Common Clinical Conditions of the Hand and Wrist

27

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Contents

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Goals and Objectives

- *Goals*: To familiarize the readers with the more common hand and wrist conditions of the musculoskeletal system to give them an understanding of the epidemiology, presentation physical exam, physical exam, work-up, treatment, and possible complications of these conditions.
- *Objectives*: At the conclusion of the chapter, the learner should be able to understand the presentation, physical exam, initial evaluation, and treatment options of the following conditions: basilar thumb arthritis, flexor tendon injuries, hand infections, trigger fingers, Dupuytren's disease, scaphoid fractures and nonunions, scapholunate ligament injuries, distal radius fractures, carpal tunnel syndrome, DeQuervain's tenosynovitis, and ganglion cysts

27.1 Basilar Thumb Arthritis

Background: Basilar thumb arthritis is arthritis found at the thumb carpometacarpal (CMC) joint. This is the second most common location for hand arthritis behind distal interphalangeal joint arthritis. It is more common in women than men with up to sixfold increase in incidence. It has also been shown to be more common in Caucasians than in Native Americans, Asians, or African Americans. It also increased in prevalence with increasing age with studies showing 6.6% of individuals 40–49 years old with radiographic evidence of thumb CMC arthritis and 36.4% in individuals over 80 years of age [1]. Radiographic findings do not always correlate with patients' symptoms, but when symptomatic it can cause up to 50% impairment to that extremity [2].

27.1.1 Anatomy and Pathophysiology

The thumb CMC joint is made up of the trapezium and the thumb metacarpal. The trapezium has a saddle-shaped distal joint surface that allows for a high degree of motion in multiple planes. Due to the mobility of this joint, soft tissue stabilizers are of utmost importance to maintain position and function of the joint. Historically it has been thought that the deep anterior oblique ligament ("beak ligament") was the pivot point around which the thumb rotated and that attenuation of this ligament leads to progression of the disease. More recently, the dorsal ligament complex of the trapeziometacarpal joint has been shown to be of substantial importance for joint stabilization [3].

27.1.2 Presentation Physical Exam

Patients will typically present with pain and swelling of the base of the thumb with specific activities including pinching and grasping. The

CMC grind test is performed by exerting an axial load across the thumb CMC with concomitant circumduction [4]. A positive test will reproduce the pain the patient experiences with their normal activities. Pinch strength can also be compared to the contralateral side as it has been recently shown that a decrease in pinch strength can be present even before radiographic changes are evident.

27.1.3 Imaging

Plain radiographs are the study of choice to evaluate basilar thumb arthritis (Fig. 27.1). This should consist of three view radiographs including an AP, lateral, and oblique view of the hand or wrist. Specialized radiographic views (Betts or Roberson) visualize the trapeziometacarpal joint in profile and allow for evaluation of disease severity. The Eaton-Littler staging system is widely used to stage basilar arthritis and is based on radiographic criteria [5].

27.1.4 Eaton-Littler Classification

Stage I	Subtle carpometacarpal joint space widening
Stage II	Slight carpometacarpal joint space narrowing, sclerosis, and cystic changes with osteophytes or loose bodies <2 mm
Stage III	Advanced carpometacarpal joint space narrowing, sclerosis, and cystic changes with osteophytes or loose bodies >2 mm
Stage IV	Arthritic changes in the carpometacarpal joint as in Stage III with scaphotrapeziotrapezoid (STT) arthritis

27.1.5 Treatment

Nonsurgical interventions are the first-line treatment for mild symptoms. Hand exercise programs, heat, joint protection education, and hand orthoses can be beneficial in symptomatic treatment of early thumb CMC arthritis. Additionally, oral and topical NSAIDs have good short- and medium-term symptomatic relief for this condition [6]. Corticosteroid injection into the thumb CMC joint is another viable non-operative treat-

Fig. 27.1 Radiograph of severe basilar thumb arthritis

ment option. A recent systematic review found that corticosteroid injections can offer good symptomatic relief in patients with mild disease up to 1 year [7].

Surgical treatment is discussed after the patient has failed a trial of non-operative intervention. Joint-preserving operations may be reasonable for patients with early-stage arthritis. This may include arthroscopic debridement and possible capsulorrhaphy or a first metacarpal dorsal closing wedge extension osteotomy [8]. For more advanced disease, stage II–IV, joint-altering procedures must be considered. This may include a complete trapeziectomy or trapeziectomy with ligament reconstruction with tendon interposition (LRTI). Another option for young laborers with stage II–III disease is a trapeziometacarpal arthrodesis as it may preserve grip strength, though it is associated with a higher complication rate than trapeziectomy procedures [9]. The possible use of silicone or metallic implants has been investigated and is currently not recommended due to their high rate of failure or dislocation of these devices.

27.1.6 Complications

The main risk of non-operative interventions includes inadequate symptomatic relief. Specifically for corticosteroid injections, there is a risk of adverse reactions including skin irritation, infection, and overlying skin hypopigmentation. For surgical intervention for basilar thumb arthritis, there is a risk of metacarpal subsidence or interposition failure [9].

27.2 Flexor Tendon Injuries

Background: Flexor tendon injuries are relatively rare injuries with an incidence of 4.83 per 100,000 people [10]. These injuries are typically due to volar lacerations, so they may present with concomitant neurovascular injuries. The severity of the injury and overall prognosis are related to the level at which the tendon is injured.

27.2.1 Anatomy and Pathophysiology

There are several flexor muscles that aid in finger and wrist motion which include the flexor digitorum profundus and superficialis, flexor pollicis longus and brevis, and flexor carpi radialis and ulnaris. There are two separate blood supply systems for the tendons. One is through diffusion through the synovial sheath. There is also direct blood supply to the other tendons that are outside of a synovial sheath. This includes the small blood vessels that are within the vincula that connect the FDS and FDP to the bone.

27.2.2 Presentation Physical Exam

The majority of patients present with a laceration over the volar aspect of the finger, hand, wrist, or forearm. The main presenting symptom will be loss of active flexion strength of the involved digit. A thorough exam of the distal aspect of the extremity is key to determine exactly which tendons are involved as well as if there is concomitant neurovascular injury. During the physical exam, each joint should be isolated to assess for the ability to actively flex and extend at that joint specifically.

27.2.3 Imaging

Radiographs are obtained to evaluate if there is any concomitant bony injury that should also be addressed. Advanced imaging is not routinely obtained as further evaluation of associated neurovascular injuries can typically be elucidated with physical exam and further explored at the time of surgery.

27.2.4 Classification

Zone of Flexor Tendon Injury (Fig. 27.2) [11]

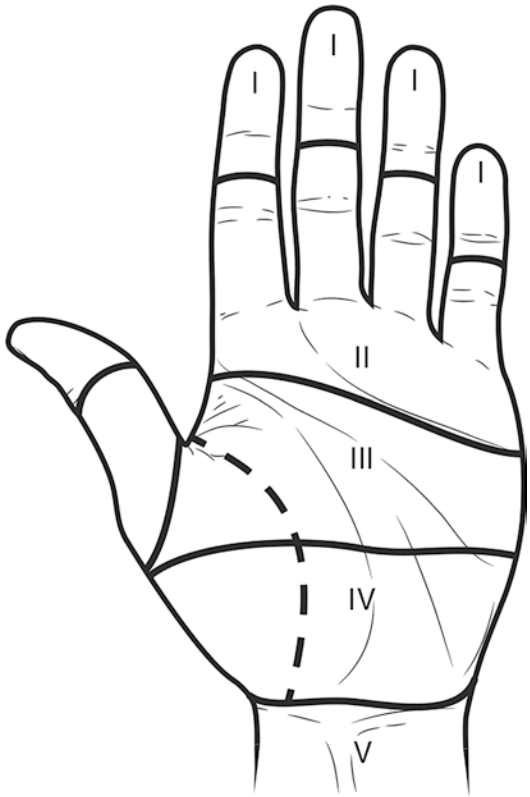

Fig. 27.2 Illustration of the palmar view of the hand demonstrating the anatomically based classification of flexor tendon injuries [71]

Zone I	From the FDS insertion to the FDP insertion
Zone II	From the proximal aspect of the A1 pulley to the FDS insertion
Zone III	From the distal aspect of the transverse carpal ligament to the A1 pulley
Zone IV	The carpal tunnel
Zone V	From the proximal border of the transverse carpal ligament to the musculotendinous junction in the forearm

27.2.5 Treatment

An acute laceration that involves over 60% of the tendon should be repaired primarily [12]. This may include multiple core suture and epitendinous suture configurations (Fig. 27.3). Chronic injuries are typically treated with staged tendon reconstruction [13].

27.2.6 Complications

The most common complication after flexor tendon repair is adhesion formation and decreased range of motion. There has also been found a 15–25% risk of rerupture of the previously repaired tendons [14]. Zone II lacerations are especially prone to complications, due to their reliance on predominately indirect nutritional supply through synovial diffusion. It is also possible to create a trigger finger due to the increased bulk of the tendon at the repair site that has to pass through the same-size fibro-osseous tunnel [14].

27.3 Infection

27.3.1 Background

Finger and hand infections are a common complaint to orthopedic surgeons and the emergency department. The complex anatomy of the hand makes it susceptible to unique infections.

27.3.2 Anatomy and Pathophysiology

Staphylococcus aureus has been implicated in 80% of all hand infections [15]. The next most common organisms include *Streptococcus* spp. and Gram-negative organisms. It has also been found that MRSA infections have been increasing over the last decade and are now implicated in up to 78% of all hand infections [16].

27.3.3 Presentation Physical Exam

The patient will typically report a recent injury to the area that was the cause of local inoculation, but it is also possible to have hematogenous seeding. The affected digit or location of infection will be swollen, erythematous, and tender to palpation. The examiner may be able to palpate underlying fluctuance, or there may be frank

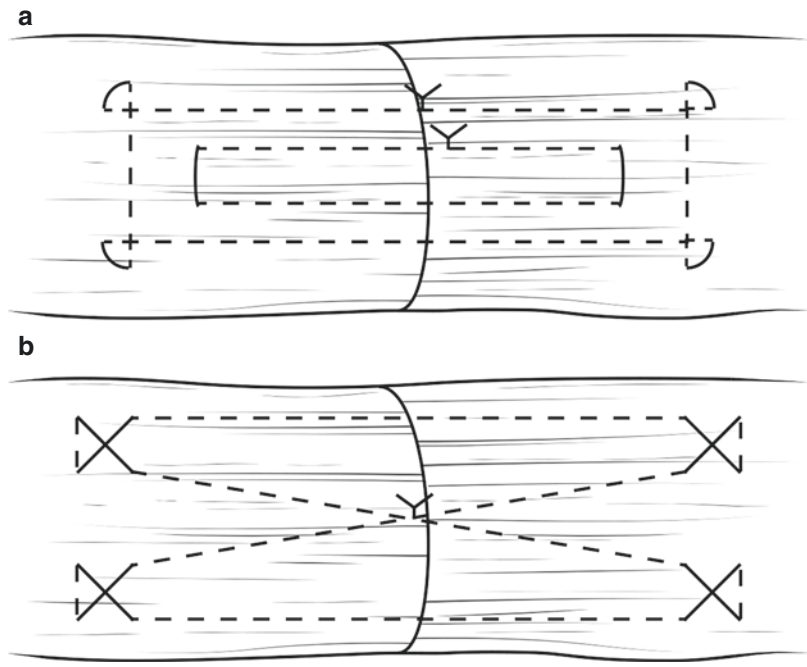

Fig. 27.3 An example of two suture fixation techniques with four core suture strands: a horizontal mattress suture added to Kessler's technique (**a**) and the cross-locked cruciate technique (**b**) [71]

purulence draining from the initial site of injury. Infection labs including WBC, ESR, and CRP may be non-specifically elevated in the setting of an acute infection with or without fever.

27.3.4 Imaging

Many of these infections can be diagnosed and treated without the need for advanced imaging. If there is doubt as to the presence of an abscess in association with overlying cellulitis or to determine the full extent of an infection in a deeper space, then an ultrasound or MRI for further characterization may be obtained.

27.3.5 Classification

Paronychia is an infection beneath the eponychial fold and is associated with manicures, fingernail biting, and hangnails. With acute infection an abscess will form in this area. If not treated expeditiously, then it may spread beneath the nail plate itself. These may be treated with a digital block and decompression of the abscess. If it has spread beneath the nail plate, then the nail should also be removed. The patient should then be discharged with local wound care instructions and antibiotics.

Felon is a closed-space infection of the finger pulp. This can cause exquisite pain as it acts like acute compartment syndrome within the pulp due to increased pressure in the many septations within this area. This should also be treated with a digital block, decompression, antibiotics, and local wound care.

Pyogenic flexor tenosynovitis is a bacterial infection within the flexor tendon sheath. Clinical diagnosis is aided with the use of Kanavel's four cardinal signs which include exquisite tenderness over the course of the sheath, limited to the sheath; resting semiflexed position of the finger; exquisite pain with passive extension of the finger; and symmetrical or fusiform swelling of the entire finger [17]. If the patient presents with less than 24 h of symptoms, then an initial trial of IV antibiotic treatment and strict elevation may be attempted. The gold standard for treatment is urgent irrigation and debridement of the flexor tendon sheath (Fig. 27.4) followed by IV antibiotics and wound care [18].

Deep-space infections of the hand can involve any of the deep spaces of the hand including the

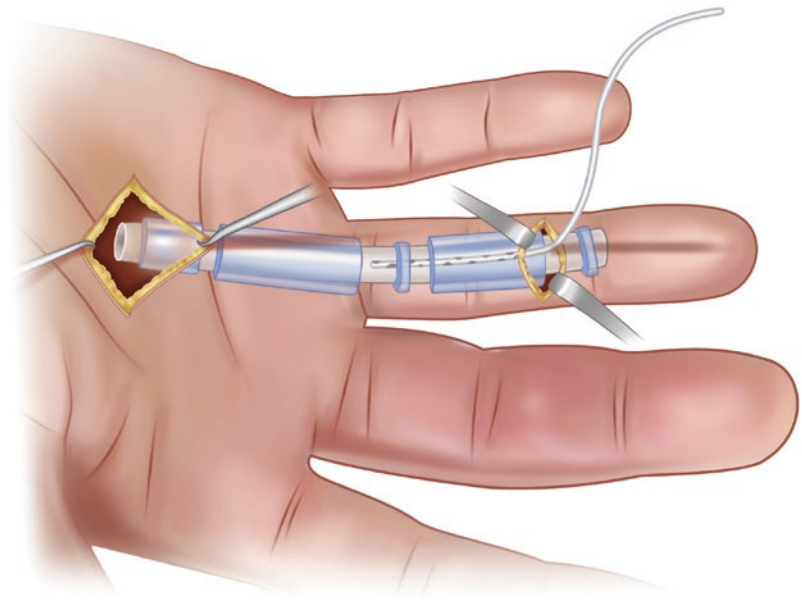

Fig. 27.4 Closed irrigation for treatment of pyogenic flexor tenosynovitis [18], illustrated in a retrograde direction here, but also may commonly be performed antegrade

thenar, hypothenar, dorsal subaponeurotic, midpalmar, and deep palmar spaces. It is also possible for these infections to spread to other spaces due to known communications between the areas. An MRI may aid in localization of the abscess, and definitive treatment includes incision and debridement in the operating room followed by appropriate antibiotic treatment.

Septic arthritis is infectious arthritis that may occur in any joint in the wrist, hand, or finger. These infections may have a rapid clinical course, and bacterial toxins, in combination with the patient's immune response, may create substantial damage to the articular cartilage. Exquisite pain with joint micromotion, sometimes coupled with joint fluid analysis from arthrocentesis, allows for diagnosis. Treatment involves irrigation and debridement of the joint followed by appropriate antibiotic treatment.

27.3.6 Treatment

General treatment guidelines consist of surgical decompression of the associated fluid collection, appropriate antibiotic treatment, and local wound care as previously discussed [19, 20].

27.3.7 Complications

If these infections are not treated appropriately, it can lead to long-standing complications including finger stiffness, loss of dexterity, or even loss of the digit. If allowed to progress, it may also lead to systemic involvement and sepsis.

27.4 Trigger Finger

27.4.1 Background

Trigger finger is most common in the fifth to sixth decades of life. It is six times more common in women than in men. The lifetime risk of developing trigger finger is 2–3% in the general population [21]. This increases to almost 10% in diabetics [22].

27.4.2 Anatomy and Pathophysiology

Trigger finger is known as tendovaginitis as it is due to pathologic inflammatory changes of the retinacular sheath (tendovagina). The retinacular

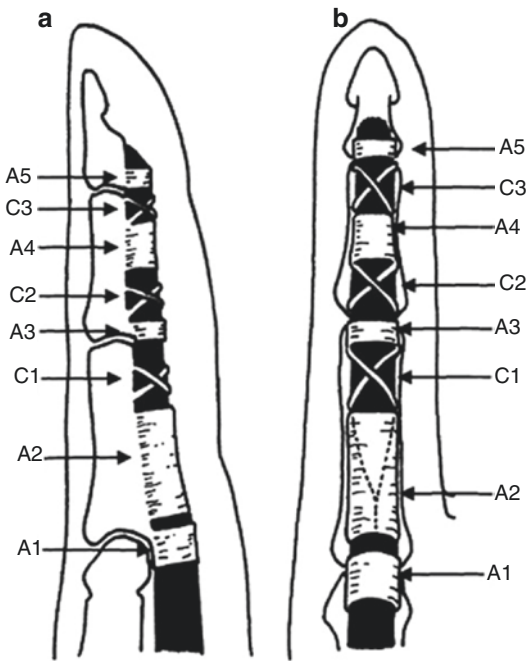

Fig. 27.5 Anatomy of flexor pulley system [73]

sheath forms a pulley system along each digit that maximizes the flexor tendon force as well as prevents bowstringing of the tendons. The most commonly involved pulley is the first annular pulley (A1), which is found at the level of the metacarpal head on the volar surface (Fig. 27.5). These inflammatory changes are due to various factors including repetitive finger movements and local trauma. This will result in increased friction at the level of the pulley and cause difficulty with flexor tendon gliding [21].

27.4.3 Presentation Physical Exam

Patients may initially present with a painless clicking with finger flexion and extension. This may then progress to a painful popping and catching. It can progress to locking of the digit in flexion or extension which may or may not be passively correctable. Physical exam will reveal tenderness over the A1 pulley, possibly with a palpable mass in the same location. One may also be able to reproduce the triggering of the finger with passive range of motion of the digit.

27.4.4 Imaging

Imaging is not routinely indicated for trigger finger.

27.4.5 Treatment

Initial treatment is with nonsurgical interventions. Activity modification, NSAIDs, and nighttime splint should be the first line of treatment. If there is no symptomatic improvement with these interventions, then a corticosteroid injection at the level of the A1 pulley should be considered. Success rates of injection vary, but the vast majority (93%) of patients obtain at least short-term relief, while long-term relief is also reported in 40–60% of individuals [23]. If the patient fails these treatments, then a surgical release of the A1 pulley should be performed. This may be percutaneous or open based upon the surgeon's preference [24].

27.4.6 Complications

Corticosteroid injections may result in dermal atrophy, overlying hypopigmentation of the skin, or in very rare cases flexor tendon rupture. With surgical release of the A1 pulley it is possible to injure the digital nerve or artery or to perform an incomplete release leading to recurrence [25].

27.5 Dupuytren's Disease

27.5.1 Background

Dupuytren's disease is a myeloproliferative disease that leads to flexion contractures of the hand. It has been found to have a genetic component and is inherited in an autosomal dominant pattern with variable penetrance. It is most common in the fifth to seventh decades of life, and it has been found to affect men more than women with a 2:1 ratio [26].

27.5.2 Anatomy and Pathophysiology

This disease is caused by the inhibition of the genes regulating the natural breakdown of collagen and the upregulation of the genes that promote structural development of collagen. The increased collagen formation can result in nodules and cords along the volar aspect of the hand. Myofibroblasts in the cords contract as the disease progresses and are responsible for generating contractures [27].

27.5.3 Presentation Physical Exam

Patients will present with palpable nodules or cords along the palmar surface of the hand that may resemble contracted flexor tendons (Fig. 27.6). The most commonly affected digit is the ring finger, but it may involve all of the digits to varying degrees. The contracture has been found to affect the metacarpal phalangeal joint prior to affecting the proximal interphalangeal joint. With progression of the disease, individuals will have difficulty opening the hand to grip objects and perform everyday tasks. When evaluating these patients, it is essential to record the range of motion of each digit at each joint in degrees [28].

Fig. 27.6 Clinical presentation of Dupuytren's contracture

27.5.4 Imaging

Imaging is not routinely indicated for Dupuytren's contracture.

27.5.5 Treatment

The presence of nodules or cords alone does not require treatment. Once contractures reach the point that they are inhibiting function, then treatment should be offered. Collagenase injection into the cord with manipulation is a minimally invasive technique that has very promising results with good improvement in range of motion [29]. Another option is percutaneous needle aponeurotomy, in which a needle is used with multiple passes to section the contracted cord followed by early active and passive range-of-motion exercises. Surgery is reserved for recalcitrant cases that failed other treatment or severe cases that are not amenable to less invasive techniques. This involves open fascial excision of the involved areas [30, 31].

27.5.6 Complications

Collagenase injection with manipulation has been associated with local ecchymosis and swelling. There is also a risk of skin tears if there is overaggressive manipulation. Percutaneous aponeurotomy has a risk of digital artery or nerve injury. Open fascial excision places the patient at risk for wound healing complications and infections. No matter what the treatment method is, recurrence is likely between 3 and 10 years following treatment [31].

27.6 Wrist

27.6.1 Scaphoid Fracture and Nonunion

Background: The scaphoid is injured in approximately 15% of all acute wrist injuries. It also accounts for 60% of all carpal fractures making it the most commonly injured carpal bone. It is most commonly injured in men aged 15–40 years old [32].

27.6.1.1 Anatomy and Pathophysiology

The scaphoid is described as having a proximal and distal pole with the waist delineating the two. It is a unique bone in that 80% of the scaphoid is covered with articular cartilage, limiting areas of vascular inflow. This tenuous blood supply is what confers the risk of poor outcomes to scaphoid fractures. The dorsal scaphoid artery is a branch of the radial artery, enters at the level of the scaphoid waist, and supplies the proximal 70–80% of the scaphoid. The volar scaphoid artery is either a branch of the radial artery or the superficial palmar arch, enters at the distal tubercle, and supplies the distal 20–30% of the scaphoid. This means that the proximal pole of the scaphoid depends solely on intra-osseous blood flow for perfusion [33].

27.6.1.2 Presentation Physical Exam

The patient typically presents following a fall onto a hyperextended and radially deviated wrist. They will have pain and swelling over the radial aspect of the wrist. Patients with a scaphoid injury will typically have tenderness dorsally at the anatomic snuffbox as well as volarly over the scaphoid tubercle. Elicited pain with resisted pronation is also common. This is typically in conjunction with reduced grip strength and possible pain with thumb range of motion [34].

27.6.1.3 Imaging

Initial imaging should include wrist radiographs including AP, lateral, 45 degree pronated oblique, and scaphoid view, which is 30 degrees of wrist extension and 20 degrees of ulnar deviation.

Fig. 27.7 Displaced scaphoid waist fracture

Fractures may be difficult to visualize on radiographs. If there is a high clinical suspicion for scaphoid fracture but negative radiographs, one may pursue advanced imaging or immobilize the patient with a thumb spica and repeat imaging in 10–14 days [35]. An MRI of the wrist may also be used to diagnose acute occult fractures with 90–100% sensitivity and 90% specificity [36]. If there is a fracture identified on plain radiograph, then one must determine if it is displaced or nondisplaced as this has implications on treatment options (Fig. 27.7). If one is unable to determine if there is displacement on plain radiograph, then a CT scan would be the imaging modality of choice.

27.6.1.4 Treatment

Stable, non-displaced, acute fractures can be treated with cast immobilization for 10–12 weeks with a thumb spica cast. The healing rate of nondisplaced scaphoid waist fractures treated with cast immobilization is 88–95% if treatment was initiated within 3 weeks of injury. Athletes and those patients that wish to return to activity in a more expedited manner may wish to discuss the possibility of surgical fixation as this may allow them to return to activity as early as 6 weeks from the time of surgery [37].

Unstable, displaced, acute fractures as well as proximal pole fractures should be treated with surgery as they have a higher risk of nonunion and avascular necrosis. As the scaphoid is 80% covered with articular cartilage, it is most common to use a headless compression screw for fixation that can be recessed below the margin of the articular cartilage. It has been found that a 95% union rate can be achieved with either the dorsal or volar approach as long as there is appropriate screw position, which is defined as within the central one third of the scaphoid [38].

27.6.1.5 Complications

Complications of cast immobilization include potential skin breakdown, increased time to union, and stiffness of the immobilized joints. In non-displaced fractures treated with cast immobilization, the rate of nonunion can be as high as 5–10%. It has also been found that there is up to 10% rate of nonunion in displaced scaphoid fractures that were treated surgically. Nonunion of the scaphoid can result in chronic pain and decreased grip strength, but it can also lead to a condition known as scaphoid nonunion advanced collapse (SNAC) which is progressive wrist arthritis due to altered mechanics [39–40].

27.6.2 Scapholunate Ligament Injury

27.6.2.1 Background

Scapholunate (SL) ligament injuries occur acutely in up to 54.5% of intra-articular distal radius fractures or carpal fractures. SL ligament injuries may also present as a degenerative tear and have been found to be present in over 50% of the population over the age of 80 years old [41].

27.6.2.2 Anatomy and Pathophysiology

The SL ligament has three components that connect the scaphoid and lunate. These include the volar, dorsal, and proximal components. These three components combine to create a C-shaped ligament. The majority of the strength of the ligament is conferred by the dorsal component. The bones of the proximal carpal row have no muscular attachments but rather are connected to each other through bony articulations and complex ligamentous structures. In an uninjured wrist, the motion of the proximal row reflects the global motion of the wrist. At baseline the scaphoid has a tendency towards flexion and the triquetrum a tendency towards extension with the lunate held in balance in-between the ligamentous structures. If there is disruption of the SL ligament, the scaphoid will collapse into flexion, and the lunate will go with the triquetrum into extension. This will result in abnormal motion and the development of degenerative changes at the radial styloid and scaphoid [42].

27.6.2.3 Presentation Physical Exam

A patient with an acute tear typically presents after a fall onto an outstretched hand with the wrist in extension, ulnar deviation, and midcarpal supination. This will cause the capitate to drive into the scapholunate articulation and result in a tear of the SL ligament [43]. These patients will present with acute wrist pain that is most significant over the dorsal radial aspect of the wrist. Pain can be elicited with loading of the wrist in a push-up position. There is also an associated decreased grip strength and range of motion of the wrist. A patient with a chronic tear will more likely present with a slow onset of persistent wrist pain in the same distribution without specific inciting event. The Watson scaphoid shift test assesses for anomalous scaphoid motion. The arm is held in a small amount of pronation, and the examiner applies a dorsal force over the scaphoid while passively moving the wrist from ulnar deviation and extension to radial deviation and flexion. If there is an injury to the SL ligament, the scaphoid will subluxate onto the dorsal rim of the distal radius, and when the force is removed the scaphoid will relocate with a clunk back into the scaphoid fossa of the distal radius. This relocation should reproduce the patient's pain.

27.6.2.4 Imaging

Initial imaging should include plain radiographs with AP, lateral, scaphoid, and bilateral PA clenched pencil views. On the AP view, one can

Fig. 27.8 AP wrist radiograph with scapolunate ligament disruption with associated radial styloid fracture

evaluate for SL interval widening, which, if present, represents a complete tear of the SL ligament. One can also evaluate scaphoid height as well as the ring sign, indicative of scaphoid flexion. The bilateral pencil grip view puts stress across the SL ligament and will show dynamic instability, which can be indicative of a partial tear or a complete tear with intact secondary stabilizers. A SL gap over 3 mm on this view is positive for a SL ligament injury [44] (Fig. 27.8). Arthrography can also be completed under fluoroscopy to evaluate for contrast communication between the radiocarpal and midcarpal compartments. MRI and MRA can also be obtained to evaluate the continuity of the ligament. Despite this, wrist arthroscopy remains the gold standard for diagnosis of acute and chronic SL ligament injuries as it can diagnose, grade, and possibly treat the injury.

27.6.2.5 Treatment

Initial treatment with immobilization is typically not recommended as it cannot reduce the scapholunate gap nor has it been shown to provide symptomatic relief in the literature. Primary repair of the ligament in the acute setting can result in good pain relief and return to activity, but it has been shown to have only fair to poor outcomes if performed in subacute or chronic injuries. Arthroscopic debridement with k-wire fixation of the scaphoid and lunate provides reliable pain relief in the setting of a partial tear. There may also be a role for the addition of capsular shrinkage with the arthroscopic procedure to enhance stability again only in a partial tear of the SL ligament [45]. With complete tears of the SL ligament as well as subacute and chronic partial tears, the recommendation is ligament reconstructive procedures [46].

27.6.2.6 Complications

It is unknown exactly what percent of patients that sustain an acute scapholunate ligament disruption will progress to scapholunate advanced collapse (SLAC) wrist [47]. The scaphoid flexion and lunate extension cause abnormal distribution of forces across the midcarpal and radiocarpal joints. This will result in progressive arthritis in these areas.

27.6.3 Distal Radius Fractures

27.6.3.1 Background

Distal radius fractures are one of the most common fractures in adults making up approximately 18% of all fractures sustained in this group, resulting in over 640,000 per year. They are more common in women than in men with approximately 32% of all fractures seen in women over the age of 35 being distal radius fractures. In 2007 Medicare paid over $170 million for distal radius fracture-related care [48].

27.6.3.2 Anatomy and Pathophysiology

The distal radius articulates with the proximal carpal row. It also articulates with the distal aspect of the ulna creating the distal radioulnar joint (DRUJ). Injuries to the distal radius can also result in injuries of the carpus or DRUJ and should also be evaluated.

27.6.3.3 Presentation Physical Exam

Injuries to the distal radius are typically sustained by a fall onto an outstretched hand as the force will be transmitted from the carpus to the distal radius. The patient will typically present with swelling and visible deformity of the wrist and pain and palpable crepitus at the level of deformity. It is important to also evaluate the entirety of the ipsilateral extremity for concomitant fractures. It is also important to perform a detailed neurovascular exam as distal radius fractures do confer a risk of developing acute carpal tunnel syndrome. Acute carpal tunnel syndrome has been found to occur in 5.4% of surgically treated distal radius fractures [49].

27.6.3.4 Imaging

Initial evaluation should include plain radiographs of the wrist (Fig. 27.9). These radiographs are used to assess if there is intra-articular involvement as well as overall alignment of the fracture. The important components include radial height, radial inclination, and volar tilt. These features will impact the final treatment of the fracture. Complex fractures with intra-articular fragmentation may benefit from a CT scan to aid in surgical planning [50].

27.6.3.5 Classification

There are several classification systems for distal radius fractures, but none of them are ubiquitous. There are several well-known eponymous distal radius fractures. Colles' fractures are low-energy extra-articular fractures that are dorsally displaced. Smith's fractures and Colles' fractures are similar as they are also low-energy and extra-articular, but they are volarly displaced. Chauffer's fractures are radial styloid fractures. Barton's fractures are intra-articular fractures involving the volar lip of the distal radius that result in a fracture dislocation of the radiocarpal joint.

27.6.3.6 Treatment

When deciding between operative and non-operative treatment of distal radius fractures, it is important to consider the age and activity level of the patient, whether it is the dominant or non-dominant arm, if there is articular involvement, and the overall alignment of the fracture. Surgical intervention is indicated in those patients with radial shortening >3 mm, dorsal tilt >10 degrees, or intra-articular step-off >2 mm measured on post-reduction radiographs. If the fracture does not meet these criteria, then it can be most likely successfully treated with cast immobilization. It has been proposed for individuals over the age of 65 to be treated with casting instead of surgical fixation, but the current guidelines recommend not using a hard age cut-off but rather factoring that in with activity level, bone quality, and involvement of dominant extremity. Surgical intervention can be accomplished with volar locking plate technology, fragment specific fixation, dorsal bridge plate fixation, or external fixation with or without percutaneous Kirschner wire fixation for augmentation [51–52].

27.6.3.7 Complications

Distal radius fractures can result in acute carpal tunnel syndrome. This is a surgical emergency and requires immediate carpal tunnel release. Prospective studies have found that approximately 90% of young adults will develop radiocarpal arthritis if there is an intra-articular step-off >2 mm that is not corrected, which is why surgical intervention is typically advocated in this group [53]. As with any fracture, malunion or nonunion is possible. One unique complication found in non-displaced distal radius fractures that are treated non-operatively includes extensor pollicis longus rupture caused by local attrition from impingement or local ischemia of the tendon at the level of the fracture due to swelling within the extensor tendon sheath.

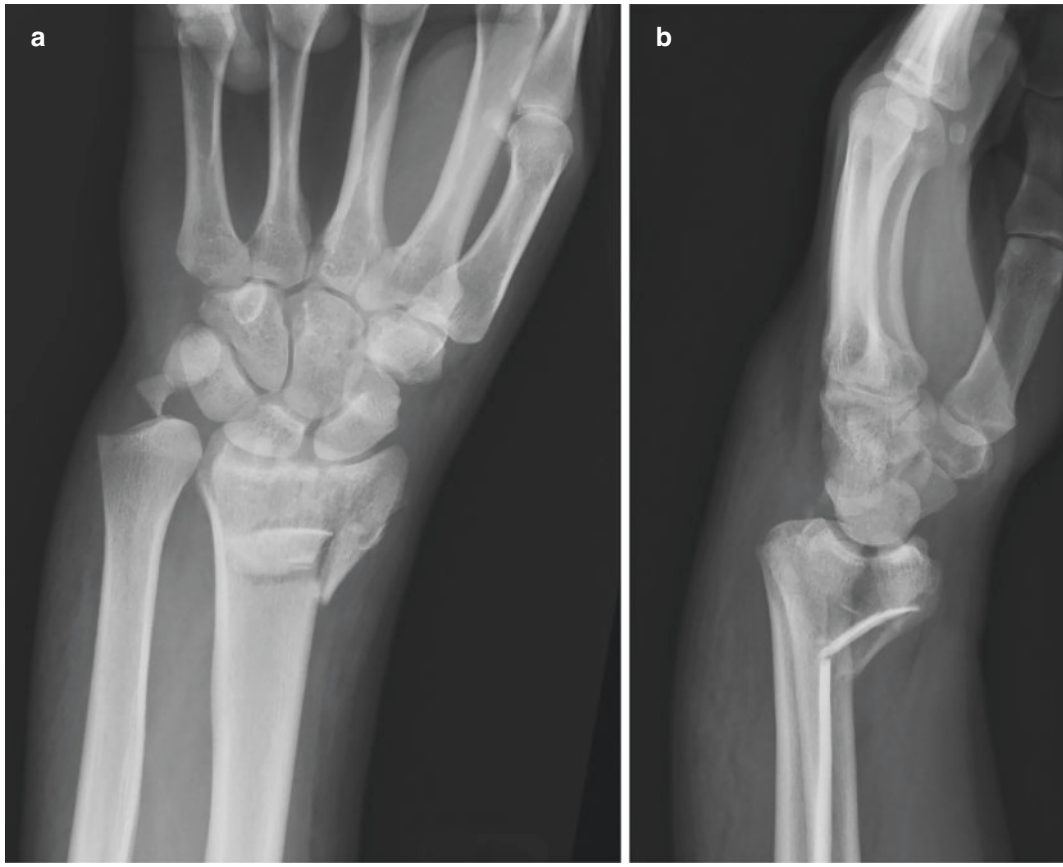

Fig. 27.9 AP (**a**) and lateral (**b**) views of distal radius fracture

27.6.4 Carpal Tunnel Syndrome

27.6.4.1 Background

Carpal tunnel syndrome refers to compression neuropathy of the median nerve as it courses through the carpal tunnel at the wrist. It is a very common problem affecting between 0.1% and 10% of the general population. As of 2007, it also accounts for approximately 500,000 surgical cases per year, which when considering cost of treatment and time out of work has an economic impact of approximately $2 billion annually [54].

27.6.4.2 Anatomy and Pathophysiology

The borders of the carpal tunnel include the scaphoid tubercle and trapezium radially, hook of hamate and pisiform ulnarly, the proximal carpal row dorsally, and the transverse carpal ligament (TCL) volarly. The carpal tunnel contains the tendons of the flexor pollicis longus (FPL), four tendons of the flexor digitorum profundus (FDP), four tendons of the flexor digitorum superficialis (FDS), and the median nerve. The FPL is the most radial structure, and the median nerve is the most superficial structure. The cause of carpal tunnel syndrome is compression of the median nerve within the carpal tunnel. This increase in pressure within the tunnel can be due to inflammation from repetitive motion in previously normal underlying anatomy or in individuals with space-occupying lesions [55].

27.6.4.3 Presentation Physical Exam

Compression of the median nerve within the carpal tunnel presents with several classic findings including numbness and tingling in the thumb, index, long, and radial ring fingers, pain and par-

esthesias that wake the patient up at night, and clumsiness of the hand. These symptoms typically are more prevalent at night, and shaking of the hand may alleviate these symptoms. With a more prolonged course of nerve compression, the patient may also present with grip and pinch weakness due to thenar muscular atrophy. Identifying and diagnosing carpal tunnel syndrome relies heavily upon the physical exam. Specific physical exam tests aim to increase the pressure within the carpal tunnel causing further compression of the median nerve to reproduce the classic symptoms of carpal tunnel syndrome. Tinel's sign is percussion over the median nerve at the wrist and palm that if positive produces an electric shock sensation in the median nerve distribution. Phalen's test is flexing the wrist by gravity for 60 seconds. This is positive if it elicits numbness or tingling in the median nerve distribution. Durkan's median nerve compression test is manual pressure over the carpal tunnel for 30 seconds that will produce numbness or tingling in the median nerve distribution if positive [56]. It is also important to perform sensory testing using both innervation density measurements with static or dynamic 2-point discrimination as well as threshold sensory assessment using Semmes-Weinstein monofilament testing. It has been found that threshold sensory testing is more sensitive than density testing [57].

27.6.4.4 Imaging

Imaging is not typically indicated in the diagnosis of carpal tunnel syndrome. Electrodiagnostic studies that include nerve conduction studies in conjunction with electromyography are valuable for the diagnosis of carpal tunnel syndrome as well as a baseline for comparison during the patient's course of symptom evolution or treatment [58].

27.6.4.5 Classification

There is no specific classification of carpal tunnel syndrome other than the acuity of onset. Acute carpal tunnel syndrome is a syndrome comprised of acute onset of symptoms with rapid progression. Chronic carpal tunnel syndrome is a slow-onset syndrome with progressively worsening symptoms that typically begin with night symptoms and positional symptoms that progress to more pervasive symptoms.

27.6.4.6 Treatment

Acute carpal tunnel syndrome is a surgical emergency, and these patients should be taken immediately for carpal tunnel release using an open, mini-open, or endoscopic surgical technique depending upon surgeon preference. Chronic carpal tunnel syndrome is managed electively and may be amendable to nonsurgical interventions. Initial treatment may consist of night-time neutral wrist immobilization, which lessens pressure in the carpal tunnel. Ergonomic changes at work and home may also lessen exacerbation of symptoms [59]. Oral medications including NSAIDs, physical therapy, and soft-tissue gliding exercises have been found to have no impact on symptoms and are therefore not recommended. Corticosteroid injections into the carpal tunnel may be diagnostic as well as therapeutic for carpal tunnel syndrome. Following injection, approximately 76% of patients will have symptomatic relief for 6 weeks, but only 30% of patients will remain symptom-free one year after injection [60]. Diabetics have a decreased likelihood of symptomatic improvement after injection. The definitive treatment for carpal tunnel syndrome is surgical release of the transverse carpal ligament. This may be done with open, mini-open, or endoscopic surgical technique based upon the surgeon's preference [61].

27.6.4.7 Complications

Chronic severe carpal tunnel syndrome can result in permanent median nerve damage, which can result in persistent numbness, tingling, and decreased pinch and grip strength. In patients with severe carpal tunnel syndrome, approximately 20% of these individuals will have persistent symptoms even after surgical release [61].

27.6.5 De Quervain's Tenosynovitis

27.6.5.1 Background

De Quervain's tenosynovitis is tenosynovitis of the tendons of the first dorsal extensor compartment of the wrist, which includes the abductor

pollicis longus (APL) and the extensor pollicis brevis (EPB). De Quervain's tenosynovitis affects approximately 1.3% of all women and 0.5% of all men. It is more common in the dominant extremity, and it may be correlated with repetitive activities, which have been implicated as risk factors, including lifting and typing. It is most common in middle-aged individuals, but it may also be found in acute and self-limiting fashion in pregnant and lactating women [62].

27.6.5.2 Anatomy and Pathophysiology

The first dorsal extensor compartment of the wrist is located over the radial styloid and contains the abductor pollicis longus and extensor pollicis brevis. Friction through the compartment will lead to swelling and thickening of the extensor retinaculum and tendon sheath. Thickening of the retinaculum and sheath will result in a narrowed fibro-osseous tunnel causing pain with resisted movement of the tendons through this tunnel. During pregnancy the pathophysiology is different as it is typically due to the increased volume state resulting in swelling of the tissues [63] (Fig. 27.10).

27.6.5.3 Presentation Physical Exam

The patient typically presents with a gradual onset of pain over the dorsal radial aspect of the wrist over the radial styloid. This pain is typically worsened with grasping and raising objects with the wrist. The classic physical exam test is the Finkelstein test, in which the examiner grasps the patient's thumb and then deviates the patient's hand and wrist ulnarly. Similarly, the Eichhoff maneuver is performed by quickly ulnarly deviating the patient's wrist while their thumb is clasped within their clenched fist.

27.6.5.4 Imaging

Imaging is not indicated in this disease as it is a clinical diagnosis. If one is attempting to differentiate De Quervain's from other causes of pain including basilar thumb arthritis, then plain radiographs should be obtained. Otherwise, a clinical exam alone is needed for diagnosis.

27.6.5.5 Treatment

Nonsurgical treatment is the first line of treatment for De Quervain's and may include rest, thumb spica splinting, NSAIDs, and possibly first dorsal compartment corticosteroid injection [64]. Corticosteroid injection into the first dorsal compartment has been shown to result in full relief in 83% of patients. If the patient fails nonsurgical treatment and has undergone two corticosteroid injections and 6 months of conservative treatment without symptomatic improvement, then surgical release of the first dorsal compartment retinaculum should be discussed [65].

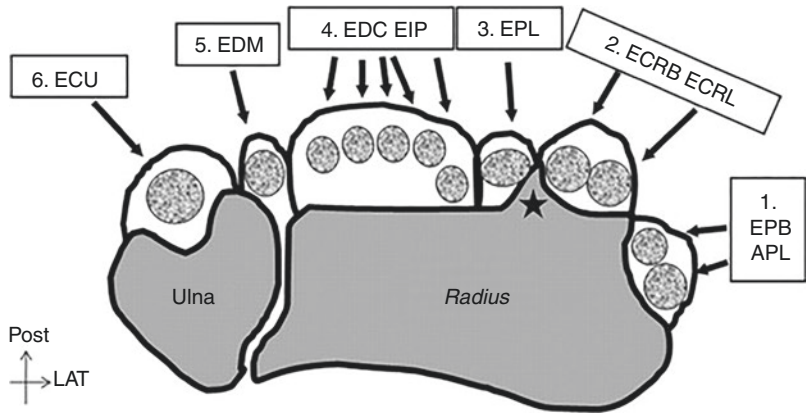

Fig. 27.10 Schematic of extensor tendons of the wrist in their six (1–6) separate compartments. *APL* abductor pollicis longus, *EPB* extensor pollicis brevis, *ECRL* extensor carpi radialis longus, *ECRB* extensor carpi radialis brevis, *EPL* extensor pollicis longus, *EIP* extensor indicis proprius, *EDC* extensor digitorum communis, *EDM* extensor digiti minimi, *ECU* extensor carpi ulnaris. ★ = Dorsal tubercle of the radius (Lister tubercle) [72]

27.6.5.6 Complications

Complications of corticosteroid injections have been previously discussed.

Care must be taken during surgical release to identify and protect the radial sensory nerve as it is in close proximity. Another risk of surgery is incomplete release resulting in persistent pain post-operatively, which may result from failure to identify and decompress tendons with multiple slips and septations within the sheath [66].

27.6.6 Ganglion Cysts

27.6.6.1 Background

Ganglion cysts are the most common soft tissue hand mass, representing approximately 70% of patients who present with a hand mass. They are benign soft tissue tumors that are treated based upon symptoms [67].

27.6.6.2 Anatomy and Pathophysiology

Approximately 70% of ganglion cysts are found dorsally originating from the scapholunate articulation. Other common sites of origin are from the volar aspect of the wrist at either the radiocarpal or scaphotrapeziotrapezoid joint (20%) and the flexor tendon sheath (10%). They are mucin-filled cysts that do not have a true synovial lining. It is thought that these cysts may actually be a herniation from the joint capsule or flexor sheath with fluid from those locations filling the cyst [67].

27.6.6.3 Presentation Physical Exam

On examination, the wrist ganglion is typically a firm rubbery feeling structure. It is typically not mobile as it is anchored in place by its stalk contiguous with the joint. The mass will transilluminate, which will differentiate it from other solid masses. Also, there is typically no associated erythema or warmth. People typically present for evaluation either due to pain, concern that the mass may be cancerous, or concern regarding cosmesis. Though over 80% of patients may report pain, less than 20% of these patients claim that the pain actually interferes with their activities of daily living.

Figure 27.11 shows the clinical presentation (a) and an intra-operative photograph (b) of distal wrist ganglion cyst.

27.6.6.4 Imaging

Radiographs of the involved area may be warranted to identify arthritis as a possible contributing factor to ganglion cyst development. Ultrasound imaging may be obtained to differentiate between a vascular malformation and ganglion cyst if the clinical exam is not conclusive. Advanced imaging is rarely indicated in the diagnosis of these cysts.

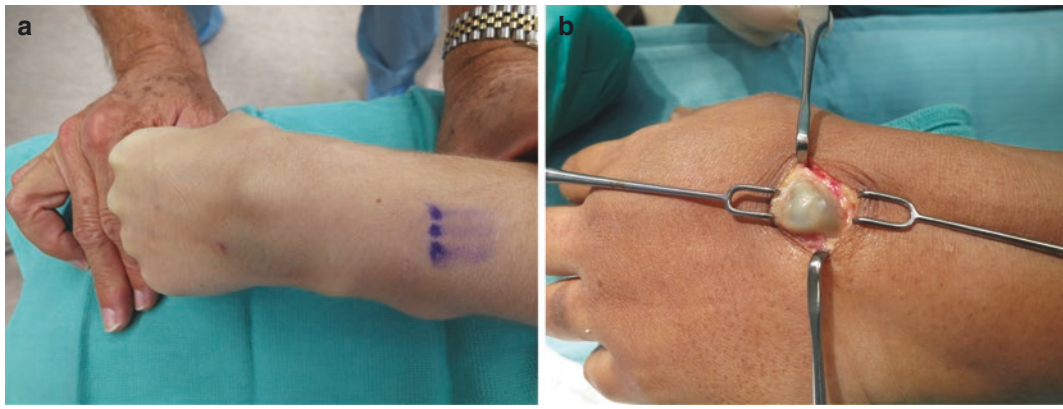

Fig. 27.11 Clinical presentation (**a**) and intra-operative photograph (**b**) of distal wrist ganglion cyst

27.6.6.5 Treatment

These are benign masses and do not inherently require treatment. Common reasons for pursuing treatment are cosmesis and pain that limits activities. Historically, ganglion cysts were treated with closed rupture, either with digital pressure or from the force of a book (hence, the historic name Bible cyst). Unfortunately, this method of treatment was found to have a recurrence rate of approximately 64%. The current mainstay of nonsurgical treatment is aspiration, though this too is associated with a high recurrence rate. Recurrence rates of 50–100% have been found for wrist ganglion cysts, with lower recurrence rates of 30–40% found with aspiration of volar retinacular ganglion cysts. The gold standard for treatment of ganglion cysts is surgical excision. The surgical technique includes excision of the cyst, pedicle, and a cuff of the adjacent joint capsule. With this technique there is a reported recurrence rate of less than 10% [68–70].

27.6.6.6 Complications

The main complication in ganglion cysts is recurrence. As previously discussed recurrence rate can be quite high, so a lengthy discussion with the patient regarding their goals of treatment should be had prior to offering any sort of intervention.

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