Hand and Wrist Injuries

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HAND AND WRIST INJURIES

I. ANATOMY

A. **Surface anatomy**: Use the terms volar (palmar), dorsal, radial, and ulnar. The creases on the volar aspect are named the proximal and distal palmar crease. The distal palmar crease overlies the mid point of the proximal finger phalanx.

B. **Skin**: The skin of the volar hand and fingers is fixed to the underlying bone by fibrous septa. This helps with grip, limits movement, and does not allow significant swelling. The dorsal hand has looser, thinner skin. This allows a fairly extensive space for swelling from trauma or infection.

C. **Nail**: The nail complex consists of the eponychium (cuticle), perionychium (nail edge), hyponychium (under the tip of the nail), and the nail bed or matrix (under the nail plate).

II. HAND EXAMINATION

A. Neurologic assessment

1. **Digital nerve**: Use **two-point discrimination** with a paper clip. Normal two-point discrimination is between 2 and 5 mm at the volar fingertip. Test an uninjured finger to estimate the patient’s normal ability. Start at 1 cm, and decrease the distance until two points are no longer felt.

2. Forearm injuries may result in neurologic deficits in the hand. It is important to document these at the time of the initial exam.
   a. **Radial nerve**: Sensory function is assessed at the dorsal web space of the thumb and index finger. Motor function is tested.
b. **Ulnar nerve**: The sensory function is tested at the volar tip of the small finger. The ulnar nerve innervates the intrinsic muscles of the hand. Have the patient spread the digits against resistance. Another reliable test for the function of this nerve is to have the patient place the ulnar edge of the hand on the exam table, and then have them attempt to abduct the index finger against resistance.

c. **Median nerve**: Sensory function is assessed at the volar tip of index finger. Motor strength is best assessed by thumb abduction (have the patient raise the thumb towards the ceiling while the dorsal hand is flat on the exam table). This tests the function of the abductor pollicis, which is reliably innervated by the motor nerve branch of the median nerve.

### B. Tendon assessment

1. With injuries that lacerate or penetrate, it is important to document tendon function. Excess flexion occurs with an extensor tear, while excess extension is seen with flexor tendon injuries.

2. Each finger should be examined independently for flexion of the distal phalanx (profundus tendon) and the whole finger (superficialis tendon). Extension can also be tested. Testing is performed against resistance. **Any weakness or pain might indicate a partial injury.**

3. Open injuries need to be assessed with a bloodless field and direct inspection of the tendon through a full range of motion.

### C. Vascular assessment

1. Injuries to vascular structures usually do not affect perfusion of the hand because of extensive anastomoses.

2. If initial inspection reveals a dusky or cool finger or hand, prompt intervention is needed. Capillary refill and pulse oximetry waveforms can give some indication of blood flow to injured digits.

### D. Anesthesia
1. Sensory examination must always precede anesthesia.

2. **Wrist block** includes:
   a. Radial nerve: Lateral to radial nerve and skin while on dorsum of hand
   b. Median nerve: Between the flexor carpi radialis and palmaris longus tendons at wrist crease
   c. Ulnar nerve: Lateral to the flexor carpi ulnaris tendon

3. Digit block options include:
   a. **Half ring block**: Each side of the base of the digits
   b. **Metacarpal block**: Between the metacarpal heads all the way to the palmar aspect of the hand
   c. **Transthecal block**: In the center of the proximal digital crease. Go to bone, pull back slightly, and then inject. Direct injection into the flexor tendon sheath.

4. Epinephrine injection into the digits has been considered taboo since the 1950s. A 2005 study of over 3,000 hand surgeries using the typical concentrations included with local anesthetics (1:100,000) did NOT find a single case of digital ischemia.

5. An allergy to a local anesthetic is rare and in most cases is due to preservatives (methylparaben) within the anesthetic. When an allergy is reported, several options exist.
   a. Use an anesthetic from the other class. Amide anesthetics have two “i”s (e.g. lidocaine) in their name. Esters have only one “i” (e.g. tetracaine).
   b. Use Benadryl 0.5%. Mix a 1mL vial of diphenhydramine 50 mg with 9 mL of saline.
   c. Use a 0.1 mL test dose of cardiac lidocaine (100 mg/5 mL), which does not contain preservatives, and therefore is unlikely to cause a reaction. If no reaction is noted within 30 minutes, proceed using cardiac lidocaine.

III. WRIST INJURIES

A. All wrist and hand movements depend on the proper alignment and orientation of the eight carpal bones and their articulations with the distal forearm and proximal metacarpals. Any disruption of these structures will disrupt function.
B. Scaphoid fracture

1. Also called the carpal navicular, this is the most commonly fractured bone of the wrist (60-80%). Usual mechanism is a fall on an outstretched hand (FOOSH) with the wrist radial deviated.
2. Pertinent anatomy: Single blood supply, distal end of bone. Articulates with the lunate, and with the capitate.
3. Exam: Tenderness at anatomic “snuff box” and pain with axial load to thumb.
4. X-ray: Usually linear waist fracture. Proximal fractures have greater incidence of non-union with subsequent avascular necrosis. About 10-20% will have a normal X-ray despite the presence of a fracture.
5. Treatment: Treat all suspected fractures with thumb spica immobilization. If no fracture identified, follow-up in 7-10 days for repeat X-ray. Other modalities include MRI, CT, or bone scanning.

C. Triquetrum fracture

1. Second most common carpal fracture (5-10%).
2. X-ray: “Dorsal chip” on lateral film. Due to ligamentous avulsion.
3. Treatment: 4-6 weeks of immobilization.

D. Lunate fracture

1. Uncommon (1-5%).
2. Pertinent anatomy: 20% have single distal blood supply. Articulates with scaphoid and capitate.
3. Exam: Tenderness over dorsal radial wrist (lunate fossa). May have increased pain with axial load on long or index finger.
4. X-ray: Can be occult, as with scaphoid. Usually linear. May develop Kienböck’s disease where the bone undergoes spontaneous avascular necrosis from repetitive microtrauma.
5. Treatment: Issues are the same as scaphoid fracture. Treat suspected fractures with immobilization and follow-up.

E. Hamate fracture

1. Uncommon (2-4%).
2. X-ray: Usually seen as fracture of the hook of the hamate, on the volar edge of the bone. May need carpal tunnel views.
3. Treatment: Non-union of hook fractures is common. Provide analgesia and bulky dressing.

F. Distal radius fracture

1. Colles fracture: Extension fracture of the metaphysis. Common in children and elderly. 10x more frequent than carpal bone fractures. Dinner fork deformity. 8% incidence of persistent neuropathy (median nerve is most common). Goal of closed reduction includes regaining normal anatomic alignment—volar tilt (11 degrees), radial tilts (22 degrees), and radial height (11 mm). Sugar-tong splint and referral
3. Hutchinson fracture: Radial styloid fracture. Also known as a chauffeur’s or backfire fracture. Associated with carpal ligamentous injury or scaphoid fracture.
4. Barton fracture: Dorsal or volar rim fracture of the radius with subluxation or dislocation of the carpal bones.
G. Carpal ligament injury

1. **Scapholunate Dissociation**: Disruption of the ligaments joining these bones. Seen as widening of the joint space on X-ray (**Terry Thomas sign**). Any space greater than 2 mm is suspicious for this injury. Left untreated, the patient develops chronic pain in the wrist. Treatment is surgical.

![X-ray of wrist](source.png)

2. **Perilunate dislocation**: Dislocation of the joint between the lunate and the capitate. On the AP view, there is overlap of the capitate with the lunate. On the lateral view, the lunate remains articulated with the distal radius, but the capitate is dislocated dorsally. This dislocation is often seen with associated fractures, and thus can be missed if not sought carefully. Operative repair is indicated.

![X-ray of wrist](source.png)

3. **Lunate dislocation**: This dislocation is similar in presentation to the perilunate. The AP view reveals that the capitate has rotated, and assumes a triangular appearance (**“piece of pie” sign**). On the lateral view, the lunate is “spilled” from the cup of the distal radius (**“spilled tea-cup” sign**). The treatment is open reduction
IV. HAND FRACTURES

A. Rotational deformities. It is important to detect and correct any rotational deformities before healing occurs, as later repair is difficult.

B. Metacarpals 2 – 5 (index through little finger)

1. Head fractures: Usually due to direct blow, and often comminuted or crushed. Treatment with hard or bulky splints, and ortho follow-up.

2. Neck fractures: Classic is “boxer's” fracture. Usually angulated in volar direction. Treatment varies for index and middle finger MCs, where anatomic alignment is much more important. Ring and little finger MCs can tolerate angulation of 30 degrees without functional impairment.

3. Shaft fractures: Often angulated, sometimes spiral or oblique. The more proximal the fracture, the more important anatomic reduction becomes. These should be splinted and referred in a timely fashion.

4. Base fractures: Uncommon, and often interarticular. Can affect the carpometacarpal function. The base of the little finger MC may present with a fracture-dislocation, as the fragment is pulled by the attachment of the extensor carpi ulnaris. This requires open fixation.

C. Thumb metacarpal

1. Base fractures. These are often comminuted and dislocated, as the abductor pollicis longus tendon pulls the fragments. A single fracture with this finding is called a Bennett’s fracture; while a comminuted fracture (often “T” or “Y” shaped) is called a Rolando’s fracture. Treatment is open fixation.
D. Phalanx fractures

1. Tuft fracture: Crush injuries. Typically torn skin, due to attachment to bone. Reduction often accomplished by repair of skin. Nail bed also frequently involved. Repair needed if nail avulsed and nail bed lacerated. Remember to maintain the eponychial space to allow continued nail growth. These are open fractures, if the skin is torn. Antibiotics can be administered, although infection is uncommon.

2. Shaft fracture: Often spiral or oblique, these will frequently require fixation. Initial reduction will often not be maintained, even with splints or buddy taping. Rotation is again important to detect.

3. Intra-articular fracture: These may need reduction if significant portions of the joint are involved. “Mallet” finger fracture occurs with a flexion force applied to the tip of the extending finger. The force causes an avulsion of the extensor tendon at the dorsal base of the distal phalanx. The treatment is splinting in extension for 6 weeks. If greater than 25% of the joint space is involved, surgical repair may be indicated.

V. FINGER DISLOCATIONS

A. Anatomy

1. The IP joints of the fingers have both collateral ligaments and the fibrous volar plate. These structures provide resistance to injury, but can be subject to large forces when the digit is twisted or forcibly extended.
2. The MCP joints have unique anatomy that provides strength with potential range of motion. The transverse metacarpal ligament provides support by attaching the MCP joints to each other (except the thumb). There are also collateral ligaments, which are supported by the lumbrical muscles. The arrangement provides the ability to abduct when extended, but not when flexed.

B. Interphalangeal joints

1. The PIP is much more commonly dislocated. These are usually dorsal. After a digital nerve block, reduction is achieved with gentle traction. Irreducible dislocations are unusual, but indicate entrapped soft tissues.
2. These injuries need to be X-rayed, as tiny fragments of avulsed bone at the joint signify ligament avulsion.
3. The post-reduction exam should also attempt to check for laxity.
4. Splint the joint in 15 – 20 degrees of flexion, for 3 – 4 weeks. Some advocate 2 weeks with subsequent buddy taping. Open injuries need orthopedic consultation for debridement, irrigation, antibiotics, and close follow-up

C. Metacarpophalangeal joints

1. The complex anatomy protects against dislocation, but also leads to a higher incidence of irreducible dislocations. The most common dislocations are dorsal, and fall into two broad categories.
2. “Simple” dislocations have a dramatic appearance clinically, with marked angulation. These are termed simple because they are usually easily reduced with closed techniques.
3. “Complex” dislocations appear subtle clinically, but are often impossible to reduce with closed techniques. This is due to the interposition of torn ligaments and the arrangement of ligaments and lumbral muscles that actually tighten around the head of the metacarpal as traction is applied, which prevents reduction.

D. Gamekeeper’s thumb

1. This injury is a sprain or tear of the ulnar collateral ligament of
the thumb MCP joint from forced radial deviation of the thumb (e.g., falling with a ski pole in the hand). This results in pain, and potential laxity with gripping. Recovery is slow and surgery may be needed. Initial treatment is with a thumb spica splint.

VI. TENDON INJURIES

A. Extensor tendons

1. More superficial with thinner skin than dorsal tendons. Easily lacerated. Tendon injury may be “open” or “closed”.
2. Open tendon injuries
   a. Divided into 8 zones. Zone I is over the distal IP joint. Zone II includes the middle phalanx. The zones of extensor tendon injury can be more easily remembered by noting that odd-numbered zones are over joints, while even-numbered zones are over bones. Zone VII and VIII involve the carpal bones and distal forearm, respectively.
   b. An emergency physician can repair complete tendon injuries in zones IV, V, and VI. Other complete extensor tendon ruptures should be referred to a hand surgeon after suturing
the skin and splinting the hand.

c. Partial open tendon ruptures should be referred, but do not require repair in most instances.

3. Closed extensor tendon injuries
   a. **Mallet finger**: Tearing of the insertion of the extensor tendon from the base of the distal phalanx is known as a “mallet finger,” and is treated with the joint in extension for 6 weeks. The patient is cautioned not to remove the splint during this time.

   ![Mallet Finger Image]

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   b. **Central slip rupture**: The central slip of the extensor tendon is located at the base of the dorsal middle phalanx. At this location, the tendon splits into three parts, with the central slip attaching to the bone, and the two lateral parts attaching to the distal phalanx with the lumbrical muscles. When the central slip is ruptured secondary to contusion, forced flexion or dislocation of the PIP joint, the extensor tendon splits and can slip to either side of the joint. In that position, attempts at extension actually cause some flexion. The end result is a “Boutonnière deformity”, where the proximal joint is flexed while the distal joint is hyperextended.

   ![Central Slip Rupture Image]

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   c. **Boxer’s knuckle**: Rupture of the extensor hood occurs as a result of injury to the dorsal aspect of the hand over the MCP joint. In this scenario, there is disruption of one of the laterally located sagittal bands that hold the tendon in a central location. The end result is subluxation of the tendon.
These injuries should be splinted and referred. Splint the hand in only as much extension as is required to keep the tendon in its proper position.

**B. Flexor tendons**

1. There are anatomical “zones” for flexor tendon injuries, with associated unique problems for healing and repair.
   a. **Zone 1**: From the mid portion of the finger to the insertion of the profundus tendon. Problems with retraction of the proximal part and the complex pulley system. The FDP emerges from the split FDS in this zone.
   b. **Zone 2**: From the distal palmar crease to zone 1, where the FDS and FDP interweave. This area is known as **“no man’s land”** because the complex relationships of multiple tendons, sheaths, and pulleys make repair difficult. Any scarring leads to long-term functional deficits. This is the most common area for injury.
   c. **Zone 3**: Mid palm from level of thenar eminence to proximal edge of flexor sheath. Easier repair with less pulleys and better visualization.
   d. **Zone 4**: Carpal tunnel area, multiple tendons usually involved.
   e. **Zone 5**: Proximal to the carpal tunnel.

2. Flexor tendon injuries require repair by a hand surgeon

**VII. BITE WOUNDS**

A. **Human bites**
   1. **Fight bite injuries** (i.e. clenched fist injuries) are injuries to tendons and joints at the MCP sustained following a punch to the mouth (i.e., tooth).
   2. Treatment of fight bite injuries involves surgical debridement, irrigation, and IV antibiotics. Noninfected bites are managed
with local wound care and oral antibiotics.
3. Amoxicillin clavulanate (Augmentin) remains the drug of choice for human bites. There are probably over 40 different “bugs” in the human mouth, but the one to recall is *Eikenella corrodens*.

B. **Dog bites**

1. Potential for significant tissue destruction from large crushing mechanisms (up to 450 psi). X-ray if any concern of bony injury.
2. Superficial wounds may do well with local care, but deeper wounds need debridement and antibiotics.
3. *Pasteurella multocida* is the bacteria to remember. Antibiotic choices are the same as human bites.

C. **Cat bites**

1. Deeper penetration than dog bites with the inability to cleanse or irrigate the depth of the wound. The end result is a higher rate of infection.
3. The antibiotic choices are the same as human bites.

VIII. AMPUTATION

A. **Digit amputation**

1. Care of the amputated part involves gentle cleansing if heavily contaminated, wrapping in moist gauze, with storage in a sealed plastic bag. The bag is then placed into ice water. Properly maintained digits have about 12 hours of viability.
2. Classical indications for digit replantation include: between PIP and DIP, thumb, multiple digits, child, or midpalmar amputation. However, any amputated part should be considered for replantation and a hand surgeon should be consulted.
3. It should always be emphasized the re-implanted digit will never function normally, and will likely have some sensory problems, as well as chronic stiffness and weakness.

B. **Fingertip amputation**

1. Treatment depends on whether bone is exposed
   a. No bone exposed (Zone 1 injuries): heal by secondary intention after wound care.
   b. Bone exposed (Zone II and III injuries): Rongeur to trim back the bone, suture soft tissue together, and allow healing by secondary intention.
IX. INFECTIONS

A. Paronychia

1. This is an infection of the base of the nail, and can involve the eponychium and perionychium. Infection may also spread under the nail in advanced cases. Use a #11 scalpel to lift (incise) the eponychium until pus is expressed. If there is no abscess, dicloxacillin and soaks may be sufficient.

B. Felon

1. This is an infection of the finger pad due to minor penetrating trauma. Because the skin is adherent to the bone (fibrous septa), there is little room for swelling in this area. This leads to a great deal of pain.

2. A felon is drained with an incision over the most prominent portion of the abscess. The two recommended incisions are the **volar longitudinal** or the **high lateral**. The “high” lateral is made just inferior to the nail plate (to avoid the digital nerve) and on the non-oppositional side of the finger (to avoid a scar that would come into contact with the thumb). One should avoid deep, lengthy incisions, which can cause the fingertip to become unstable because they cut the fibrous septa.

3. Packing is placed and close follow-up is indicated. Antibiotics are usually prescribed.
C. Flexor Tenosynovitis

1. A serious infection that can follow minor finger injuries in which the tendon sheath is penetrated.
2. The tendon sheaths allow spread of the infection, and, in the case of the thumb and little finger, communicate at the level of the wrist in 50% of the population.
3. The classic presentation are **“Kanavel’s signs”**: 
   a. Tenderness along the tendon sheath
   b. Digit held in slight flexion
   c. Pain with forced extension
   d. Diffuse “sausage like” swelling of the digit.
4. Initial treatment includes splinting, IV antibiotics, and prompt surgical referral.

D. Deep Space Infections

1. Represent 5-15% of hand infections
2. Five types
   a. **Web space**: Significant swelling and pain in the web space and distal palmar regions. Drainage via a longitudinal incision in the web space.
   b. **Midpalmar space**: Maximal tenderness in the mid palm with loss of the normal concavity of the palm. Drainage in the OR.
   c. **Dorsal subaponeurotic space**: Dorsal hand swelling that is tender to palpation. Requires hand consultation for drainage.
   d. **Thenar space**: Tenderness and swelling within the thenar space. Thumb is held in abduction. Requires hand consultation for drainage.
   e. **Hypothenar space**: Rare infection with swelling and tenderness in the hypothenar area. Requires hand consultation for drainage.
X. OTHER CONDITIONS

A. De Quervain’s tenosynovitis

1. Inflammatory condition of the **first dorsal wrist compartment** containing the abductor pollicis longus and extensor pollicis brevis.
2. The patient experiences pain over the radial portion of the wrist. There is a marked increase in pain with the thumb folded into the palm and the wrist ulnar deviated (**Finkelstein test**).
3. Treatment is NSAIDs and immobilization with a thumb splint. Injection with local anesthetic and steroid has a success rate of up to 90%.

B. High pressure injection injuries

1. Secondary to paint guns, grease guns, or diesel injectors. High pressures deposit material deep into the finger, and possibly into the tendon sheath.
2. Usually due to attempts to clear the “blocked” tool with the non-dominant hand.
3. The initial injury often looks benign, so delayed presentations are most common. Within hours, the finger starts to become painful, and vasoconstriction may occur due to the inflammatory response from the substance.
4. Treatment includes prophylactic antibiotics, tetanus, and incision and drainage in the operating room for all significant injections.
HAND AND WRIST INJURIES

PEARLS

1. **Two-point discrimination** to 4-5 mm implies normal digital nerve sensory function. Digital nerve is superficial to the digital artery; hence, an arterial injury would almost necessitate a nerve injury.

2. Radial nerve innervates extensor muscles. Median nerve is responsible for thumb abduction and flexion of the wrist and IP joint of the thumb. Ulnar nerve provides grip strength via innervation to the intrinsic hand muscles.

3. Amides have two "i's" in the generic name: lidocaine, bupivacaine, mepivacaine, and prilocaine. The esters have only one “i”: cocaine, procaine, tetracaine, and benzocaine.

4. **Allergies to local anesthetics** are rare and usually due to preservatives. If a patient reports an allergy to an amide, consider using an ester, Benadryl, or a test dose of cardiac lidocaine (no preservative).

5. The **scaphoid** accounts for 60-80% of carpal bone fractures. It is occult in 10-20% of initial radiographs, necessitating immobilization when snuffbox tenderness is present. Avascular necrosis is a common complication.

6. **Triquetrum fracture** is the second most common carpal bone fracture and is best seen on the lateral radiograph.

7. Kienböck’s disease is avascular necrosis of the lunate.

8. **Colles fracture** is associated with median neuropathy.

9. **Scapholunate dissociation** is seen on the PA wrist film by noting the **Terry Thomas sign** (>3 mm between scaphoid and lunate). **Perilunate dislocation** maintains the normal lunate-radius association. **Lunate dislocation** (“spilled teacup”) does not.

10. **Rotational deformities** following fractures to the phalanges or metacarpals may result in significant hand disability.

11. Complications of **partial tendon injuries** include delayed rupture, painful tenosynovitis, triggering, and contraction scarring.

12. **Gamekeeper's thumb** is an injury to the first MCP ulnar collateral ligament due to hyperabduction.
13. Consider a central slip rupture in any patient presenting with an injury to the PIP joint. Missing this injury may result in a *Boutonnière deformity*.

14. **Felon** is a deep space infection of the fingertip requiring surgical decompression and antibiotics.

15. **Kanavel's four cardinal signs of flexor tendon sheath infection** are finger flexion, diffuse finger swelling, tenderness localized to the flexor tendon sheath, and pain on passive extension.

16. With human bites, cover for staph, strep, anaerobes AND *Eikenella corrodens*.

17. With animal (dog/cat) bites, consider *Pasteurella multocida* in addition to the usual oral flora.

18. Digit replantation is favored when the site of injury is between the PIP and DIP, when the thumb is involved, when multiple digits are involved, or in a child.

19. **De Quervain's syndrome** is a tenosynovitis of the first dorsal compartment. Finkelstein test is nearly diagnostic.

20. **High-pressure injection injuries** are usually benign appearing, but frequently harbor significant injury beneath the surface that requires surgical debridement in many cases.
# REFERENCES
