias et al., 2005, Toby et al., 1997, Vinnars et al., 2007). These studies generally indicate earlier, short-term functional recovery is achieved by surgery compared with prolonged casting (Vinnars et al., 2008, Saeden et al., 2001, Adolfsson et al., 2001, Bond et al., 2001, Dias et al., 2005). A Swedish study also found higher costs among manual workers treated with casts due to longer periods of lost time (Vinnars et al., 2007). 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(Vinnars et al., 2008, Saeden et al., 2001). Another study noted a significant potential for overtreatment of these patients with surgery (Dias et al., 2005). 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 osteoarthrosis.

**Evidence**

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.

## ULTRASOUND WITH BONE GRAFT FOR SCAPHOID FRACTURES

**No Recommendation**

There is no recommendation for or against the use of ultrasound to accelerate bone graft healing for scaphoid fractures.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

Low-intensity pulsed ultrasound has been evaluated for the treatment of fractures (Parvizi et al., 2005, Pounder et al., 2008, Riboh et al., 2012, Rubin et al., 2001, Siska et al., 2008, Barry, 2015). 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 (Ricardo, 2006).

**Evidence**

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.

### OSTEOGENIC PROTEIN ADJUVANT FOR SCAPHOID FRACTURES

**No Recommendation**

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**

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 (Bilic et al., 2006). The study reported the following healing rates: sclerotic area at 3 months 138.3±15.1 versus 74.0±14.1 versus 103.6±13.2mm2 respectively. However, the results need repeating in a larger sample size prior to a recommendation.

**Evidence**

There is 1 moderate-quality RCT incorporated into this analysis.

## 12. GANGLION CYSTS

## 12.1. OVERVIEW

Ganglion cysts occur in nearly any joint of the hand and wrist and have an estimated prevalence rate of 14% (414), although prevalence rates based on MRIs are approximately 50%, with asymptomatic ganglia more likely to be volar (palmar) than dorsal (415). 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 (416). 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 (417). Approximately 10% of all hand and wrist ganglia are found on a flexor tendon sheath of the fingers (418).

A ganglion is a cystic structure, although is not technically a cyst as it has no synovial lining (419). 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 (419).

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 (419,420,421,422). Each of these theories fails to wholly explain all of the known facts, particularly because there seems to be no inflammatory process.

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 (423). 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 and Elbow Disorders Guideline).

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 (424).

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% (415). Symptomatic ganglia were more likely to be volar (palmar) than dorsal (415).

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.

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.

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% (414). 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.

## 12.2. DIAGNOSTIC RECOMMENDATIONS

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.

### ROUTINE X-RAYS FOR DIAGNOSIS OF WRIST GANGLIA

**Recommended**

X-ray to diagnose dorsal or volar wrist ganglia in select patients is recommended.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Ganglia, especially occurring in the context of trauma where fracture may be present.

**Frequency/Dose/Duration**

Obtaining x-rays once is generally sufficient.

**Rationale**

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%) (Wong et al., 2007).

**Evidence**

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.

## ROUTINE USE OF X-RAYS FOR EVALUATION OF DORSAL OR VOLAR WRIST GANGLIA

**Not Recommended**

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**

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%) (Wong et al., 2007).

**Evidence**

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 FOR EVALUATION OF WRIST PAIN WITH SUSPECTED OCCULT DORSAL OR VOLAR WRIST GANGLIA

**No Recommendation**

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**

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% (Goldsmith et al., 2008). 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 (Lowden et al., 2005), 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 (Anderson et al., 2006). 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**

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 FOR EVALUATION OF CHRONIC WRIST PAIN WITH SUSPECTED OCCULT DORSAL OR VOLAR WRIST GANGLIA

**No Recommendation**

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**

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% (Lowden et al., 2005), 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**

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.

## 12.3. TREATMENT RECOMMENDATIONS

## 12.3.1. INITIAL CARE

### NON-OPERATIVE MANAGEMENT (NO TREATMENT) FOR ACUTE ASYMPTOMATIC WRIST AND HAND GANGLIA

**Recommended**

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**

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 (Dias et al., 2007). 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 (Dias et al., 2007).

**Evidence**

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.

## EXERCISE FOR GANGLION CYSTS

**Not Recommended**

Exercise is not generally indicated acutely. For those with residual deficits, particularly post-operatively, see the recommendations for carpal tunnel syndrome.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

### MEDICATIONS FOR GANGLION CYSTS

**No Recommendation**

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.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 12.3.2. SURGICAL CONSIDERATIONS

### ASPIRATION (WITHOUT OTHER INTERVENTION) FOR ACUTE COSMETIC AND GANGLIA RELATED PAIN

**Recommended**

Aspiration (without other intervention) of the cystic fluid is recommended as it may result in immediate relief of acute cosmetic and ganglia related pain.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Frequency/Dose/Duration**

One aspiration is recommended (Latif et al., 2014). 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.

**Rationale**

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 (Gude et al., 2008). 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.

**Evidence**

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.

## ASPIRATION WITH STEROIDS

**No Recommendation**

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**

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 (Gude et al., 2008). 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.

**Evidence**

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.

## ASPIRATION AND MULTIPLE PUNCTURES OF CYST WALL

**Not Recommended**

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**

There is one quality study comparing simple aspiration with multiple wall punctures (Stephen et al., 1999), 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 (Gude et al., 2008). 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.

**Evidence**

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.

## SPLINTING AFTER ASPIRATION FOR ACUTE OR SUBACUTE DORSAL OR VOLAR WRIST GANGLIA

**No Recommendation**

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**

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 (Korman et al., 1992). However, in an earlier study including multiple punctures, immobilization had a positive effect for successful outcomes (Richman et al., 1987). These conflicting results, in the absence of quality experimental data, preclude making recommendation for or against this intervention.

**Evidence**

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.

## HYALURONIDASE INSTILLATION AFTER ASPIRATION

**No Recommendation**

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**

One moderate-quality study compared the standard therapy of aspiration and steroids with the addition of hyaluronidase to the mixture (Paul et al., 1997). 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.

**Evidence**

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.

## ASPIRATION AND SCLEROSING AGENTS

**Not Recommended**

Sclerosing agents (e.g., phenol, 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**

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 (Dogo et al., 2003). A small study of 10 patients treated with phenol injection was reported with good results (Park et al., 2002). 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.

**Evidence**

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.

## SURGICAL EXCISION FOR SUBACUTE OR CHRONIC UPPER EXTREMITY GANGLIA

**Recommended**

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**

Surgical intervention is the most effective treatment method for upper extremity ganglia despite the significant recurrence rates and higher risk of complications (Limpaphayom et al., 2004, Latif et al., 2014, Khan et al., 2011, Head et al., 2015, Tadjerbashi et al., 2014). 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 (Limpaphayom et al., 2004). 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 (Gude et al., 2008).

**Evidence**

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.

## ARTHROSCOPIC VERSUS OPEN EXCISION

**Recommended**

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**

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 (Kang et al., 2008, Rocchi et al., 2008), 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 (Rocchi et al., 2008). 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 (Rizzo et al., 2004), 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.

**Evidence**

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.

# 13. HAND-ARM VIBRATION SYNDROME

## 13.1. OVERVIEW

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 (425,426,427) or from vibratory rich activities such as driving off-road vehicles (428). 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” (429).

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 (430,431). There are also several reports of association of CTS with HAVS and exposure to vibration (430,432,433,434,435).

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 (294). 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.

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 (436,437).

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.

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 (438). 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 (439), vascular spasm related to activation of alpha-2 adrenoreceptor in the vessel walls (440), or the release of a potent vasoconstrictor known as salivary endothelin (441). The pathophysiology of neurologic deficits is also unknown, but presumably is related to vibration induced microvascular changes and demylelination (438).

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 (442). 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 (443). The range of vibration frequencies thought to be harmful is 4Hz to 5000Hz (430,433,444) 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 (445,446,52). 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 (444,447,27,35).

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.

## 13.2. DIAGNOSTIC RECOMMENDATIONS

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 (448,449) which is subjective and relies on patient recall (450). 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 (451).

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 (452,453,454,455,456). 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.

### DIAGNOSTIC STUDIES FOR HAND-ARM VIBRATION SYNDROME

**No Recommendation**

There is no recommendation for or against the use of a cold provocation test, cold stress thermograpy (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**

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 (Thompson et al., 2008), and a general inability of these tests to reliably differentiate HAVS from controls (Poole et al., 2006, Poole et al., 2004).

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 (Harada et al., 2008). 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 (Proud et al., 2003). 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 (Jankovic et al., 2008). 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 (Kurozawa et al., 1991). 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 (McGeoch et al., 2004).

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**

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 aesthesiomtry, 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.

## SEROLOGIC TESTS (THROMBOMODULIN, SOLUBLE INTRACELLULAR ADHESION MOLECULE 1 [S1-CAM 1]) TO DIAGNOSE HAND-ARM VIBRATION SYNDROME

**Not Recommended**

Serologic tests, such as thrombomodulin and soluble intracellular adhesion molecule 1 (s1-CAM 1), are not recommended to diagnose hand-arm vibration syndrome (HAVS).

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Kao et al., 2008), 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**

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 aesthesiomtry, 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.

### TESTING FOR CONNECTIVE TISSUE DISORDERS TO DIAGNOSE HAND-ARM VIBRATION SYNDROME

**No Recommendation**

There is no recommendation for or against the use of testing for connective tissue disorders to diagnose hand-arm vibration syndrome (HAVS).

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Kao et al., 2008), 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.

## 13.3. TREATMENT RECOMMENDATIONS

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. 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.

### AVOIDANCE OF RISK FACTORS (INCLUDING VIBRATION EXPOSURE AND SMOKING) FOR HAND-ARM VIBRATION SYNDROME

**Recommended**

The avoidance of risk factors, including removal/reduction of the exposure to vibration and smoking cessation, is recommended for individuals with hand-arm vibration syndrome (HAVS).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 . 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 (Nowak et al., 1996), 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.

## VIBRATION EXPOSURE WORK RESTRICTIONS FOR HAND-ARM VIBRATION SYNDROME

**Recommended**

Restricting work to tasks that do not involve high-amplitude, low-frequency vibration exposures from hand-held tools is recommended for patients with hand-arm vibration syndrome (HAVS).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**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.

**Rationale**

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 (Pelmear et al., 2000). 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.

## COLD EXPOSURE WORK RESTRICTIONS FOR HAVS

**Sometimes Recommended**

Restricting work to tasks that do not involve cold exposure is recommended for select patients with hand-arm vibration syndrome (HAVS).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**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.

**Rationale**

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 (Pelmear et al., 2000). 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.

## CALCIUM CHANNEL BLOCKERS FOR ADVANCED SUBACUTE OR CHRONIC HAND-ARM VIBRATION SYNDROME

**Recommended**

Use of calcium channel blockers (nifedipine) for treatment of vascular symptoms similar to Raynaud's phenomenon is recommended for advanced subacute or chronic hand-arm vibration syndrome (HAVS).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Patients with HAVS. Generally used in patients with sufficient symptoms such that removal from exposure is insufficient for management.

**Frequency/Dose/Duration**

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.

**Indications for discontinuation**

Resolution, intolerance, adverse effects.

**Rationale**

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**

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.

## EXERCISE FOR HAND-ARM VIBRATION SYNDROME

**No Recommendation**

Exercise is not generally indicated for hand-arm vibration syndrome (HAVS).

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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 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.

**Rationale**

There are no quality studies on exercise for HAVS, and thus there is no recommendation.

**Evidence**

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.

# 14. HAND AND FINGER OSTEOARTHROSIS

## 14.1. OVERVIEW

Hand and finger osteoarthrosis is extraordinarily common, affecting over 50% of the aged population. It is believed to be largely non-occupational (457,458), but some cases may be covered under certain workers' compensation jurisdictions, usually under fairly limited circumstances. This is particularly true for monoarticular arthrosis as a consequence of an occupational injury.

Most cases of osteoarthrosis 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. 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.

Mild cases may show few, if any abnormalities. However, as the disease progresses, more findings develop. Boney 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. Boney 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.

Many patients require no follow-up appointments as the main thrust of the initial treatment generally focuses on securing the diagnosis and initiating treatment. Some patients may require a few follow-up appointments, depending on severity and need for workplace limitations.

Hand osteoarthrosis 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.

There is one cross sectional study from the textile industry that suggests some cases of hand osteoarthrosis may have a component of occupational tasks (459); 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 osteoarthrosis 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.

## 14.2. DIAGNOSTIC RECOMMENDATIONS

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 osteoarthrosis as well as show evidence of disease among those asymptomatic.

### X-RAYS TO EVALUATE HAND OSTEOARTHROSIS

**Recommended**

X-rays are recommended to define objective evidence of the extent of hand osteoarthrosis.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

There are no quality studies evaluating x-rays for hand osteoarthrosis. 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 osteoarthrosis.

**Evidence**

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 osteoarthrosis, 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.

## 14.3. TREATMENT RECOMMENDATIONS

### 14.3.1. INITIAL CARE

Relative rest, splints, ice, and heat have been utilized for treatment of hand osteoarthrosis (460,461,462). Uncontrolled trials have reported splinting reduced the need for hand surgery (463,464). Exercises have been recommended as well (462,465,466,467,468,469,470).

#### RELATIVE REST FOR CHRONIC HAND OSTEOARTHROSIS

**Not Recommended**

Relative rest is not recommended for chronic hand osteoarthrosis.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies of this treatment. 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.

**Evidence**

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, 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 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.

## SPLINTING FOR ACUTE FLARES OR CHRONIC HAND OSTEOARTHROSIS

**Recommended**

Splinting is recommended for acute flares or chronic hand osteoarthrosis.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

Hand osteoarthrosis symptoms insufficiently treated with NSAIDs, acetaminophen, and/or topical medications. Prefabricated or custom-made orthoses may be utilized.

**Rationale**

All quality studies of splinting addressed thumb CMC/trapeziometacarpal OA. There is one quality study evaluating splinting versus no splinting that suggested modest benefits (Rannou et al., 2009), 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 (Buurke et al., 1999, Weiss et al., 2004). A fourth study compared two different exercise and splint regimens and found no differences (Wajon et al., 2005); 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.

**Evidence**

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, osteoarthrosis, 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, 107 randomized trials and 10 systematic studies met the inclusion criteria.

## EXERCISE FOR ACUTE FLARES OR CHRONIC HAND OSTEOARTHROSIS

**Recommended**

Exercise is recommended for treatment of acute flares or chronic hand osteoarthrosis.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

Hand osteoarthrosis symptoms insufficiently treated with NSAIDs, acetaminophen, and/or topical medications.

**Frequency/Dose/Duration**

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 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.

**Rationale**

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 osteoarthrosis 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 osteoarthrosis (Stamm et al., 2002). An uncontrolled trial found strength training increased grip strength and reduced pain(Rogers et al., 2007); 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 (Rogers et al., 2009). As well, a study of combined exercises and splints failed to find one program superior (Wajon et al., 2005). 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**

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, 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 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.

## SELF-APPLICATION OF HEAT FOR ACUTE FLARES OR CHRONIC HAND OSTEOARTHROSIS

**Recommended**

Self-application of heat is recommended for acute flares or chronic hand osteoarthrosis.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Hand osteoarthrosis symptoms insufficiently treated with NSAIDs, acetaminophen, and/or topical medications.

**Frequency/Dose/Duration**

Self-applications of heat, most commonly 15 to 20 minutes, 3 to 5 times a day.

**Rationale**

There are no quality studies of this treatment. 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.

## 14.3.2. MEDICATIONS

NSAIDs and acetaminophen are widely used to treat pain associated with osteoarthrosis (OA), and are considered highly efficacious, although most studies evaluating their use lasted not longer than 6 weeks (471,472,473,474). 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 Disorders and Low Back Disorders Guidelines). Few have evaluated hand osteoarthrosis patients (475,476,477).

### NSAIDS FOR ACUTE FLARES, SUBACUTE, OR CHRONIC HAND OSTEOARTHROSIS

**Recommended**

NSAIDs are moderately recommended to control pain associated with acute flares, subacute, or chronic hand osteoarthrosis.

[Evidence is robust and strongly recommended for the treatment of osteoarthrosis 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

**Rationale**

There is abundant quality evidence that COX-1 and COX-2 NSAIDs improve pain and produce higher functional status among chronic osteoarthrosis patients (see Hip and Groin Disorders Guideline), and two quality studies included hand OA patients. There are a few studies of osteoarthrosis 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 (Levi et al., 1985) and there is no similar result with the longer half-life agent celecoxib (Stengaard-Pedersen et al., 2004). 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 the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006). However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational 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 are low cost when generic medications are used. 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, NSAIDS, 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.

## NSAIDS FOR ACUTE FLARES, SUBACUTE, OR CHRONIC HAND OSTEOARTHROSIS

**No Recommendation**

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

**Rationale**

There is abundant quality evidence that COX-1 and COX-2 NSAIDs improve pain and produce higher functional status among chronic osteoarthrosis patients (see Hip and Groin Disorders Guideline), and two quality studies included hand OA patients. There are a few studies of osteoarthrosis 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 (Levi et al., 1985) and there is no similar result with the longer half-life agent celecoxib (Stengaard-Pedersen et al., 2004). 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 the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006).

However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational 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 are low cost when generic medications are used. 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, NSAIDS, 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.

## NSAIDS FOR ACUTE FLARES, SUBACUTE, OR CHRONIC HAND OSTEOARTHROSIS

**No Recommendation**

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

**Rationale**

There is abundant quality evidence that COX-1 and COX-2 NSAIDs improve pain and produce higher functional status among chronic osteoarthrosis patients (see Hip and Groin Disorders Guideline), and two quality studies included hand OA patients. There are a few studies of osteoarthrosis 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 (Levi et al., 1985) and there is no similar result with the longer half-life agent celecoxib (Stengaard-Pedersen et al., 2004). 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 the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006). However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational 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 are low cost when generic medications are used. 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, NSAIDS, 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.

## ACETAMINOPHEN FOR ACUTE FLARES, SUBACUTE, OR CHRONIC HAND OSTEOARTHROSIS

**Recommended**

Acetaminophen (or the analog paracetamol) may be a reasonable alternative for treatment of osteoarthrosis pain (Amadio et al., 1983, Pincus et al., 2004), although quality evidence is available that documents these are consistently less efficacious in comparison with NSAIDs (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed et al., 2006) and at least two quality trials with placebo comparisons have been negative including one with a large sample size of 779 patients (Case et al., 2003, Miceli-Richard et al., 2004). Yet, acetaminophen may be preferable for initial treatment of elderly patients and others with risks for gastrointestinal bleeding.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** High

**Indications**

For hand osteoarthrosis patients, NSAIDs and acetaminophen are recommended for treatment. Over-the-counter agents may suffice and may be tried first.

**Frequency/Dose/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 (Levi et al., 1985), 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 (Stengaard-Pedersen et al., 2004).

**Indications for discontinuation**

Resolution of hand pain, lack of efficacy, or development of adverse effects that necessitate discontinuation.

**Rationale**

Quality evidence documents NSAIDs as superior to acetaminophen for symptomatic relief of OA (see the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006). However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational 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 are low cost when generic medications are used. 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, NSAIDS, 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.

## RISK ASSESSMENT FOR ADVERSE EVENTS FROM CHRONIC NSAID USE

**Recommended**

Risk of adverse events from chronic NSAID use should be incorporated, especially including risk of gastrointestinal bleeding.

**Strength of evidence** Strongly Recommended, Evidence (A)
**Level of confidence** High

**Indications**

For hand osteoarthrosis patients, NSAIDs and acetaminophen are recommended for treatment. Over-the-counter agents may suffice and may be tried first.

**Rationale**

Quality evidence documents NSAIDs as superior to acetaminophen for symptomatic relief of OA (see the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006). However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational for utilization of acetaminophen to treat some patients, particularly the elderly and others prone to GI complications.

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 (see Hip and Groin Disorders Guideline) (Berenbaum et al., 2005, Garner et al., 2005, Agrawal et al., 1999, Bocanegra et al., 1998, Fenton et al., 2004, Melo Gomes et al., 1993). While COX-2 selective agents have generally been recommended as either third- or fourth-line medications for routine use in osteoarthrosis 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) (Agrawal et al., 1999, Bocanegra et al., 1998, Melo Gomes et al., 1993, Agrawal et al., 1998, Desai et al., 2008, Goldstein et al., 2007, Hawkey et al., 2008, Lazzaroni et al., 1999, Lazzaroni et al., 2009, Niwa et al., 2008, Bianchi Porro, 1998, Yeomans et al., 2008), while there is substantially less evidence in support of sucralfate (Bianchi Porro, 1998). 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 (Goldstein et al., 2007). Should rofecoxib become available, it is suggested that it be considered as a fourth- or fifth-line medication for treatment of osteoarthrosis, 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.

**Evidence**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, NSAIDS, 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.

## NSAIDS FOR PATIENTS AT RISK FOR GI ADVERSE EFFECTS

**Recommended**

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, ranitindine, cimetadine, 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 (Graham et al., 2002), 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).

**Strength of evidence** Strongly Recommended, Evidence (A)
**Level of confidence** High

**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/Dose/Duration**

As recommended.

**Indications for discontinuation**

Intolerance, development of adverse effects, or discontinuation of NSAIDs.

**Rationale**

There is abundant quality evidence that COX-1 and COX-2 NSAIDs improve pain and produce higher functional status among chronic osteoarthrosis patients (see Hip and Groin Disorders Guideline), and two quality studies included hand OA patients. There are a few studies of osteoarthrosis 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 (Levi et al., 1985) and there is no similar result with the longer half-life agent celecoxib (Stengaard-Pedersen et al., 2004). 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 the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006). However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational 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 are low cost when generic medications are used. 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis NSAIDS, 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.

## DISCUSSION REGARDING NSAIDS FOR PATIENTS AT RISK FOR CARDIOVASCULAR ADVERSE EFFECTS

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Frequency/Dose/Duration**

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 (Antman et al., 2007).

**Rationale**

There is abundant quality evidence that COX-1 and COX-2 NSAIDs improve pain and produce higher functional status among chronic osteoarthrosis patients (see Hip and Groin Disorders Guideline), and two quality studies included hand OA patients. There are a few studies of osteoarthrosis 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 (Levi et al., 1985) and there is no similar result with the longer half-life agent celecoxib (Stengaard-Pedersen et al., 2004). 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 the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006). However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational 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 are low cost when generic medications are used. 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, NSAIDS, cardiovascular tolerability; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 article in PubMed, 6 in Scopus, 3 in CINAHL, 10 in Cochrane Library, 5425 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

## ACETAMINOPHEN OR ASPIRIN FOR PATIENTS AT RISK FOR CARDIOVASCULAR ADVERSE EFFECTS

**Recommended**

Acetaminophen or aspirin is strongly recommended as the first-line therapy for patients with known or multiple risk factors for cardiovascular disease.

**Strength of evidence** Strongly Recommended, Evidence (A)
**Level of confidence** High

**Rationale**

There is abundant quality evidence that COX-1 and COX-2 NSAIDs improve pain and produce higher functional status among chronic osteoarthrosis patients (see Hip and Groin Disorders Guideline), and two quality studies included hand OA patients. There are a few studies of osteoarthrosis 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 (Levi et al., 1985) and there is no similar result with the longer half-life agent celecoxib (Stengaard-Pedersen et al., 2004). 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 the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006). However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational 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 are low cost when generic medications are used. 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, Acetaminophen, Aspirin, cardiovascular tolerability; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 6 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 5199 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

## ACETAMINOPHEN FOR ACUTE FLARES, SUBACUTE, OR CHRONIC HAND OSTEOARTHROSIS

**Recommended**

Acetaminophen is recommended to control pain associated with acute flares, subacute, or chronic hand osteoarthrosis pain, particularly for patients with contraindications for NSAIDs.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

There is abundant quality evidence that COX-1 and COX-2 NSAIDs improve pain and produce higher functional status among chronic osteoarthrosis patients (see Hip and Groin Disorders Guideline), and two quality studies included hand OA patients. There are a few studies of osteoarthrosis 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 (Levi et al., 1985) and there is no similar result with the longer half-life agent celecoxib (Stengaard-Pedersen et al., 2004). 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 the Chronic Pain. Low Back Disorders, and Hip and Groin Disorders guidelines) (Boureau et al., 2004, Bradley et al., 1991, Case et al., 2003, Geba et al., 2002, Golden et al., 2004, Pincus et al., 2001, Temple et al., 2006, Towheed, 2006). However, quality evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and generally lower overall adverse effects profiles for acetaminophen, providing rational 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 are low cost when generic medications are used. 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: antiinflammatory agents, non-steroidal, Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, Acetaminophen, Aspirin,

cardiovascular tolerability; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 6 in Scopus, 0 in CINAHL, 0 in Cochrane Library, 5199 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

### TOPICAL NSAIDS FOR HAND OSTEOARTHROSIS

**Recommended**

Topical NSAIDs are recommended to control pain associated with hand osteoarthrosis.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Rothacker et al., 1994, Rothacker et al., 1998). 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**

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, 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 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

See the ACOEM Opioids guideline.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 14.3.3. ALLIED HEALTH

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 osteoarthrosis. (These are reviewed in detail in the Hip and Groin Disorders guideline.)

Low-level laser therapy has been used for treatment of hand osteoarthrosis patients, although the evidence has been noted to conflict (478,479,480).

## CAPSAICIN FOR CHRONIC HAND OSTEOARTHROSIS OR ACUTE FLARES OF OSTEOARTHROSIS

**Recommended**

Capsaicin is recommended for treatment of chronic hand osteoarthrosis or acute flares of osteoarthrosis.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

Hand osteoarthrosis pain or acute flares (study has also included rheumatoid arthritis patients) (McCarthy et al., 1992, Schnitzer et al., 1994).

**Frequency/Dose/Duration**

Up to 4 times a day. 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.

**Rationale**

There is one quality study of capsaicin for treatment of these patients and it suggests benefits over a 4-week trial (McCarthy et al., 1992). Thus, it is recommended.

**Evidence**

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, 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 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.

## YOGA FOR CHRONIC HAND OSTEOARTHROSIS OR ACUTE FLARES OF OSTEOARTHROSIS

**Recommended**

Yoga is recommended for treatment of chronic hand osteoarthrosis or acute flares of osteoarthrosis.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Hand osteoarthrosis pain in motivated patients.

**Frequency/Dose/Duration**

Self-directed program after up to 8 supervised sessions (Garfinkel et al., 1994).

**Indications for discontinuation**

Intolerance, non-compliance.

**Rationale**

There is one low-quality study of yoga that suggested benefits (Garfinkel et al., 1994). As yoga is not invasive, has few adverse effects, and is low cost, it is recommended for select, motivated patients.

**Evidence**

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, 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 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.

## COMPLEMENTARY AND ALTERNATIVE THERAPIES FOR CHRONIC HAND OSTEOARTHROSIS OR ACUTE FLARES

**No Recommendation**

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 osteoarthrosis or acute flares.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 osteoarthrosis 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 (Rovetta et al., 2002). 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 (Randall et al., 2000) 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**

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, 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 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 FOR HAND OSTEOARTHROSIS

**Not Recommended**

Low-level laser therapy is moderately not recommended for treatment of hand osteoarthrosis.

**Strength of evidence** Moderately Not Recommended, Evidence (B)
**Level of confidence** Moderate

**Rationale**

There is one high-quality study that suggests low-level laser therapy is ineffective for treatment of hand osteoarthrosis (Brosseau et al., 2005). Low-level laser therapy is not invasive and has low adverse effects, but it is costly. Thus, in the absence of efficacy, it is not recommended.

**Evidence**

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, 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 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.

## 14.3.4. INJECTION THERAPY

Intraarticular glucocorticosteroid and hyaluronidate injections are sometimes performed to attempt to deliver medication with minimal systemic effects to the arthritic joint (481,482,483,484,485,486,487,488,489), particularly when acetaminophen and NSAIDs have failed.

These injections are generally performed without fluoroscopic or ultrasound guidance in the distal upper extremity.

## INTRAARTICULAR GLUCOCORTICOSTEROID INJECTION FOR SUBACUTE OR CHRONIC HAND OSTEOARTHROSIS

**Recommended**

Intraarticular glucocorticosteroid injections are recommended for the treatment of subacute or chronic hand osteoarthrosis.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

Moderately severe or severe hand osteoarthrosis 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/Dose/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). 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.

**Rationale**

There are several quality studies for treatment of hand osteoarthrosis with glucocorticosteroids. However, the studies conflict regarding the length of benefits. However, nearly all studies have suggested benefits (Fuchs et al., 2006, Heyworth et al., 2008, Stahl et al., 2005, Wollstein et al., 2007). No studies have suggest prolonged benefits after more than approximately 3 months; thus, these injections are short- to intermediate-term interventions. 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.

**Evidence**

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.

## INTRAARTICULAR HYALURONATE INJECTION FOR SUBACUTE OR CHRONIC HAND OSTEOARTHROSIS

**Recommended**

Intraarticular hyaluronate injections are recommended for the treatment of subacute or chronic hand osteoarthrosis.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

Hand osteoarthrosis 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/Dose/Duration**

Number and frequency of injections are unclear (one trial found no differences between 1, 2, or 3 injections) (Roux et al., 2007). Most physicians perform 3 injections (Fuchs et al., 2006). See manufacturer's recommendations.

**Indications for discontinuation**

Sufficient relief to not require additional injection(s), failure to improve, or allergic reactions.

**Rationale**

There are a few quality studies of hyaluronate injections for treatment of hand osteoarthrosis, which suggest benefits. Duration of improvement is uncertain, although one trial suggested pain relief as long as 26 weeks (Heyworth et al., 2008). These injections are invasive, have moderate adverse effects, and are costly. In select cases where other treatments have failed, these injections are recommended.

**Evidence**

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.

### PROLOTHERAPY INJECTIONS FOR SUBACUTE OR CHRONIC HAND OSTEOARTHROSIS

**No Recommendation**

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**

Prolotherapy injections are invasive because they require numerous, repeated injections in phalangeal joints. The magnitude of the purported benefits is modest. The results of the (Reeves et al., 2000) study suggesting some benefits compared with placebo injections needs to be replicated, including with a larger sample size, evaluation of functional outcomes, and a sufficient follow-up duration to allow for an adequate assessment of the risks and benefits of these procedures prior to a recommendation in favor of this treatment.

**Evidence**

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.

## 14.3.5. SURGICAL CONSIDERATIONS

Various surgical procedures are utilized to treat patients with hand osteoarthrosis (490,491,492,493,494,495,496,497,498,499,500,501,502,503). Among these are arthrodesis, arthroplasty and various other reconstructive procedures, although many have been developed and utilized to primarily treat patients with rheumatoid arthritis (504,505,506).

### RECONSTRUCTIVE SURGERY FOR SELECT PATIENTS WITH TRAPEZIOMETACARPAL ARTHROSIS

**Recommended**

Reconstructive surgery is recommended for treatment of select patients with trapeziometacarpal arthrosis.

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

**Level of confidence** Low

**Rationale**

There are many moderate-quality studies evaluating surgery for hand osteoarthrosis, all of which concern the basal thumb joint (trapeziometacarpal joint) (Atroshi et al., 1998, Belcher et al., 2000, Davis et al., 1997, Gibbons et al., 1999, Horlock et al., 2002, Tagil et al., 2002, De Smet et al., 2002, Vandenbroucke et al., 1997, Young et al., 1998, Davis et al., 2009, Davis et al., 2004). There are a few quality studies of surgery for rheumatoid arthritic joints, such as MCP joint replacement (Delaney et al., 2005, McArthur et al., 1998, Moller et al., 2005, Sollerman et al., 1996). 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 by most measures (Davis et al., 1997, Field et al., 2007, Wajon et al., 2005, Davis et al., 2009, Davis et al., 2004, Kriegs-Au et al., 2004, Ulrich-Vinther et al., 2008) (Horlock et al., 2002). A 17-year follow-up study found similar conclusions regarding a lack of longer-term superiority of the LRTI procedure (Brennan A, 2021). Some studies suggest longer recovery and higher complication rates with the more extensive procedures, with an average 2-fold greater comlication rate for LRTI (Liu Q, 2022). Thus, the ligament reconstruction with tendon interposition procedure is generally not recommended for most patients. However, there is evidence that grip strength and tip pinch strength were both superior in the LRTI group compared witih simple trapeziectomy (Liu Q, 2022). Accordingly, selective use of the LRTI procedure is recommended for workers with hand-intensive work, especially that which requires moderate to high hand forces. 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 osteoarthrosis who fail to achieve sufficient relief from other treatments.

**Evidence**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Reconstructive surgery , Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, trapeziometacarpal arthrosis, trapeziectomy with ligament reconstruction and tendon interposition, thumb CMC joint osteoarthritis, fusion, hand osteoarthrosis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 136 articles in PubMed, 22 in Scopus, 6 in CINAHL, 1 in Cochrane Library, 20105 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 3 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 1 from other sources. Of the 5 articles considered for inclusion, 5 randomized trials and 2 systematic studies met the inclusion criteria.

## TRAPEZIECTOMY WITH LIGAMENT RECONSTRUCTION AND TENDON INTERPOSITION FOR THUMB CMC JOINT OSTEOARTHRITIS

**Recommended**

Trapeziectomy with ligament reconstruction and tendon interposition arthroplasty (LRTI) is selectively recommended for treatment of thumb CMC joint osteoarthrosis for those individuals performing moderate- to high-force hand activities. However, for most patients, simple trapeziectomy has a lower

complication rate than LRTI and therefore is preferred absent any forceful hand activity requirements (Liu Q, 2022).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Trapeziometacarpal osteoarthrosis that has failed non-operative treatment, including NSAIDs.

**Benefits**

Improved pain and function.

**Harms**

Operative complications, including infection. May also experience no appreciable benefit. Insufficient improvement may also result in disability status.

**Rationale**

There are many moderate-quality studies evaluating surgery for hand osteoarthrosis, all of which concern the basal thumb joint (trapeziometacarpal joint) (Atroshi et al., 1998, Belcher et al., 2000, Davis et al., 1997, Gibbons et al., 1999, Horlock et al., 2002, Tagil et al., 2002, De Smet et al., 2002, Vandenbroucke et al., 1997, Young et al., 1998, Davis et al., 2009, Davis et al., 2004). There are a few quality studies of surgery for rheumatoid arthritic joints, such as MCP joint replacement (Delaney et al., 2005, McArthur et al., 1998, Moller et al., 2005, Sollerman et al., 1996). 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 by most measures (Davis et al., 1997, Field et al., 2007, Wajon et al., 2005, Davis et al., 2009, Davis et al., 2004, Kriegs-Au et al., 2004, Ulrich-Vinther et al., 2008) (Horlock et al., 2002). A 17-year follow-up study found similar conclusions regarding a lack of longer-term superiority of the LRTI procedure (Brennan A, 2021). Some studies suggest longer recovery and higher complication rates with the more extensive procedures, with an average 2-fold greater complication rate for LRTI (Liu Q, 2022). Thus, the ligament reconstruction with tendon interposition procedure is generally not recommended for most patients.

However, there is evidence that grip strength and tip pinch strength were both superior in the LRTI group compared with simple trapeziectomy (Liu Q, 2022). Accordingly, selective use of the LRTI procedure is recommended for workers with hand-intensive work, especially that which requires moderate to high hand forces.

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 osteoarthrosis who fail to achieve sufficient relief from other treatments.

**Evidence**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Reconstructive surgery , Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, trapeziometacarpal arthrosis, trapeziectomy with ligament reconstruction and tendon interposition, thumb CMC joint osteoarthritis, fusion, hand osteoarthrosis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 136 articles in PubMed, 22 in Scopus, 6 in CINAHL, 1 in Cochrane Library, 20105 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 3 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 1 from other sources. Of the 5 articles considered for inclusion, 5 randomized trials and 2 systematic studies met the inclusion criteria.

### FUSION FOR SELECT PATIENTS WITH HAND OSTEOARTHROSIS

**Sometimes Recommended**

Fusion is recommended for treatment of select patients with hand osteoarthrosis.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies of joint fusion. However, joint fusion is generally helpful for patients with significantly symptomatic osteoarthrosis who fail to achieve sufficient relief from other treatments.

**Evidence**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Reconstructive surgery , Hand, Fingers, Thumb, Metacarpus, Osteoarthritis, Osteoarthrosis, trapeziometacarpal arthrosis, trapeziectomy with ligament reconstruction and tendon interposition, thumb CMC joint osteoarthritis, fusion, hand osteoarthrosis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 136 articles in PubMed, 22 in Scopus, 6 in CINAHL, 1 in Cochrane Library, 20105 in Google Scholar, and 0 from other sources. We considered for inclusion 1 from PubMed, 3 from Scopus, 0 from CINAHL, 0 from Cochrane Library, 0 Google Scholar, and 1 from other sources. Of the 5 articles considered for inclusion, 5 randomized trials and 2 systematic studies met the inclusion criteria.

## 15. HUMAN AND ANIMAL BITES

## 15.1. OVERVIEW

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 (507,508,509). Data on cat bites are more limited, but they are the second most common animal bite, with an estimated 66,000 emergency room visits (510), 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 (511), animal handlers, police officers, utility services personnel who access private property, mail carriers, and other similar professions. Human bites are common in care givers (512,513), educators (514), law enforcement officers (515), and in instances of accident or workplace violence that may involve the fist or hand being cut by contact with teeth.

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.

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.

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.

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% (516,517), from cats is 20 to 50% (507), and from humans is up to 50% (518). 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.

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.

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

Causation is based on the specific major incident that produced the injury.

## 15.2. DIAGNOSTIC RECOMMENDATIONS

### ROUTINE WOUND CULTURE AND SENSITIVITY OF ANIMAL AND HUMAN BITES

**Not Recommended**

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**

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 (Boenning et al., 1983, Skurka et al., 1986). In both studies, there was no correlation between the pathogens that were cultured and any subsequent cultures from infected wounds (Boenning et al., 1983, Skurka et al., 1986). Another study also provided culture data, which confirmed expected flora, but no association was drawn in the analyses with subsequent infections (Brakenbury et al., 1989). These analyses only apply to wounds that have no joint, tendon, or tendon sheath involvement.

**Evidence**

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.

## 15.3. TREATMENT RECOMMENDATIONS

### BLOODBORNE PATHOGEN PROTOCOL FOR HUMAN BITES

**Recommended**

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 bloodborne pathogen protocols.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

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 (Sonder et al., 2005).

**Evidence**

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.

## PROPHYLACTIC ANTIBIOTICS FOR DOG BITE WOUNDS

**Recommended**

Prophylactic antibiotics are recommended for treatment of dog bite wounds.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

All dog bites. It may be reasonable to omit antibiotics for minor wounds.

**Frequency/Dose/Duration**

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.

**Rationale**

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 (Boenning et al., 1983, Skurka et al., 1986), penicillinase-resistant penicillins (Dire et al., 1992, Elenbaas et al., 1982, Rosen, 1985), sulfa compounds (Jones et al., 1985), erythromycin (Dire et al., 1992, Rosen, 1985), or amoxicillin/ clavulanate (Brakenbury et al., 1989). 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). Thus, they are recommended for treatment of dog bites.

**Evidence**

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.

## PROPHYLACTIC ANTIBIOTICS FOR UNCOMPLICATED HUMAN BITE WOUNDS

**Recommended**

Prophylactic antibiotics are recommended for treatment of uncomplicated human bite wounds.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

There is one moderate-quality study of human bites (Zubowicz et al., 1991), and another moderate-quality study that included human bites along with other animals (Brakenbury et al., 1989) 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 IV antibiotics was found to be effective in preventing infection (Zubowicz et al., 1991). The study, which included dogs, cats, humans, and other animals, did not find any significant differences using Augmentin® (Brakenbury et al., 1989). 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**

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.

## PROPHYLACTIC ANTIBIOTICS FOR UNCOMPLICATED CAT BITE WOUNDS

**Recommended**

Prophylactic antibiotics are recommended for treatment of uncomplicated cat bite wounds.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Elenbaas et al., 1984). 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% (Patrick et al., 1998), 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 (Talan et al., 1999), may be indicated.

**Evidence**

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

## LACERATION REPAIR FOR DOG-BITE WOUNDS

**Recommended**

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**

There is one moderate-quality study of laceration repair for dog bite wounds (Dire et al., 1992). 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 (Maimaris et al., 1988). 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 (Dire et al., 1992). 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**

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

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

# 16. KIENBÖCK DISEASE

## 16.1. OVERVIEW

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.

The patient typically presents with progressive pain and disability and has characteristic wrist x-rays demonstrating changes in the lunate. The patient may complain of increasing wrist pain, pain with movement, pain with use, and limited range of motion.

The physical examination may be normal early, but generally the patient has mild to moderate dorsal wrist tenderness while also having asymmetric, limited range of motion. Tenderness and limited range of motion tend to progress.

Patients with Kienbock 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.

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.

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.

## 16.2. DIAGNOSTIC RECOMMENDATIONS

Diagnosis is based on the presentation of non-radiating wrist compartment pain, limited range of motion, and x-ray evidence of radiological collapse of the lunate.

### X-RAYS TO DIAGNOSE KIENBOCK DISEASE

**Recommended**

X-rays are recommended to diagnose Kienbock disease.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

There are no quality studies evaluating the use of x-rays to diagnose Kienbock 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library and Google Scholar without date limits using the following terms: Kienbock'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 TO DIAGNOSE KIENBOCK DISEASE

**Recommended**

CT is recommended to diagnose Kienbock disease when x-rays are negative or unclear.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Moderate

**Rationale**

There is one quality study evaluating the use of CT scans that included patients with Kienböck disease, suggesting that 3-D CT may provide more information than x-ray or plain CT (Nakamura et al., 1990). CT is used to assist with diagnosis and management; thus, it is recommended where x-rays are negative or unclear.

**Evidence**

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, Kienbock'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 TO DIAGNOSE KIENBOCK DISEASE

**Recommended**

MRI is recommended to diagnose Kienbock disease.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are 2 moderate-quality articles evaluating the use of MRI to diagnose Kienböck disease. However, MRI was not shown to have superior performance for diagnostic purposes. MRI is used to assist with diagnosis and management; thus, it is recommended. There are 2 moderate-quality studies incorporated into this analysis (Hashizume et al., 1996, Imaeda et al., 1992).

**Evidence**

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, Kienbock'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 FOR KIENBOCK DISEASE

**Recommended**

Screening for systemic disorders is recommended for patients with Kienbock disease.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

There are multiple disorders that are thought to predispose to Kienbock 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**

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, Kienbock'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.

## 16.3. TREATMENT RECOMMENDATIONS

Over-the-counter medications are generally helpful for pain associated with Kienbock disease. Prescription medications may be needed for moderate to severe cases. Patients with Kienbock disease often develop chronic pain (see Chronic Pain Guideline for a comprehensive approach to managing chronic pain). An abbreviated approach is noted below. Exercise is generally not utilized during acute presentations of Kienbock disease. However, exercise is nearly always necessary for post-operative patients and is frequently used for patients in the subacute and chronic phases.

## SELF-APPLICATION OF ICE FOR ACUTE, SUBACUTE, OR CHRONIC KIENBOCK DISEASE

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies evaluating the use of ice or heat for treatment of Kienbock 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 Kienbock 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Kienbock'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.

## SELF-APPLICATION OF HEAT FOR ACUTE, SUBACUTE, OR CHRONIC KIENBOCK DISEASE

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies evaluating the use of ice or heat for treatment of Kienbock 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 Kienbock 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Kienbock'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 FOR ACUTE, SUBACUTE, OR CHRONIC KIENBOCK DISEASE

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies evaluating the use of ice or heat for treatment of Kienbock 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 Kienbock 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**

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, Kienbock'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.

## NSAIDS FOR ACUTE, SUBACUTE, OR CHRONIC KIENBOCK DISEASE

**Recommended**

NSAIDs are recommended to control pain associated with acute, subacute, or chronic Kienbock disease.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Pain due to acute, subacute, or chronic Kienbock disease.

**Frequency/Dose/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.

**Rationale**

There are no quality studies evaluating NSAIDs and acetaminophen for Kienbock 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDS, Acetaminophen, Kienbock'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.

## ACETAMINOPHEN FOR ACUTE, SUBACUTE, OR CHRONIC KIENBOCK DISEASE

**Recommended**

Acetaminophen is recommended to control pain associated with acute, subacute, or chronic Kienbock disease.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Pain due to acute, subacute, or chronic Kienbock disease.

**Frequency/Dose/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.

**Rationale**

There are no quality studies evaluating NSAIDs and acetaminophen for Kienbock 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**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: NSAIDS, Acetaminophen, Kienbock'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 FOR TREATMENT OF ACUTE, SUBACUTE, OR CHRONIC KIENBOCK DISEASE

**Recommended**

Topical medications including topical creams, ointments, and lidocaine patches are recommended for treatment of pain associated with acute, subacute, or chronic Kienbock disease.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies evaluating the use of topical medications for treatment of Kienbock 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**

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, Kienbock's disease, Kienbock disease; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found, reviewed and considered for inclusion 1 article in PubMed, 3 in Scopus, zero in CINAHL, 72 in Cochrane Library, 14 in Google Scholar and zero in other sources. Zero articles met the inclusion criteria.

## EXERCISE FOR KIENBOCK DISEASE

**Sometimes Recommended**

Exercise is generally not utilized during acute presentations of Kienbock disease. However, exercise is nearly always necessary for post-operative patients and is frequently used for patients in the subacute and chronic phases.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise, Kienbock'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.

## SURGICAL REPAIR FOR CHRONIC KIENBOCK DISEASE

**Recommended**

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 Kienbock disease.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Kato et al., 1986, Lichtman et al., 1982, Lichtman et al., 1977) (no longer recommended), excision with autogenous soft tissue implants including coiled palmaris longus tendon (Kato et al., 1986, Horita et al., 1990, Minami et al., 1994, Rhee et al., 1996, Sakai et al., 2004, Ueba et al., 1999, Yajima et al., 1998), external fixation (Ueba et al., 1999, Zelouf et al., 1996), arthrodesis (Meier et al., 2004, Watson et al., 1985), radial shortening (Nakamura et al., 1990, Takahara et al., 2009), scaphoid-trapezium-trapezoid fusion (Yajima et al., 1998, Soejima et al., 2002, Watson et al., 2003), in advanced cases, proximal row carpectomy (Begley et al., 1994, Culp et al., 1993, Diao et al., 2005), lunate core decompression (Mehrpour et al., 2011, Rodrigues-Pinto et al., 2012), and vascularized bone transfers (Lu et al., 2006). 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 (Sakai et al., 2004). 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**

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, Kienbock'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.

### OPIOIDS

See ACOEM Opioids guideline.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 17. LACERATIONS

## 17.1. OVERVIEW

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 (519). 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 (520) and patient satisfaction (521). 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 (522,523,524).

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 (525). Tetanus immunization status should be noted and are recommended to be updated per CDC guidelines (see Table 4).

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.

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 (526).

Causation is based on the specific major incident that produced the injury.

**Table 4. 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: http://www.cdc.gov/vaccines/pubs/surv-manual/.

## 17.2. DIAGNOSTIC RECOMMENDATIONS

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 (527). 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 FOR EVALUATION OF LACERATIONS WITH SUSPECTED FRACTURE OR FOREIGN BODY

**Recommended**

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

**Rationale**

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 (Blankenship et al., 2007). However, x-ray images do not reliably detect radiolucent foreign bodies such as wood, plastic, or vegetative material.

**Evidence**

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 FOR EVALUATION OF SUSPECTED SUPERFICIAL FOREIGN BODIES

**Recommended**

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

**Rationale**

Ultrasound is increasingly being utilized for the evaluation of suspected radiolucent foreign bodies (Blankenship et al., 2007), although there are no quality studies available. There are several case series and cadaver studies (Banerjee et al., 1991, Crawford et al., 1989, Gilbert et al., 1990, Hill et al., 1997, Levine et al., 1993) providing reports of high sensitivity, although there are also a small number of false positives related to tendons or other artifacts.

**Evidence**

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 45 diagnostic studies met the inclusion criteria.

### CT FOR EVALUATION OF SUSPECTED SUPERFICIAL FOREIGN BODIES

**No Recommendation**

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

**Rationale**

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.

**Evidence**

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.

## 17.3. TREATMENT RECOMMENDATIONS

## 17.3.1. INITIAL CARE

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 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. 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 (523). 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.

### WOUND CLEANSING, IRRIGATION, AND DEBRIDEMENT

**Recommended**

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

**Rationale**

Wounds become infected when they contain more than 105 bacteria per gram of tissue (Moscati et al., 2007). 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 (Bansal et al., 2002). 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 (Moscati et al., 2007). 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 (Gravett et al., 1987), another low-quality study found no difference in infection rates between normal saline, povidine, and Shur Clens® (Dire et al., 1990). There is some concern that concentrated povidine-iodine, hydrogen peroxide, and detergents may cause tissue toxicity (Singer et al., 1997).

There are no quality studies on irrigation pressures. High-pressure irrigation may result in increased trauma (Singer et al., 1997). Optimal pressures of 5 to 8 psi generated by large syringe and 16- to 19-gauge needle have been recommended (Singer et al., 1997). 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 (Chisholm et al., 1992). 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 (Perelman et al., 2004), thus either is recommended.

**Evidence**

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 IRRIGATION WITH STERILE SALINE OR TAP WATER

**Recommended**

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

**Rationale**

Wounds become infected when they contain more than 105 bacteria per gram of tissue (Moscati et al., 2007). 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 (Bansal et al., 2002). 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 (Moscati et al., 2007). 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 (Gravett et al., 1987), another low-quality study found no difference in infection rates between normal saline, povidine, and Shur Clens® (Dire et al., 1990). There is some concern that concentrated povidine-iodine, hydrogen peroxide, and detergents may cause tissue toxicity (Singer et al., 1997). There are no quality studies on irrigation pressures. High-pressure irrigation may result in increased trauma (Singer et al., 1997). Optimal pressures of 5 to 8 psi generated by large syringe and 16- to 19-gauge needle have been recommended (Singer et al., 1997). 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 (Chisholm et al., 1992). 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 (Perelman et al., 2004), thus either is recommended.

**Evidence**

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.

## STERILE OR CLEAN GLOVE USE DURING WOUND CLEANING

**Recommended**

The use of either sterile or clean gloves during wound cleaning is recommended.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** High

**Rationale**

Wounds become infected when they contain more than 105 bacteria per gram of tissue (Moscati et al., 2007). 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 (Bansal et al., 2002). 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 (Moscati et al., 2007). 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 (Gravett et al., 1987), another low-quality study

found no difference in infection rates between normal saline, povidine, and Shur Clens® (Dire et al., 1990). There is some concern that concentrated povidine-iodine, hydrogen peroxide, and detergents may cause tissue toxicity (Singer et al., 1997). There are no quality studies on irrigation pressures. High-pressure irrigation may result in increased trauma (Singer et al., 1997). Optimal pressures of 5 to 8 psi generated by large syringe and 16- to 19-gauge needle have been recommended (Singer et al., 1997). 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 (Chisholm et al., 1992). 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 (Perelman et al., 2004), thus either is recommended.

**Evidence**

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.

## LOCAL INFILTRATION PLUS TOPICAL ANESTHETIC OR DIGITAL BLOCK FOR FINGER LACERATION REPAIR

**Recommended**

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

**Rationale**

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 (Chale et al., 2006). Digital anesthesia was preferred by providers and patients for both the application and quality of anesthesia in a moderate quality study (Robson et al., 1990), 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 (Pryor et al., 1980), 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 (Pryor et al., 1980, Kuhn et al., 1996, Vinci et al., 1996), 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 (Ernst et al., 1995) for topical anesthesia and as effective in another high-quality study (Schilling et al., 1995) for topical pre-treatment for infiltration. EMLA was also shown to be more effective for topical anesthesia than TAC in a moderate quality study (Zempsky et al., 1997). 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 (Singer et al., 2001). 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 (Ernst et al., 1995) 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**

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.

## LOCAL INFILTRATION FOR EXTREMITY WOUND REPAIR

**Recommended**

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

**Rationale**

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 (Chale et al., 2006). Digital anesthesia was preferred by providers and patients for both the application and quality of anesthesia in a moderate quality study (Robson et al., 1990), 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 (Pryor et al., 1980), 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 (Pryor et al., 1980, Kuhn et al., 1996, Vinci et al., 1996), 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 (Ernst et al., 1995) for topical anesthesia and as effective in another high-quality study (Schilling et al., 1995) for topical pre-treatment for infiltration. EMLA was also shown to be more effective for topical anesthesia than TAC in a moderate quality study (Zempsky et al., 1997). 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 (Singer et al., 2001). 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 (Ernst et al., 1995) 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**

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.

## TOPICAL ANESTHETICS FOR LACERATIONS

**Recommended**

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**

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 (Chale et al., 2006). Digital anesthesia was preferred by providers and patients for both the application and quality of anesthesia in a moderate quality study (Robson et al., 1990), 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 (Pryor et al., 1980), 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 (Pryor et al., 1980, Kuhn et al., 1996, Vinci et al., 1996), 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 (Ernst et al., 1995) for topical anesthesia and as effective in another high-quality study (Schilling et al., 1995) for topical pre-treatment for infiltration. EMLA was also shown to be more effective for topical anesthesia than TAC in a moderate quality study (Zempsky et al., 1997). 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 (Singer et al., 2001). 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 (Ernst et al., 1995) 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**

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.

## EXERCISE FOR PATIENTS WITH LACERATIONS

**Sometimes Recommended**

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 the recommendations for carpal tunnel syndrome.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## 17.3.2. MEDICATIONS

### ANTIBIOTIC PROPHYLAXIS IN UNCOMPLICATED HAND AND FOREARM LACERATIONS

**Not Recommended**

Routine antibiotic prophylaxis is not recommended for uncomplicated hand and forearm lacerations.

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Moderate

**Rationale**

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, trilopen, and aerosolized povidine – iodine applied directly into the wound (Roberts et al., 1977, Roberts et al., 1985). However, one moderate-quality study did find that wound irrigation with penicillin provided reduced rates of wound infection (Lindsey et al., 1982). 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 (Morgan et al., 1980, Thirlby et al., 1983). 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 (Dire et al., 1995) 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 (Patel et al., 2007). An additional concern is that neomycin is considerably allergenic, thus neomycin-containing compounds may have a relative disadvantage.

**Evidence**

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.

## USE OF TOPICAL ANTIMICROBIALS FOR WOUND CARE

**No Recommendation**

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**

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, trilopen, and aerosolized povidine – iodine applied directly into the wound (Roberts et al., 1977, Roberts et al., 1985). However, one moderate-quality study did find that wound irrigation with penicillin provided reduced rates of wound infection (Lindsey et al., 1982). 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 (Morgan et al., 1980, Thirlby et al., 1983). 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 (Dire et al., 1995) 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 (Patel et al., 2007). An additional concern is that neomycin is considerably allergenic, thus neomycin-containing compounds may have a relative disadvantage.

**Evidence**

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 FOR UPPER EXTREMITY POST-LACERATION REPAIR

**Recommended**

NSAIDs are recommended to control pain associated with upper extremity post-laceration repair.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to upper extremity post-laceration repair.

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

### ACETAMINOPHEN FOR UPPER EXTREMITY POST-LACERATION REPAIR

**Recommended**

Acetaminophen is recommended to control pain associated with upper extremity post-laceration repair.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to upper extremity post-laceration repair.

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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 recommendations in Carpal Tunnel Syndrome section.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 17.3.3. SURGICAL CONSIDERATIONS

### NON-SURGICAL MANAGEMENT OF NON-COMPLICATED HAND LACERATIONS LESS THAN 2CM IN LINEAR LENGTH

**Recommended**

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

**Rationale**

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 (Quinn et al., 2002). 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 (Jones et al., 1993). 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 (Alam et al., 2006). 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 (Singer et al., 2005). 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 (Durani et al., 2009). One moderate-quality study showed comparability of absorbable catgut to nylon sutures for simple repair (Karounis et al., 2004). A low-quality study showed no difference between absorbable suture with nylon suture (Mouzas et

al., 1975). A systematic review in pediatric and adult populations of absorbable vs. non-absorbable sutures did not find superiority of one over the other (Al-Abdullah et al., 2007). Another moderate-quality study compared Teno Fix® 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® had lower rupture rates and similar functional outcomes when compared with conventional repair (Su et al., 2005). 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 (Orlinsky et al., 1995).

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 (Limpaphayom et al., 2004, Barnett et al., 1998, Bruns et al., 1998, Bruns et al., 1996, Handschel et al., 2006, Holger et al., 2004, Hollander et al., 1998, Quinn et al., 1997, Quinn et al., 2002, Shamiyeh et al., 2001, Simon et al., 1997, Simon et al., 1998, Singer et al., 2002, Singer et al., 2002, Sinha et al., 2001, Toriumi et al., 1998, Goktas et al., 2002, Mattick et al., 2002, Zempsky et al., 2001). 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 (Quinn et al., 1993). The only two direct comparisons of the compounds, which showed no difference in outcomes measures (Osmond et al., 1999, Singer et al., 2003).

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 (Mattick et al., 2002, Zempsky et al., 1997) or as part of the “standard care” treatment arm (Bruns et al., 1998, Hollander et al., 1998, Shamiyeh et al., 2001, Singer et al., 2002, Singer et al., 2002). 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 (Singer et al., 1998, Bruns et al., 1996, Hollander et al., 1998, Singer et al., 2002, Singer et al., 2002) 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**

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.

## SURGICAL REFERRAL FOR HAND LACERATIONS WITH EVIDENCE OF NERVE INJURY

**Recommended**

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

**Rationale**

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 (Quinn et al., 2002). 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 (Jones et al., 1993). 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 (Alam et al., 2006). 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 (Singer et al., 2005). 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 (Durani et al., 2009). One moderate-quality study showed comparability of absorbable catgut to nylon sutures for simple repair (Karounis et al., 2004). A low-quality study showed no difference between absorbable suture with nylon suture (Mouzas et al., 1975). A systematic review in pediatric and adult populations of absorbable vs. non-absorbable sutures did not find superiority of one over the other (Al-Abdullah et al., 2007). Another moderate-quality study compared Teno Fix® 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® had lower rupture rates and similar functional outcomes when compared with conventional repair (Su et al., 2005). 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 (Orlinsky et al., 1995). 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 (Limpaphayom et al., 2004, Barnett et al., 1998, Bruns et al., 1998, Bruns et al., 1996, Handschel et al., 2006, Holger et al., 2004, Hollander et al., 1998, Quinn et al., 1997, Quinn et al., 2002, Shamiyeh et al., 2001, Simon et al., 1997, Simon et al., 1998, Singer et al., 2002, Singer et al., 2002, Sinha et al., 2001, Toriumi et al., 1998, Goktas et al., 2002, Mattick et al., 2002, Zempsky et al., 2001). 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 (Quinn et al., 1993). The only two direct comparisons of the compounds, which showed no difference in outcomes measures (Osmond et al., 1999, Singer et al., 2003). 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 (Mattick et al., 2002, Zempsky et al., 1997) or as part of the “standard care” treatment arm (Bruns et al., 1998, Hollander et al., 1998, Shamiyeh et al., 2001, Singer et al., 2002, Singer et al., 2002). 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 (Singer et al., 1998, Bruns et al., 1996, Hollander et al., 1998, Singer et al., 2002, Singer et al., 2002) 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**

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.

## SUTURE REPAIR FOR HAND OR FOREARM LACERATIONS

**Recommended**

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

**Rationale**

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 (Quinn et al., 2002). 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 (Jones et al., 1993). 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 (Alam et al., 2006). 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 (Singer et al., 2005). 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 (Durani et al., 2009). One moderate-quality study showed comparability of absorbable catgut to nylon sutures for simple repair (Karounis et al., 2004). A low-quality study showed no difference between absorbable suture with nylon suture (Mouzas et al., 1975). A systematic review in pediatric and adult populations of absorbable vs. non-absorbable sutures did not find superiority of one over the other (Al-Abdullah et al., 2007). Another moderate-quality study compared Teno Fix® 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® had lower rupture rates and similar functional outcomes when compared with conventional repair (Su et al., 2005). 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 (Orlinsky et al., 1995). 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 (Limpaphayom et al., 2004, Barnett et al., 1998, Bruns et al., 1998, Bruns et al., 1996, Handschel et al., 2006, Holger et al., 2004, Hollander et al., 1998, Quinn et al., 1997, Quinn et al., 2002, Shamiyeh et al., 2001, Simon et al., 1997, Simon et al., 1998, Singer et al., 2002, Singer et al., 2002, Sinha et al., 2001, Toriumi et al., 1998, Goktas et al., 2002, Mattick et al., 2002, Zempsky et al., 2001). 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 (Quinn et al., 1993). The only two direct comparisons of the compounds, which showed no difference in outcomes measures (Osmond et al., 1999, Singer et al., 2003). 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 (Mattick et al., 2002, Zempsky et al., 1997) or as part of the "standard care" treatment arm (Bruns et al., 1998, Hollander et al., 1998, Shamiyeh et al., 2001, Singer et al., 2002, Singer et al., 2002). 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 (Singer et al., 1998, Bruns et al., 1996, Hollander et al., 1998, Singer et al., 2002, Singer et al., 2002) 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**

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.

## USE OF TISSUE ADHESIVE, STAPLES, AND SURGICAL TAPE (STERI-STRIPS) FOR UNCOMPLICATED LACERATION REPAIR

**Recommended**

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**

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 (Quinn et al., 2002). 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 (Jones et al., 1993). 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 (Alam et al., 2006). 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 (Singer et al., 2005). 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 (Durani et al., 2009). One moderate-quality study showed comparability of absorbable catgut to nylon sutures for simple repair (Karounis et al., 2004). A low-quality study showed no difference between absorbable suture with nylon suture (Mouzas et al., 1975). A systematic review in pediatric and adult populations of absorbable vs. non-absorbable sutures did not find superiority of one over the other (Al-Abdullah et al., 2007). Another moderate-quality study compared Teno Fix® 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® had lower rupture rates and similar functional outcomes when compared with conventional repair (Su et al., 2005). 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 (Orlinsky et al., 1995). 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 (Limpaphayom et al., 2004, Barnett et al., 1998, Bruns et al., 1998, Bruns et al., 1996, Handschel et al., 2006, Holger et al., 2004, Hollander et al., 1998, Quinn et al., 1997, Quinn et al., 2002, Shamiyeh et al., 2001, Simon et al., 1997, Simon et al., 1998, Singer et al., 2002, Singer et al., 2002, Sinha et al., 2001, Toriumi et al., 1998, Goktas et al., 2002, Mattick et al., 2002, Zempsky et al., 2001). 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 (Quinn et al., 1993). The only two direct comparisons of the compounds, which showed no difference in outcomes measures (Osmond et al., 1999, Singer et al., 2003). 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 (Mattick et al., 2002, Zempsky et al., 1997) or as part of the "standard care" treatment arm (Bruns et al., 1998, Hollander et al., 1998, Shamiyeh et al., 2001, Singer et al., 2002, Singer et al., 2002). 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 (Singer et al., 1998, Bruns et al., 1996, Hollander et al., 1998, Singer et al., 2002, Singer et al., 2002) 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**

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.

## SEMI-OCCLUSIVE OR OCCLUSIVE DRESSING OF WOUNDS

**No Recommendation**

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

**Rationale**

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 (Howell et al., 1992).

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 (Hinman et al., 1963, Jones, 2005, Winter, 1962). 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 (Heal et al., 2006). 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 (Patel et al., 2007).

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 (Singer et al., 1998, Patel et al., 2007, DeBoard et al., 2007). 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**

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.

## ROUTINE WOUND RECHECK BY HEALTH PROFESSIONAL

**Recommended**

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**

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 (Howell et al., 1992). 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 (Hinman et al., 1963, Jones, 2005, Winter, 1962). 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 (Heal et al., 2006). 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 (Patel et al., 2007). 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 (Singer et al., 1998, Patel et al., 2007, DeBoard et al., 2007). 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**

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.

# 18. MALLET FINGER

## 18.1. OVERVIEW

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.

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 (528). The patient is unable to extend the distal phalangeal segment. Swelling often signifies a fracture fragment, while most are extensor tendon ruptures (529) and have no significant swelling.

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 (356). 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 osteoarthrosis and Heberden's nodes or other chronic joint pathology.

Mallet finger is a common occupational and sports injury (530), although it may occur with minimal apparent trauma (528). 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 (356).

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.

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.

## 18.2. DIAGNOSTIC RECOMMENDATIONS

Mallet finger is a clinical diagnosis with a characteristic presentation of inability to extend the distal segment when the extensor tendon is damaged.

## X-RAYS FOR MALLET FINGER

**Recommended**

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**

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**

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 TO DIAGNOSE MALLET FINGER

**Not Recommended**

Ultrasound is not recommended to diagnose mallet finger.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies evaluating the use of ultrasound to diagnose mallet finger. While ultrasound has been used for imaging (Bianchi, 2008, Kleinbaum et al., 2005), 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.

**Evidence**

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.

## 18.3. TREATMENT RECOMMENDATIONS

Care usually involves a splint and 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. Large fracture fragments are rare (529,531,532,533,534) and necessitate surgery.

### SPLINTS FOR ACUTE OR SUBACUTE MALLET FINGER

**Recommended**

Extension splinting with the joint in a neutral or hyperextended position is moderately recommended for treatment of acute or subacute mallet finger (Maitra et al., 1993, Warren et al., 1988).

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** High

**Rationale**

There are five moderate-quality RCTs incorporated in this analysis. Splints must hold the finger in continuous, full extension for a minimum duration of 6 weeks (Hong, 2005, Smit et al., 2010). Some protocols involve 8 weeks, while some involve nocturnal use for an additional 2 to 4 weeks (Maitra et al., 1993, Kinninmonth et al., 1986, Warren et al., 1988, Hong, 2005, Betts-Symonds et al., 1982, Chan, 2002, Valdes et al., 2015). There are many different types of splints and no quality evidence of the unequivocal superiority of one versus another (Handoll et al., 2004, O'Brien et al., 2011, Pike et al., 2010). A padded aluminum splint was reportedly superior compared to a Stack (pre-fabricated plastic) splint due to easier fit and fewer skin complications (Maitra et al., 1993). Another trial found the Stack splint superior to the Abouna splint (Warren et al., 1988). 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 (Handoll et al., 2004). One quality study suggested better outcomes with fixation for patients presenting with delayed treatment (Auchincloss, 1982).

**Evidence**

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, 11 randomized trials and 3 systematic studies met the inclusion criteria.

### INSTRUCTIONS FOR SPLINT WEAR

**Recommended**

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**

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**

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, 11 randomized trials and 3 systematic studies met the inclusion criteria.

## MEDICATIONS FOR MALLET FINGER

**Not Recommended**

Nonprescription medications are usually not required and prescription medications are rarely required because mallet finger is generally not painful.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## EXERCISE FOR MALLET FINGER

**No Recommendation**

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 (see Education above). For patients with residual deficits, particularly post-operatively, see the recommendations for carpal tunnel syndrome.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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, 01 randomized trials and 0 systematic studies met the inclusion criteria.

## SURGICAL INTERVENTIONS FOR MALLET FINGER WITH DISPLACED FRACTURES

**Recommended**

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

**Rationale**

Quality studies to determine which patients with mallet finger would be optimal for surgical interventions are not currently available (Handoll et al., 2004). One study reported a non-statistically significant trend suggesting preference for fixation among those presenting late for treatment (Auchincloss, 1982); however, the dropout rate was high. A low-quality study also suggested no difference in splinting outcomes among those presenting late (Garberman et al., 1994). Surgery is invasive, has relatively few adverse effects for this disorder, and is high cost; however, surgery is recommended for these select patients.

**Evidence**

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.

### SURGICAL INTERVENTIONS FOR FAILED SPLINTING CASES OF MALLET FINGER

**Recommended**

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**

Quality studies to determine which patients with mallet finger would be optimal for surgical interventions are not currently available (Handoll et al., 2004). One study reported a non-statistically significant trend suggesting preference for fixation among those presenting late for treatment (Auchincloss, 1982); however, the dropout rate was high. A low-quality study also suggested no difference in splinting outcomes among those presenting late (Garberman et al., 1994). Surgery is invasive, has relatively few adverse effects for this disorder, and is high cost; however, surgery is recommended for these select patients.

**Evidence**

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.

## 19. NONSPECIFIC HAND, WRIST, OR FOREARM PAIN

## 19.1. OVERVIEW

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 (535). The initial step is a careful history and physical examination, particularly to attempt to ascertain a specific musculoskeletal disorder.

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.

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.

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).

Patients may require 1 to 3 appointments depending on the severity or the pain and need for workplace limitations.

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.

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.

## 19.2. DIAGNOSTIC RECOMMENDATIONS

Non-specific pain is not a discrete diagnosis, per se, but the absence of a discrete diagnosis.

### RHEUMATOLOGICAL STUDIES FOR ARTHRALGIAS

**Recommended**

Rheumatological studies are recommended for evaluation of patients with persistent unexplained arthralgias or tenosynovitis.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Indications**

Persistent unexplained arthralgias or tenosynovitis.

**Frequency/Dose/Duration**

Repeat studies may be required after passage of time as some patients, particularly those with less severe diseases, tend to develop positive antibodies after months to years.

**Rationale**

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**

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, Arthocentesis, 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.

## ARTHROCENTESIS FOR JOINT EFFUSIONS

**Recommended**

Arthrocentesis (joint aspiration) of inexplicable joint effusions, particularly for evaluation of infections and crystalline arthropathies is recommended.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Indications**

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

**Rationale**

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**

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, Arthocentesis, 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 TO EVALUATE NON-SPECIFIC HAND, WRIST, OR FOREARM PAIN IN PATIENTS WITH PARESTHESIAS OR OTHER NEUROLOGICAL SYMPTOMS

**Recommended**

Electrodiagnostic studies are recommended to evaluate non-specific hand, wrist, or forearm pain for patients with paresthesias or other neurological symptoms.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**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/Duration**

Should generally be performed at least 3 weeks after symptom onset.

**Rationale**

There is 1 low-quality study evaluating electrodiagnostic studies for non-specific pain (Calder et al., 2009). However, electrodiagnostic studies may assist in diagnosing and treating the condition and thus are recommended.

**Evidence**

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Electrodiagnostic, studies, Nerve conduction, study, NCS, Electromyography, EMG, Non-specific, hand, wrist, forearm, paint controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 31 articles in PubMed, 10870 in Scopus, 298 in CINAHL, 183 from Google Scholar, and 7 in Cochrane Library. We considered for inclusion 1 from PubMed, 0 from Scopus, 1 from CINAHL, 0 from Cochrane Library and 0 from other sources. Of the 11358 articles considered for inclusion, 1 randomized trials and 1 systematic studies met the inclusion criteria.

## X-RAYS FOR EVALUATION OF NON-SPECIFIC HAND, WRIST, OR FOREARM PAIN

**Recommended**

X-rays are recommended for evaluation of cases in which non-specific hand, wrist, or forearm pain persists.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Indications**

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

**Rationale**

There is 1 moderate-quality study evaluating x-ray studies for non-specific pain (Huellner et al., 2013). X-rays may assist in diagnosing and treating the condition and thus are recommended.

**Evidence**

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.

## 19.3. TREATMENT RECOMMENDATIONS

### RELATIVE REST FOR ACUTE NON-SPECIFIC HAND, WRIST, OR FOREARM PAIN

**Recommended**

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**

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**

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.

## EXERCISE FOR NON-SPECIFIC HAND, WRIST, AND FOREARM PAIN

**Not Recommended**

Exercise is not generally indicated for acute, nonspecific hand, wrist, and forearm pain.

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

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 (van Eijsden-Besseling et al., 2008). 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 for patients with carpal tunnel syndrome.

**Evidence**

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.

## SPLINTING FOR ACUTE OR SUBACUTE NON-SPECIFIC HAND, WRIST, OR FOREARM PAIN

**No Recommendation**

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**

There are no quality studies and treatment is empiric. Splinting may at times be helpful, but it enforces debility; thus, there is no recommendation for or against its use. It is generally not recommended for chronic use.

**Evidence**

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.

## SELF-APPLICATION OF ICE OR HEAT FOR ACUTE OR SUBACUTE NON-SPECIFIC HAND, WRIST, OR FOREARM PAIN

**Recommended**

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**

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; thus, they are recommended.

**Evidence**

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.

## NSAIDS FOR ACUTE OR SUBACUTE NON-SPECIFIC HAND, WRIST, OR FOREARM PAIN

**Recommended**

NSAIDs are recommended for control of pain associated with acute or subacute non-specific hand, wrist, or forearm pain.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Indications**

Acute or subacute non-specific hand, wrist, or forearm pain.

**Frequency/Dose/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.

**Rationale**

There are two moderate-quality studies evaluating the use of NSAIDs or acetaminophen for treatment of non-specific lower extremity pain (Muckle, 1974, Muckle, 1977), 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**

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.

## ACETAMINOPHEN FOR ACUTE OR SUBACUTE NON-SPECIFIC HAND, WRIST, OR FOREARM PAIN

**Recommended**

Acetaminophen is recommended for control of pain associated with acute or subacute non-specific hand, wrist, or forearm pain.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Indications**

Acute or subacute non-specific hand, wrist, or forearm pain.

**Frequency/Dose/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.

**Rationale**

There are two moderate-quality studies evaluating the use of NSAIDs or acetaminophen for treatment of non-specific lower extremity pain (Muckle, 1974, Muckle, 1977), 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**

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.

## PHYSICAL OR OCCUPATIONAL THERAPY FOR ACUTE, SUBACUTE, OR CHRONIC NON-SPECIFIC HAND, WRIST, OR FOREARM PAIN

**No Recommendation**

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**

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**

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.

### OPIOIDS

See ACOEM Opioids guideline.

### ANTIMETICS

See the ACOEM Antiemetics Guideline.

## 20. RADIAL NERVE ENTRAPMENT AT THE WRIST

## 20.1. OVERVIEW

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 (536,537,538). The medical history should include a search for sensory symptoms. Symptoms may also include pain over the course of the nerve.

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 (537). 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.

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.

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 (536,537,539). 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 (539).

Compression of the radial sensory nerve has been attributed to wearing a tight wrist or forearm band, anomalous brachioradialis tendon (538,540), repeated wrist flexion and ulnar deviation, external compression and trauma (539,541,542), or from mass or bony lesions (543). Case studies have also hypothesized an association with de Quervain's tenosynovitis, which occurs in roughly 50% of cases diagnosed with Wartenberg Syndrome (544).

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

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 (538,540). 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.

## 20.2. DIAGNOSTIC RECOMMENDATIONS

Electrodiagnostic studies can confirm the diagnosis of a radial nerve motor neuropathy (536). Ultrasound has been used as an adjunct to electrophysiological studies for evaluation of radial nerve neuropathy (545).

### ELECTRODIAGNOSTIC TESTING FOR RADIAL NERVE MOTOR NEUROPATHY

**Recommended**

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**

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 (Carlson et al., 1999, Eaton et al., 1992, Corwin, 2006). However, studies need to be performed by well-trained electrodiagnosticians, preferably certified by the American Board of Electrodiagnostic Medicine.

**Evidence**

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.

### DIAGNOSTIC ULTRASOUND FOR RADIAL NERVE NEUROPATHY

**No Recommendation**

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**

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**

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.

## 20.3. TREATMENT RECOMMENDATIONS

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 (546); and temporary thumb spica splinting (544,547).

### MODIFICATION OF WORK ACTIVITIES FOR RADIAL NERVE ENTRAPMENT

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**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.

**Rationale**

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.

## WRIST EXTENSION OR THUMB SPICA SPLINT FOR ACUTE, SUBACUTE, OR CHRONIC RADIAL NERVE COMPRESSION NEUROPATHY

**Recommended**

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**

Splints appear to be helpful for many cases and thus are recommended, particularly wrist extension splints.

**Evidence**

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.

## NSAIDS FOR ACUTE, SUBACUTE, OR CHRONIC RADIAL NERVE COMPRESSION NEUROPATHY

**No Recommendation**

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

**Rationale**

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 (Plate et al., 2000); 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.

**Evidence**

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 FOR ACUTE, SUBACUTE, OR CHRONIC RADIAL NERVE COMPRESSION AT THE WRIST

**No Recommendation**

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**

The mechanism(s) of efficacy of glucocorticosteroids is unclear (Rinkel et al., 2013). 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.

**Evidence**

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 (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

**No Recommendation**

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**

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**

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 FOR RADIAL NERVE ENTRAPMENT AT THE WRIST

**No Recommendation**

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 the recommendations for carpal tunnel syndrome.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## SURGICAL RELEASE FOR SUBACUTE OR CHRONIC RADIAL NERVE COMPRESSION NEUROPATHY

**Recommended**

Surgical release is recommended for subacute or chronic cases of radial nerve compression neuropathy that persist despite other interventions (Plate et al., 2000).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

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**

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.

## ANTIEMETICS

See the ACOEM Antiemetics Guideline.

# 21. TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

## 21.1. OVERVIEW

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 (548,549) and evidence that degeneration increases with age (550). Since abnormalities are commonly found on MRI and/or arthrography (551), indications for surgical interventions are somewhat unclear.

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 (548,552,553). 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 (554,555,556) as well as sports (557,558). 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.

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.

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.

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.

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.

## 21.2. 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 (548,552,553). 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 (555) which has been utilized to develop treatment recommendations (see Table 5). 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 | | 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 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 (354,552,559).

**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.

## 21.3. DIAGNOSTIC RECOMMENDATIONS

Diagnostic arthroscopy is often combined with surgical repair (see Surgical Considerations).

### X-RAYS TO DIAGNOSE TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

X-rays are recommended to diagnose triangular fibrocartilage complex (TFCC) tears.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

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

**Frequency/Dose/Duration**

Obtaining x-rays once is generally sufficient.

**Rationale**

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 osteoarthrosis. Positive ulnar variance (an ulna that extends more distally than the radius) is thought to increase risk.

### MR ARTHROGRAPHY OR MRI TO DIAGNOSE TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

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**

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 (Chung et al., 1996, Golimbu et al., 1989, Potter et al., 1997, Schers et al., 1995, Skahen et al., 1990, Slutsky, 2007). Virtual MR arthroscopy is in development, but its utility is not yet demonstrated (Sahin et al., 2004).

## 21.4. TREATMENT RECOMMENDATIONS

Splinting has been used for treatment of TFCC tears (560) as have ice, heat, and rest. Over-the-counter medications are generally helpful. Prescription medications may be needed in moderate to severe cases.

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.

### RELATIVE REST FOR ACUTE, SUBACUTE, OR CHRONIC TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

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

**Rationale**

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). 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**

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 FOR MODERATE OR SEVERE ACUTE OR SUBACUTE TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

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

**Rationale**

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). 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**

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.

## SELF-APPLICATION OF ICE FOR ACUTE, SUBACUTE, OR CHRONIC TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

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

**Rationale**

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). 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**

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.

## SELF-APPLICATION OF HEAT FOR ACUTE, SUBACUTE, OR CHRONIC TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

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**

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). 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**

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.

## NSAIDS FOR ACUTE, SUBACUTE, OR CHRONIC TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to acute, subacute, or chronic TFCC tears.

**Frequency/Dose/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.

**Rationale**

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**

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.

## ACETAMINOPHEN FOR ACUTE, SUBACUTE, OR CHRONIC TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

Acetaminophen is recommended to control pain associated with acute, subacute, or chronic TFCC tears particularly for patients with significant pain.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to acute, subacute, or chronic TFCC tears.

**Frequency/Dose/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.

**Rationale**

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**

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.

## ARTHROSCOPIC OR OPEN SURGICAL REPAIR FOR SUBACUTE OR CHRONIC TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

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**

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 (Palmer, 1990). Arthroscopic repair is most typically used, with excellent or good results reported in 74% of a case series of 35 patients (Estrella et al., 2007) and other estimates of success up to 93% (Bednar et al., 1994, Corso et al., 1997, de Araujo et al., 1996, Ruch et al., 2003, Westkaemper et al., 1998), although open repairs may be performed (Hermansdorfer et al., 1991).

**Evidence**

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.

## ULNA SHORTENING AND WAFER PROCEDURES FOR CHRONIC TRIANGULAR FIBROCARTILAGE COMPLEX (TFCC) TEARS

**Recommended**

Ulna shortening and wafer procedures are recommended for select cases of chronic Types IIC and IID 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**

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 (Minami et al., 1998). 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**

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.

## EXERCISE FOR TFCC TEARS

**No Recommendation**

Exercise is generally not indicated acutely; however, exercise may be needed in the recovery or post-operative phases.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 22. ULNAR NERVE ENTRAPMENT AT THE WRIST

## 22.1. OVERVIEW

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 (561). 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 (562). 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 (563,564,565,566,567).

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 (561).

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 (568), particularly for those cases thought to involve vascular symptoms and hypothenar hammer-like symptoms.

The location of the lesion affecting the ulnar nerve as it crosses through Guyon's canal and the wrist is predictive of clinical symptoms, 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 (562).

Guyon's canal syndrome is relatively uncommon, occurring about 20 times less frequently than ulnar lesions at the elbow (569). 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 (561); although there is no quality evidence that median nerve neuropathy is similarly associated with ulnar nerve involvement.

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.

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

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 (562,569,541) (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 (542). 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) (561). Other described causes include aberrant muscles at the wrist affecting both median and ulnar nerves (570), and distal neuropathy caused by systemic diseases, particularly diabetes mellitus and systemic sclerosis (scleroderma) (571,572,573). As there are no quality epidemiological studies among non-traumatic patients, work-relatedness is speculative in those populations.

## 22.2. DIAGNOSTIC RECOMMENDATIONS

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 (561). 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 (574).

### ELECTRODIAGNOSTIC TESTING FOR ULNAR NERVE ENTRAPMENT AT THE WRIST

**Recommended**

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**

There are 3 moderate studies supporting the use of electrodiagnostic testing (Alaranta et al., 1977, Chatterjee et al., 1982, Lander et al., 2007). However, studies need to be performed by well-trained electrodiagnosticians, preferably certified by the American Board of Electrodiagnostic Medicine.

**Evidence**

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, 00 from Google Scholar, and 20 from other sources. Of the 42 articles considered for inclusion 42 diagnostic studies met the inclusion criteria.

## MRI TO DIAGNOSE ULNAR NERVE ENTRAPMENT AT THE WRIST

**No Recommendation**

There is no recommendation for or against the use of MRI 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

**Rationale**

There are no quality studies evaluating the use of ultrasound or MRI for ulnar nerve entrapment at the wrist. 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 (Witmer et al., 2002, Chiodo et al., 2007, Seror et al., 2000). 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**

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 TO DIAGNOSE ULNAR NERVE ENTRAPMENT AT THE WRIST

**No Recommendation**

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

**Rationale**

There are no quality studies evaluating the use of ultrasound or MRI for ulnar nerve entrapment at the wrist. 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 (Witmer et al., 2002, Chiodo et al., 2007, Seror et al., 2000). 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**

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 TO DIAGNOSE ULNAR NERVE ENTRAPMENT AT THE WRIST

**Recommended**

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**

There are no quality studies evaluating the use of ultrasound or MRI for ulnar nerve entrapment at the wrist. 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 (Witmer et al., 2002, Chiodo et al., 2007, Seror et al., 2000). 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**

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.

## 22.3. TREATMENT RECOMMENDATIONS

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. 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 (575). Another case series demonstrated similar results, also favoring recovered function in the upper extremities (576).

### MODIFICATION OF WORK ACTIVITIES FOR ULNAR NEUROPATHY

**Recommended**

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

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**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.

**Rationale**

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.

**Evidence**

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.

## ACTIVITY MODIFICATION FOR ULNAR NERVE COMPRESSION AT THE WRIST

**Recommended**

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

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## NEUTRAL WRIST SPLINTING FOR ACUTE, SUBACUTE, OR CHRONIC ULNAR NERVE COMPRESSION AT THE WRIST

**Recommended**

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

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

## NSAIDS FOR ACUTE, SUBACUTE, OR CHRONIC ULNAR NERVE COMPRESSION AT THE WRIST

**No Recommendation**

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**

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 the recommendations for carpal tunnel syndrome); thus, other options are generally preferable.

**Evidence**

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 FOR ACUTE, SUBACUTE, OR CHRONIC ULNAR NERVE COMPRESSION AT THE WRIST

**No Recommendation**

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**

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**

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.

## PHYSICAL METHODS/REHABILITATION FOR ACUTE, SUBACUTE, OR CHRONIC ULNAR NEUROPATHY AT THE WRIST

**No Recommendation**

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**

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; therefore, there is no recommendation for or against the use of these treatments.

**Evidence**

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 FOR ULNAR NERVE ENTRAPMENT AT THE WRIST

**No Recommendation**

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 the recommendations for carpal tunnel syndrome.

**Strength of evidence** No Recommendation, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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.

### SURGICAL DECOMPRESSION FOR SUBACUTE OR CHRONIC ULNAR NERVE COMPRESSION AT THE WRIST

**Recommended**

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**

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**

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.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 23. WRIST SPRAINS

## 23.1. OVERVIEW

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 because fracture(s) may be present in a minority of cases.

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.

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

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.

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

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.

## 23.2. DIAGNOSTIC RECOMMENDATIONS

Wrist sprains are diagnosed by 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.

### X-RAYS FOR WRIST SPRAINS

**Recommended**

X-rays are recommended to determine whether a fracture is present, particularly for patients with scaphoid pain or scaphoid tubercle tenderness.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** High

**Rationale**

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 (Guly, 2002) and thus are recommended.

**Evidence**

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 FOR WRIST SPRAINS

**Recommended**

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 (Guly, 2002).

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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 FOR WRIST SPRAINS

**Recommended**

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**

There 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**

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.

## 23.3. TREATMENT RECOMMENDATIONS

Over-the-counter medications are generally helpful for pain associated with wrist sprain. Prescription medications may be needed for moderate to severe cases.

### RELATIVE REST FOR ACUTE WRIST SPRAINS

**Recommended**

Relative rest is recommended for treatment of acute wrist sprains.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

There are no quality studies evaluating relative rest, splints, or ice for wrist sprains. However, these treatments may help with symptomatic relief. (Physicians should be aware that 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.

**Evidence**

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.

## SPLINTING FOR MODERATE OR SEVERE ACUTE OR SUBACUTE WRIST SPRAINS

**Recommended**

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

**Rationale**

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 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.

**Evidence**

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.

## SELF-APPLICATION OF ICE FOR ACUTE WRIST SPRAIN

**Recommended**

Self-application of ice is recommended for treatment of acute wrist sprain.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

There are no quality studies evaluating relative rest, splints, or ice for wrist sprains. However, these treatments may help with symptomatic relief. These interventions are not invasive, have no adverse effects, and are low cost, thus they are recommended.

**Evidence**

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.

## SELF-APPLICATION OF HEAT FOR ACUTE WRIST SPRAIN

**Recommended**

Self-application of heat is recommended for treatment of acute wrist sprain.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

There is one moderate-quality RCT that shows heat is effective in reducing pain from wrist sprains (Michlovitz et al., 2004). Heat is not invasive, has no adverse effects, and is low cost; thus, it is recommended.

**Evidence**

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.

## NSAIDS FOR ACUTE OR SUBACUTE WRIST SPRAIN

**Recommended**

NSAIDs are recommended to control pain associated with acute or subacute wrist sprain.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Moderate

**Indications**

Pain due to acute or subacute wrist sprain.

**Frequency/Dose/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.

**Rationale**

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 (Muckle, 1974, Muckle, 1977) 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**

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.

## ACETAMINOPHEN FOR ACUTE OR SUBACUTE WRIST SPRAIN

**Recommended**

Acetaminophen is recommended to control pain associated with acute or subacute wrist sprain.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Pain due to acute or subacute wrist sprain.

**Frequency/Dose/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.

**Rationale**

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 (Muckle, 1974, Muckle, 1977) 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**

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.

## EXERCISE FOR WRIST SPRAINS

**Sometimes Recommended**

Exercise is not generally indicated acutely. Patients with deficits may require a home exercise program during recovery phases. Some patients require a formal exercise program.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Frequency/Dose/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.

**Rationale**

There are no quality studies incorporated into this analysis.

**Evidence**

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 FOR TREATMENT OF ACUTE OR SUBACUTE WRIST SPRAIN

**Not Recommended**

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**

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**

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.

### OPIOIDS

See ACOEM Opioids guideline.

### ANTIEMETICS

See the ACOEM Antiemetics Guideline.

## 24. POSTOPERATIVE REHABILITATION

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 (577,578,579,580,581). But, plaster casts have been replaced by splints which were later replaced by soft bandages and dressings

(582,583,584,585,586,587,588,589,590,591) which has also coincided with, or been facilitated by, less invasive and smaller incisions.

## SOFT BANDAGES DURING POST-OPERATIVE REHABILITATION

**Recommended**

Soft bandages are recommended during post-operative rehabilitation.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Bhatia et al., 2000, Bury et al., 1995, Martins et al., 2006); 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**

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.

## SPLINTS DURING POST-OPERATIVE REHABILITATION

**Recommended**

Splints are recommended during post-operative rehabilitation for select patients.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Bhatia et al., 2000, Bury et al., 1995, Martins et al., 2006); 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**

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 DURING POST-OPERATIVE REHABILITATION

**Recommended**

NSAIDs are moderately recommended to control pain during post-operative rehabilitation.

**Strength of evidence** Moderately Recommended, Evidence (B)
**Level of confidence** High

**Indications**

All hand, wrist, forearm post-operative patients may be candidates other than those with contraindications for use.

**Frequency/Dose/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.

**Rationale**

Acetaminophen has been shown to be less efficacious than naproxen, but is recommended due to its lower adverse effects (Husby et al., 2001).

**Evidence**

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.

## ACETAMINOPHEN DURING POST-OPERATIVE REHABILITATION

**Recommended**

Acetaminophen is recommended to control pain during post-operative rehabilitation.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

All hand, wrist, forearm post-operative patients may be candidates other than those with contraindications for use.

**Frequency/Dose/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.

**Rationale**

Acetaminophen has been shown to be less efficacious than naproxen, but is recommended due to its lower adverse effects (Husby et al., 2001).

**Evidence**

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 DURING POST-OPERATIVE REHABILITATION

**Not Recommended**

Arnica is not recommended during post-operative rehabilitation.

**Strength of evidence** Not Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

Arnica has been utilized for post-operative recovery in CTS patients (Stevinson et al., 2003, Jeffrey et al., 2002), 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 it is not recommended.

**Evidence**

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 DURING POST-OPERATIVE REHABILITATION

**Recommended**

Cryotherapy is recommended for post-operative rehabilitation for carpal tunnel release patients.

**Strength of evidence** Recommended, Evidence (C)
**Level of confidence** Low

**Rationale**

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; therefore, a cooling blanket is recommended during post-operative rehabilitation (Hochberg, 2001).

**Evidence**

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.

## COOLING BLANKET DURING POST-OPERATIVE REHABILITATION

**Recommended**

A cooling blanket is recommended during post-operative rehabilitation.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Low

**Rationale**

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 (Hochberg, 2001).

**Evidence**

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 DURING POST-OPERATIVE REHABILITATION FOR PATIENTS WITH FUNCTIONAL DEFICITS

**Recommended**

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

**Indications**

Failure to progress, or moderate to severe functional deficits.

**Frequency/Dose/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 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.

**Indications for discontinuation**

Achievement of goals, failure to progress, adverse effects, non-compliance.

**Rationale**

Most of the quality studies that have described post-operative rehabilitation components have not prescribed formal physical or occupational therapy for rehabilitation (Dumontier et al., 1995, Trumble et al., 2002, Ferdinand et al., 2002, Blair et al., 1992). Instead, most instructed patients to "keep fingers moving" or perform finger exercises (Golimbu et al., 1989, Park et al., 2010), perform mobility exercises (Wong et al., 2003), use the hand daily as tolerated (Atroshi et al., 2006), use "as comfort allowed," (Saw et al., 2003) or "use as much as possible" or "as soon as possible" (Korthals-de Bos et al., 2006, Siegmeth et al., 2006, Menovsky et al., 2004). 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**

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.

## EXERCISE DURING POST-OPERATIVE REHABILITATION FOR PATIENTS WITH FUNCTIONAL DEFICITS

**Recommended**

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

**Indications**

Failure to progress, or moderate to severe functional deficits.

**Frequency/Dose/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 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.

**Indications for discontinuation**

Achievement of goals, failure to progress, adverse effects, non-compliance.

**Rationale**

Most of the quality studies that have described post-operative rehabilitation components have not prescribed formal physical or occupational therapy for rehabilitation (Dumontier et al., 1995, Trumble et al., 2002, Ferdinand et al., 2002, Blair et al., 1992). Instead, most instructed patients to "keep fingers moving" or perform finger exercises (Golimbu et al., 1989, Park et al., 2010), perform mobility exercises (Wong et al., 2003), use the hand daily as tolerated (Atroshi et al., 2006), use "as comfort allowed," (Saw et al., 2003) or "use as much as possible" or "as soon as possible" (Korthals-de Bos et al., 2006, Siegmeth et al., 2006, Menovsky et al., 2004). 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**

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.

## FORMAL PHYSICAL OR OCCUPATIONAL THERAPY DURING POST-OPERATIVE REHABILITATION FOR PATIENTS WITH FUNCTIONAL DEFICITS

**Recommended**

A low threshold for institution of formal physical or occupational therapy for rehabilitation is recommended for postoperative patients.

Postoperative 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. 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.

**Strength of evidence** Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Indications**

Failure to progress, or moderate to severe functional deficits.

**Frequency/Dose/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 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.

**Indications for discontinuation**

Achievement of goals, failure to progress, adverse effects, non-compliance.

**Rationale**

Most of the quality studies that have described post-operative rehabilitation components have not prescribed formal physical or occupational therapy for rehabilitation (Dumontier et al., 1995, Trumble et al., 2002, Ferdinand et al., 2002, Blair et al., 1992). Instead, most instructed patients to “keep fingers moving” or perform finger exercises (Golimbu et al., 1989, Park et al., 2010), perform mobility exercises (Wong et al., 2003), use the hand daily as tolerated (Atroshi et al., 2006), use “as comfort allowed,” (Saw et al., 2003) or “use as much as possible” or “as soon as possible” (Korthals-de Bos et al., 2006, Siegmeth et al., 2006, Menovsky et al., 2004). 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**

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.

## 25. 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 (592,593,594).

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 (595,596,597,598,599).

### RETURN-TO-WORK PROGRAMS FOR SUBACUTE OR CHRONIC HAND, WRIST, OR FOREARM MSDS

**Recommended**

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

**Rationale**

There are no quality studies that review the types of return-to-work programs typically found in the United States. There is one quality study from Spain (Feuerstein et al., 1993); 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 United States. 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**

There is 1 moderate-quality RCT incorporated into this analysis. See Chronic Pain Guideline for additional studies.

## RETURN-TO-WORK PROGRAMS FOR ACUTE HAND, WRIST, OR FOREARM DISORDERS

**Not Recommended**

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

**Strength of evidence** Not Recommended, Insufficient Evidence (I)
**Level of confidence** Moderate

**Rationale**

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 (Feuerstein et al., 1993); 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.

# 26. CONTRIBUTORS

## 26.1. CONTRIBUTORS

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*These panel members represent expertise in occupational medicine, orthopedic surgery, hand surgery, occupational therapy, physical medicine and rehabilitation, sports medicine, internal medicine, family practice, forensic medicine, and electrodiagnostic medicine. As required for quality guidelines (Institute of Medicine's [IOM] Standards for Developing Trustworthy Clinical Practice Guidelines and Appraisal of Guidelines for Research and Evaluation [AGREE]), a detailed application process captured conflicts of interest. The above Panel has none to declare relevant to this guideline.*

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***Other Guidelines Related Professional Activities***—Chair, Evidence-based Practice Committee, ACOEM (2006-present); Member, Council on Scientific Affairs (2001-05), ACOEM

***Research Grants/Other Support***—NIOSH (CDC) Training grants and research grants primarily on the epidemiology of musculoskeletal disorders (e.g., CTS, shoulder tendinosis, LBP) and truck driver safety.

***Financial/Non-Financial Conflict of Interest***—Honoraria: Teaching honoraria from various courses, mostly ACOEM-related; Consultations: Reed Group (consulting fee for ACOEM Guidelines Editor-in-Chief); Consulting with companies regarding how to reduce work-related injuries, causation and apportionment of injuries and consultations with unions regarding return to work, work restrictions and work-relatedness injuries; Clinical: Primary, secondary and tertiary clinical management of occupational injuries and diseases

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***Financial/Non-Financial Conflict of Interest***—None

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***Research Grants/Other Support***—None

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***Other Guidelines Related Professional Activities***—Reviewer (on behalf of ACOEM), AAOS' Guidelines on Carpal Tunnel Syndrome and Distal Radius Fractures; Member, Editorial Advisory Board, *Journal of Plastic Reconstructive & Aesthetic Surgery*; Member, Editorial Board, *Hand*; Member, Editorial Board,

*Journal of Hand Surgery (European Volume)*; Member, Editorial Board, *Annals of Plastic Surgery*; Member, Editorial Board, *Indian Journal of Plastic Surgery*, Statistical Advisor, *Journal of Hand Surgery (European Volume);* Reviewer, *Journal of Medical Internet Research*, *Archives of Dermatological Research*, *Dermatology and Therapy*, *International Journal of Surgery Case Reports*

***Research Grants/Other Support***—None

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