36 Wrist and Hand Dislocations and Fractures

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36.1 Distal Radius Fracture

36.1.1 Synonyms

- Colles' fracture
- Smith's fracture
- Barton's fracture
- Fracture of the forearm

36.1.2 ICD 10 Code

S52.50–S52.59

36.1.3 Description

Anatomy The distal radius has two articulations, the distal articular surface, which articulates with the scaphoid and lunate, and the sigmoid notch, which articulates with the head of the ulna [1, 2, 10]. These joints are stabilized, respectively, by the volar extrinsic and distal radioulnar ligaments (Fig. 36.1), permitting axial load transmission. The metaphyseal cortex is relatively thin and susceptible to fracture, particularly in the setting of osteoporosis.

Distal radius fractures are among the most common orthopedic injuries, accounting for 20% of all fractures seen in the emergency department [1]. The injury is equally likely to occur in both males and females, with the vast majority being the result of a traumatic incident in which the patient falls onto an outstretched hand [1–4]. There is a bimodal age distribution, with fractures in younger patients typically the result of high-energy injuries and geriatric fractures the result of low-energy falls. The Colles' fracture, an extra-articular, dorsally angulated, shortened fracture, is the most common type [1]. Fractures can also involve the articular surface (intra-articular fractures), which can predispose to arthritis if displaced [1, 5]. Of note, over 50% of distal radius fractures are associated with fracture of the ulnar styloid, with possible disruption of the radioulnar ligaments [2, 6–9]. Closed reduction and cast treatment are usually adequate for simple fracture patterns in younger patients. Comminuted (multi-fragmentary), displaced, intra-articular fractures are often best treated surgically. The most common long-term complication of this injury is malunion, which may result in chronic pain, wrist stiffness, and arthritis. Differential diagnosis for distal radius fracture is presented in Table 36.1.

36.1.4 Clinical Presentation

Patients sustaining distal radius fractures commonly report having fallen onto an outstretched hand. In the elderly, such fractures raise the suspicion of osteoporosis. Patients usually describe an acute onset of wrist pain and may have numbness and tingling in the median nerve distribution. They often will have difficulty moving the wrist and fingers.

36.1.5 Physical Examination

In addition to ruling out other associated trauma, physical examination of a patient with a suspected distal radius fracture involves a focused musculoskeletal examination.

Inspection The affected wrist may be grossly deformed, with swelling and ecchymosis. Examination for any lacerations or open wounds should be done circumferentially to exclude an open fracture.

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S. A. Mostoufi et al. (eds.), *Clinical Guide to Musculoskeletal Medicine*, https://doi.org/10.1007/978-3-030-92042-5_36

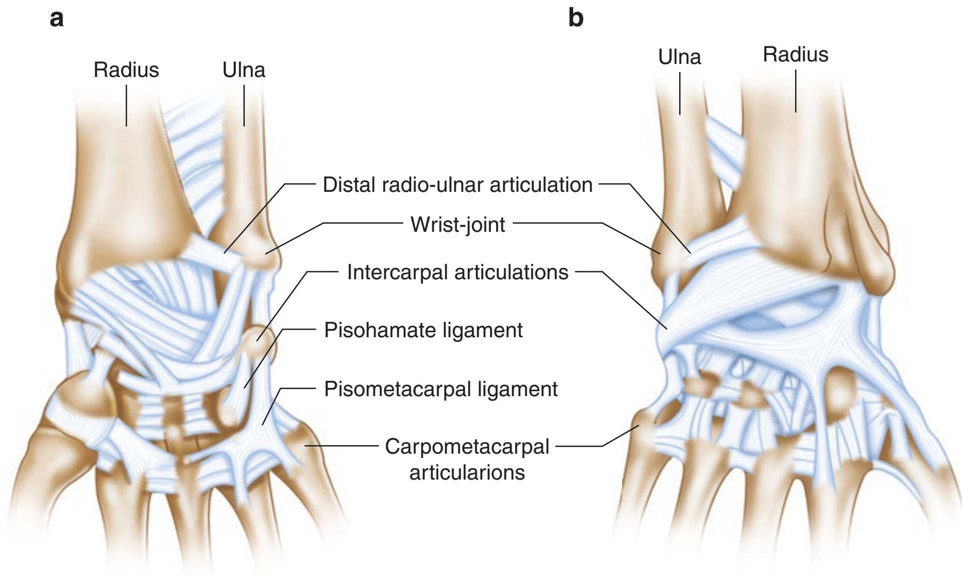

Fig. 36.1 Volar (**a**) and dorsal (**b**) views of the wrist with associated ligamentous attachments. (Courtesy of Williams et al. 2020)

Table 36.1 Differential diagnosis for distal radius fracture

Scapholunate ligament tear
Scaphoid fracture
Kienbock's disease
Extensor tenosynovitis
Lunotriquetral tear

Palpation Tenderness is present, particularly over Lister's tubercle. Patients typically have intact distal pulses and capillary refill.

Neurovascular Sensation to the hand is normally intact, although numbness in median nerve distribution can occur due to contusion of the median nerve or compression due to swelling in the carpal tunnel. The hand should be warm and well perfused, but checking the radial and ulnar pulses is a must with any wrist fracture.

Strength Strength is likely to be diminished due to pain and fracture instability.

Range of motion Wrist motion is often limited due to pain. Patients usually retain the ability to manipulate their fingers although many will endorse pain due to finger flexor and extensor tendons crossing near the fracture site.

36.1.6 Diagnostic Workup

Radiographs

Routine X-ray evaluation of a suspected distal radius fracture includes posteroanterior (PA), lateral, and oblique views (Fig. 36.2) [1, 11]. The images are scrutinized for displacement, including angulation, translation, comminution, shortening, and intra-articular extension. If a reduction maneuver is performed, repeat radiographs are obtained to evaluate the adequacy of the reduction [1].

Computed Tomography

Computed tomography (CT) provides an enhanced level of detail over plain radiographs and may be useful in complex cases, occult fractures (Fig. 36.3), or those with significant articular involvement and displacement [1]. The CT scan can inform the surgeon as to the best approach and method of fixation for a given fracture.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is not typically used in evaluating acute distal radius fractures. However, this modality may be of benefit in evaluating concomitant soft tissue injuries, such as scapholunate ligament or triangular fibrocartilage tears, or occult fractures. [1, 11]

36.1.7 Treatment

The goal in treating distal radius fractures is to achieve appropriate alignment to preserve wrist and hand function. This can be achieved through both operative and nonoperative means depending on the fracture pattern, bone quality, adequacy of reduction, and articular involvement.

Medical Management

Immobilization is the mainstay of treatment for distal radius fractures. Nondisplaced fractures can be treated with immobilization alone, typically with a plaster splint acutely and subsequently transitioned to a cast after a few days once the swelling has subsided. For displaced fractures, closed reduc-

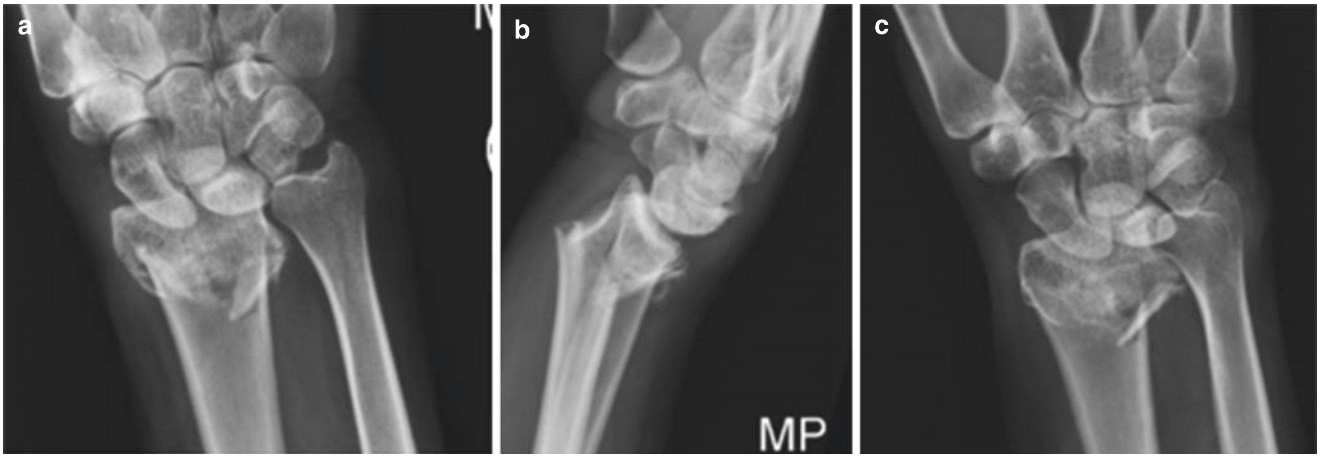

Fig. 36.2 PA (**a**), lateral (**b**), and oblique (**c**) radiographs demonstrating a comminuted, dorsally displaced distal radius fracture. (Figures from author's library)

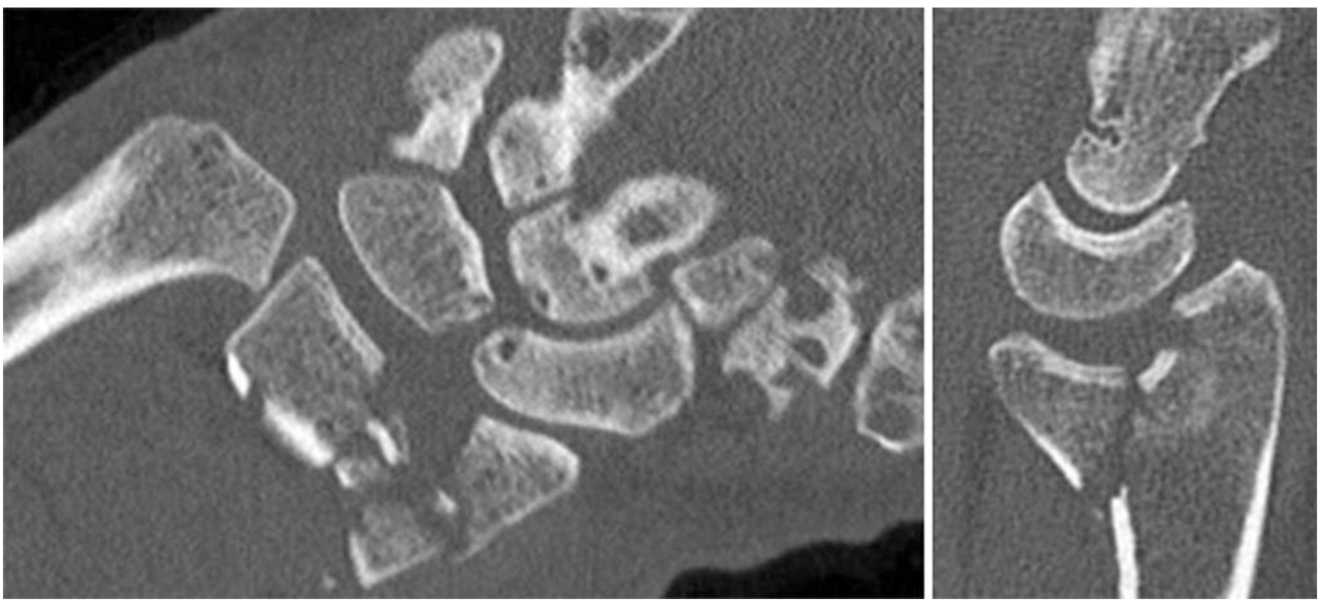

Fig. 36.3 Coronal (left) and sagittal (right) CT images of a comminuted intra-articular distal radius fracture. (Figures from author's library)

tion and splinting are performed acutely. It is important to monitor these patients with weekly serial radiographs for the first 3 weeks to evaluate for loss of reduction that may require surgical intervention. If reduction is maintained, the patient is transitioned to a short arm cast for an additional 3 weeks. The important parameters to evaluate include maintenance of radial height, volar tilt, and radial inclination; radiographs of the non-injured side can be obtained to gauge the patient's normal anatomy [12, 13].

Rehabilitation

There is much debate regarding the utility of formal therapy in the period following distal radius fractures [14]. The vast majority of studies on the subject have been of low quality, with limited participants and a high potential bias. Though physicians may favor a course of therapy to reduce pain and improve range of motion, there is not a clear benefit of formal therapy over a home exercise program. Formal therapy is usually reserved for patients who have delayed recovery of motion and function after a course of home exercises. The initial treatment is directed to edema control and restoration of digital motion. This is followed by strengthening, active-assisted, and passive motion of the wrist and forearm.

Procedure

In patients undergoing closed reduction of distal radius fracture, 32.2% patients developed complex regional pain (CRP) syndrome. Procedures to treat CRP may become relevant including sympathetic blocks and neuromodulation [55].

Surgery
Surgical options are described in the Chap. 37. Indications include persistent displacement after attempted closed reduction, open fractures, significant articular involvement, and acute carpal tunnel syndrome. Volar plate fixation is the most common surgical intervention, usually permitting earlier return to function and reducing the risk of post-traumatic osteoarthritis compared to nonoperative treatment [15–17].

36.2 Ulnar Styloid Fracture

36.2.1 Synonyms

Fracture of the distal ulna

36.2.2 ICD 10 Code

S52.611–S52.616

36.2.3 Description

Anatomy The most distal portion of the ulna, known as the styloid, is a protrusion that serves as an attachment point for the triangular fibrocartilage complex (TFCC), including the palmar and dorsal radioulnar ligaments (Fig. 36.4), which is responsible for providing stability to the distal radioulnar joint (DRUJ) [21, 22]. The ulnocarpal ligaments also originate from this area. The ulnar styloid serves as an attachment point for the ligamentous stabilizers of the distal radioulnar joint and ulnar wrist.

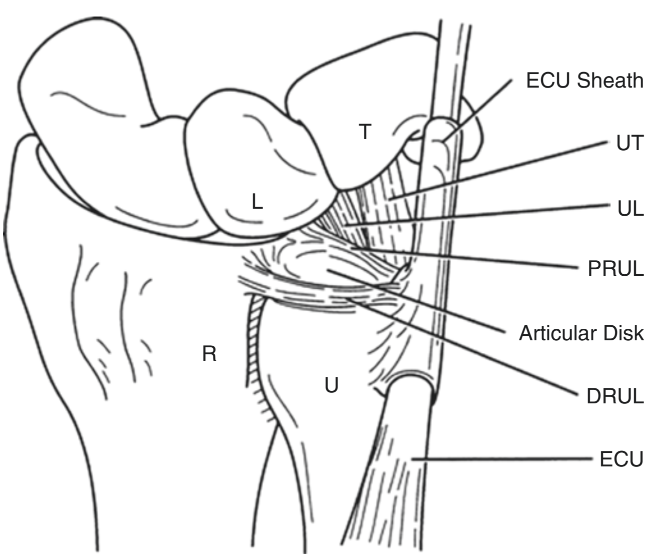

Fig. 36.4 Illustration of the wrist with the TFCC. R radius, U ulna, ECU extensor carpi ulnaris, DRUL dorsal radioulnar ligament, PRUL palmar radioulnar ligament, L lunate, T triquetrum, UL ulnolunate ligament, UT ulnotriquetral ligament

Table 36.2 Differential diagnosis for ulnar styloid fracture

TFCC tear
ECU subluxation/dislocation
Triquetral fracture
Lunotriquetral tear

The deep portion of the distal radioulnar ligament (DRUL) attaches to the fovea of the ulna. The superficial portion of the DRUL surrounds the articular disc at its apex and is integrated into the meniscus homologue. The attachment of the superficial ligament is poorly defined. The superficial ligament lies distal to the deep ligament. The tissue between and peripherally integrated into the ulnar aspect of the superficial ligament and the ulnar capsule is the meniscus homologue. The ligamentum subcruentum is between the deep portion of the DRUL and the meniscus homologue.

Ulnar styloid fractures are usually associated with distal radius fractures and are the result of a fall onto an outstretched hand [6, 8, 9, 18, 19]. Isolated styloid fractures are rare but can be the result of direct trauma to the ulnar portion of the wrist [20]. Diagnosis is made with traditional radiographs. These fractures are usually treated nonoperatively. Fibrous unions are relatively common and are often asymptomatic. Surgery is reserved for ulnar styloid fractures associated with distal radioulnar joint instability [19, 20]. Differential diagnosis for ulnar styloid fracture is presented in Table 36.2.

36.2.4 Clinical Presentation

Many patients with ulnar styloid fractures present with wrist pain in the hours after a fall onto an outstretched hand [1, 3, 18, 23]. A majority of these patients have an associated distal radius fracture [6, 8, 9, 18, 19]. Individuals with acute isolated ulnar styloid fractures will describe a recent direct blow to the ulnar portion of the wrist or a forced radial deviation injury [20]. In cases of nonunion, the patient may report a history of a prior distal radius fracture.

36.2.5 Physical Examination

In addition to ruling out other associated trauma, including distal radius fractures, physical examination of a patient with a suspected ulnar styloid fracture involves a focused musculoskeletal examination.

Inspection Obvious deformity may be seen as a result of an associated distal radius fracture, including swelling and ecchymosis. In cases of chronic ulnar styloid fractures, the wrist may appear normal or there may be a prominence of the ulnar head.

Palpation Tenderness is present over the region of the ulnar styloid. Laxity may be present with stress of the radioulnar joint.

Neurovascular Sensation to the hand is normally intact, though numbness in the median nerve distribution may be present due to compression from swelling in the carpal tunnel. Patients may report vague numbness in the ulnar nerve distribution from an isolated ulnar styloid fracture. As noted, checking pulses and warmth of the hand and wrist, and comparison to contralateral side, is imperative if someone has sustained an injury such as a fracture.

Strength Strength may be decreased due to pain.

Range of motion Wrist motion, including forearm rotation, may be decreased due to pain. Patients usually retain the ability to manipulate their fingers without issue.

36.2.6 Diagnostic Workup

Radiographs
Routine evaluation of a suspected fracture of the ulnar styloid includes plain radiographs of the wrist with posteroanterior (PA), lateral, and oblique views [20] (Fig. 36.5).

Computed Tomography
CT provides an enhanced level of detail over plain radiographs and may be useful in more complex cases of ulnar styloid fractures where the plan radiographs are inconclusive or in cases where the physician may require a greater level of detail [20].

Magnetic Resonance Imaging
MRI may be useful in diagnosing concomitant soft tissue injuries that may be in the differential for ulnar-sided wrist pain. These include but are not limited to TFCC tears or extensor carpi ulnaris (ECU) tears or subluxation.

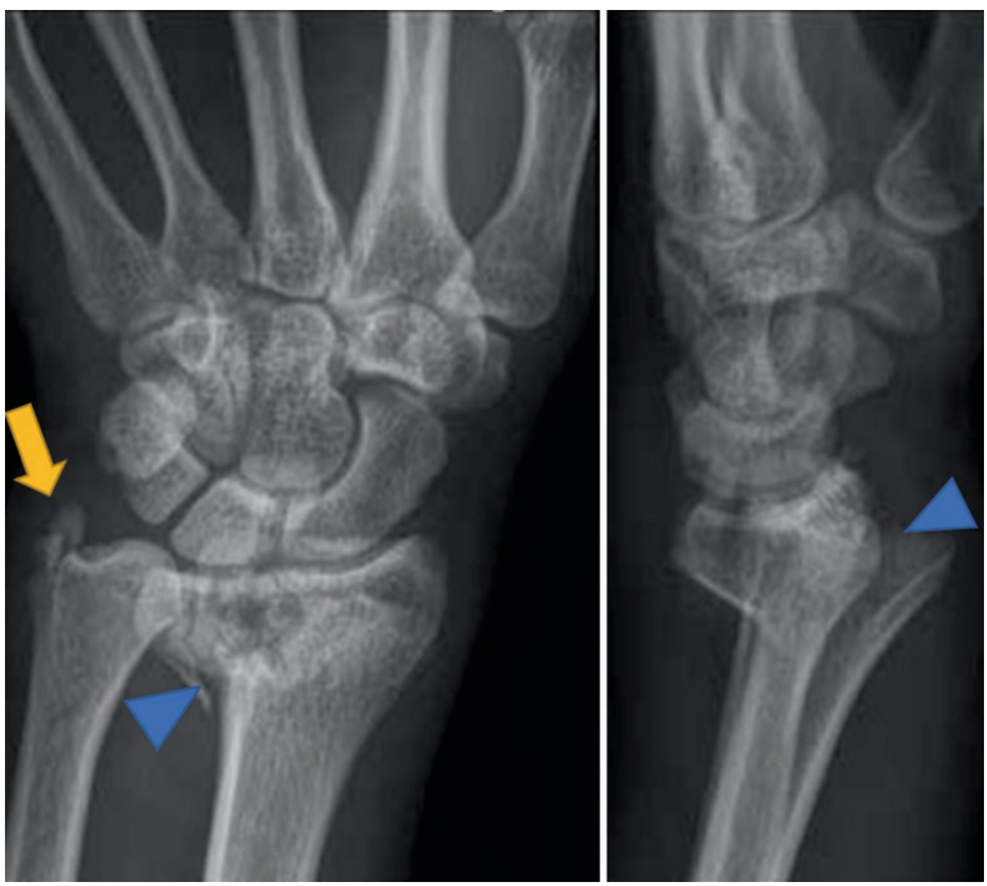

Fig. 36.5 PA and lateral radiographs of distal radius fracture (triangle) with dorsal displacement with associated ulnar styloid fracture (arrow). (Used with permission from Springer publication, Chen AC et al., Indian J Orthop. 2017;51 (1):93–98)

36.2.7 Treatment

For the majority of ulnar styloid fractures associated with distal radius fractures, the major focus of attention is on the distal radius. [9, 18, 19] In many instances, reducing the radius will simultaneously reduce the ulnar styloid, though nonunion is still possible [17, 20]. The ulnar side of the wrist tends to be painful for several months after the distal radius is healed [17, 23, 25–31].

Medical Management
Splint or cast treatment is typically below the elbow (e.g., a short arm cast), unless the injury is associated with distal radioulnar joint instability in which case a long arm or above the elbow cast is indicated [7, 27].

Surgery
Surgical options are described in the Chap. 37. Indications include concomitant distal radioulnar joint instability, which is more common with fractures at the base of the styloid rather than the tip [32]. Surgery may also be indicated in the treatment of symptomatic nonunion [20, 27].

36.3 Scaphoid Fractures

36.3.1 ICD-10 Codes

S62.00–03

36.3.2 Description

Anatomy The scaphoid has a complex three-dimensional anatomy that has been described as a "twisted peanut." The term is derived from the Greek word "skaphe," meaning boat or skiff [36]. It is considered to be the most important carpal bone due to its function in bridging the proximal and distal carpal rows. Due to its complex shape, scaphoid fractures are difficult to diagnose and treat.

Scaphoid fractures account for 50–80% of all carpal fractures [33, 35] and typically result from a fall on an outstretched hand with hyperextension of the wrist. They commonly occur in young, active adult males [35]. Diagnosis can be difficult as initial radiographs may be negative and many patients do not present immediately. CT or MRI may be necessary to confirm a suspected fracture. Untreated scaphoid fractures may result in wrist arthritis later in life. Treatment options range from cast immobilization for non-displaced fractures to open reduction internal fixation with or without bone grafting for displaced fractures and nonunions.

The scaphoid is predominantly covered with articular cartilage (80%) due to its numerous articulations with the distal radius, lunate, capitate, trapezium, and trapezoid [34, 36]. As a result, there are very few points of entry for the blood supply, mainly through the non-articular dorsal ridge and the distal tubercle (Fig. 36.6). Consequently, proximal pole fractures are more prone to osteonecrosis and nonunion due to the retrograde blood supply. The stability of the wrist is dependent on the integrity of the scaphoid. An unstable scaphoid fracture results in the typical "humpback deformity" (apex dorsal and radial), due to the ligamentous attachments of the proximal row. This results in extension of the lunate and subsequent dorsal intercalated segment instability (DISI). Differential diagnosis for scaphoid fracture is presented in Table 36.3.

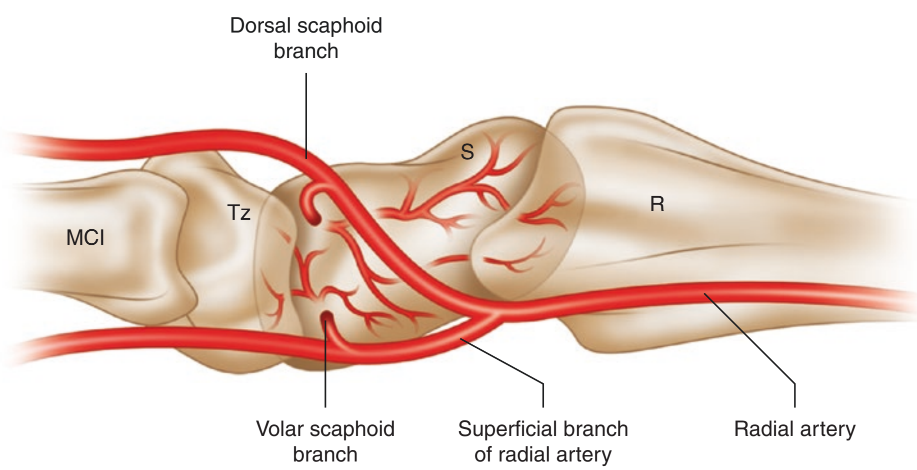

Fig. 36.6 Scaphoid blood supply. Most of the blood flow enters the scaphoid distally at the level of the dorsal ridge and through the proximal tubercle. Hence, fractures of the proximal pole may leave a segment of proximal bone with poor intrinsic blood supply and at risk of nonunion and avascular necrosis [34]. (Image adopted and modified by Yasmine from open access article by Jamie Corcoran et al. Surgical angiogenesis for scaphoid non-union: a literature review Vascular Cell. 2020; 12 (1):1)

Table 36.3 Differential diagnosis for scaphoid fracture

Distal radius fracture
Scapholunate ligament tear
De Quervain's tenosynovitis
First carpometacarpal dislocation

36.3.3 Clinical Presentation

Patients are typically young, active individuals. As with patient's age, the distal radial metaphysis is more likely to be the point of failure rather than the scaphoid for falls on an outstretched hand. Concomitant injuries are commonly seen, including distal radius fractures, fractures of other carpal bones, and associated perilunate injuries in cases of high-energy trauma. In the case of scaphoid nonunion, it is not uncommon for patients to present with wrist pain following a minor injury and report having had wrist trauma years earlier that was felt to be a "sprain."

36.3.4 Physical Examination

Evaluation of a patient with a suspected scaphoid fracture should involve the entire carpus and hand. Given the difficulty of diagnosis on a physical exam alone, any patient with a concern for occult scaphoid fracture should be immobilized until further imaging is obtained.

Inspection The affected wrist usually has deceptively little swelling. In the setting of a more severe trauma such as a trans-scaphoid perilunate injury, the wrist may be grossly deformed with swelling and ecchymosis.

Palpation Patients will have tenderness in the "anatomic snuff box," which is located between the tendons of the first and third extensor compartments, the abductor policis longus (APL)/extensor policis brevis (EPB) and extensor policis longus (EPL), respectively. Patients may also have tenderness on the volar aspect of the hand along the scaphoid tubercle.

Sensation Sensation to the hand is normally intact.

Strength Strength can be decreased due to pain.

Range of motion Wrist motion may be limited due to pain, particularly at the wrist and base of the thumb. Patients usually retain the ability to manipulate their fingers without issue.

Special Test

Special maneuvers include the compression test and pinching of the thumb and index finger in pronation. *Compression test*: Axial compression of the thumb or palpation of the scaphoid tubercle on the volar aspect of the wrist will elicit pain. Pinching of the thumb and index finger with the forearm in pronation may elicit pain [37].

36.3.5 Diagnostic Workup

Radiograph

X-rays should be obtained that include PA (Fig. 36.7) and lateral radiographs with the wrist in neutral position, oblique radiographs at 45–60° of pronation, and a posteroanterior radiograph with the wrist in 45° of ulnar deviation and pronation. X-rays tend to underestimate the true displacement of the fracture and will often miss nondisplaced fractures, with a false-negative rate as high as 25% [2]. If there is an obvious fracture line present on plain radiographs, the fracture is considered displaced. If no fracture line is evident, but there is clinical concern for a scaphoid fracture, there are two options. First, the patient can be placed in a short arm thumb spica cast for 10–14 days prior to repeat imaging. Second, advanced imaging such as CT or MRI can be obtained.

Magnetic Resonance Imaging (MRI)

MRI has been found to have a pooled estimate for sensitivity of 96% and specificity of 99% in many studies. [53] It prevents unnecessary radiation and prolonged immobilization in individuals that require their hands for work or sport. However, MRI can also "over diagnose" fractures as bone bruises can be difficult to distinguish from fractures. MRI is typically reserved for evaluation of concomitant ligament tears. It can also be used to assess vascularity of the proximal pole of the scaphoid.

Ultrasound (US)

US is becoming popular as an alternative for diagnosis as it is available in most emergency departments and clinics. Further, it can be quickly and safely performed while avoiding radiation exposure. US can diagnose scaphoid fracture with sensitivity of 85.6% and specificity of 83.3% based on a systematically review by Kwee et al [54].

36.3.6 Treatment

Treatment is dictated by the location of the fracture, degree of displacement, associated injuries, and patient-specific factors such as occupation or activity level. [39]

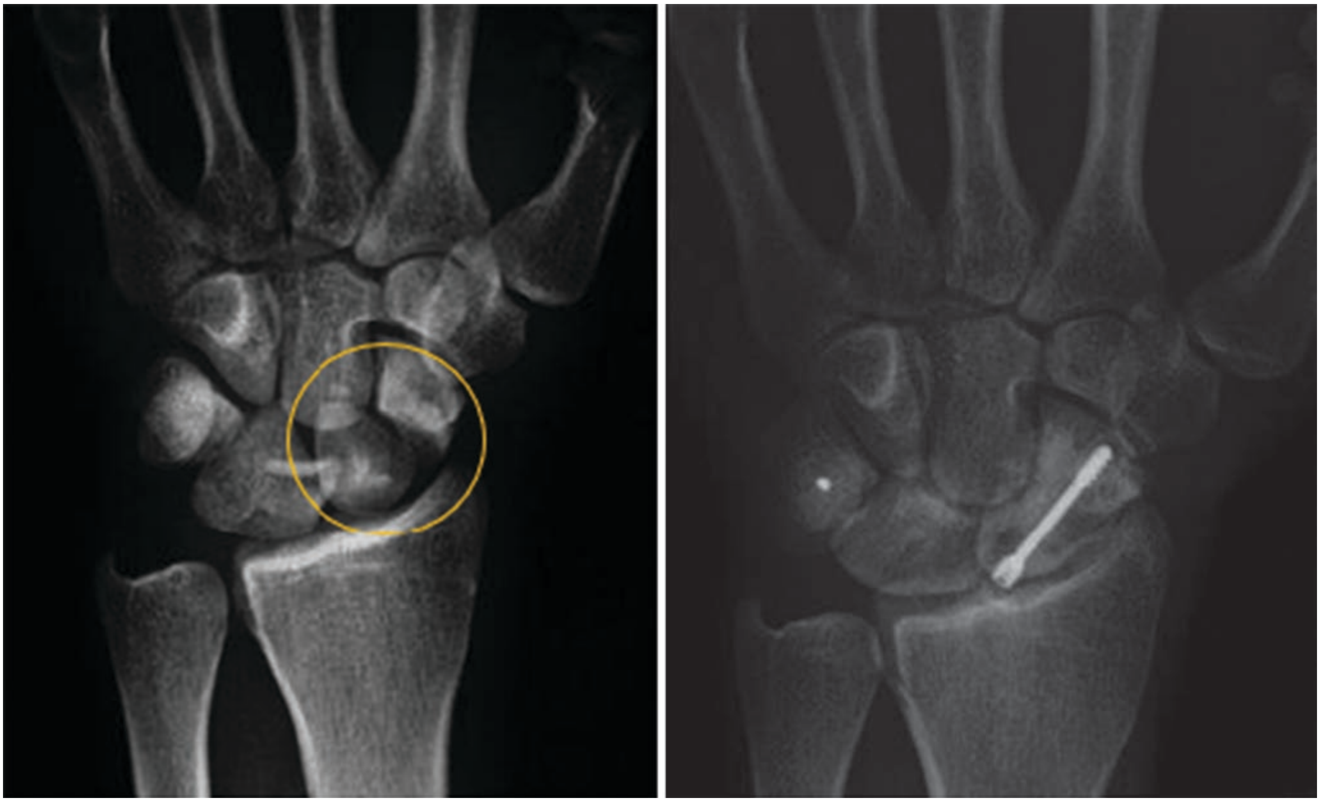

Fig. 36.7 Wrist PA X-ray at presentation showing a displaced scaphoid fracture with disruption of Gilula's arcs. A 20-month postoperative PA films suggesting scaphoid fracture union. (Used with permission, Springer publication, Orthop Traumatol. 2011;12 (3):159–162)

Medical Management

In addition to immobilization as described below, multiple adjunctive therapies have been described, including low-intensity pulsed ultrasound (LIPUS) and pulsed electromagnetic fields (PEMF), which have been used to stimulate bone growth. [35]

Immobilization

Nondisplaced, distal, and middle one-third scaphoid fractures can be managed with immobilization for 6–12 weeks in a short arm thumb spica cast. X-rays are taken at 3-week intervals until union is assured. CT may be helpful in equivocal cases. Approximately 95% of nondisplaced scaphoid waist and distal pole scaphoid fractures will heal with this form of treatment. Short-term complications related to cast treatment include stiffness, muscle atrophy, weakness, and pain.

Rehabilitation

After discontinuation of immobilization, therapy is first directed at restoration of range of motion in the wrist. The "dart thrower's" motion from wrist extension and radial deviation to wrist flexion and ulnar deviation appears to result in low stress across the proximal row of carpal bones. Once motion is reestablished, the next phase includes wrist and forearm strengthening prior to resumption of unrestricted activity.

Surgery

Surgery is reserved for displaced scaphoid fractures and proximal pole fractures and for patients that require skilled use of their hand and earlier return to function. [39] Athletes typically undergo surgery more commonly than non-athletes as operative fixation results in decreased immobilization time and quicker return to play [37]. Surgery results in faster union rate and approximately 1 month earlier return to full activity. Complications, while uncommon, include infection and hardware prominence.

36.4 Hook of Hamate Fractures

36.4.1 ICD-10 Codes

S62.141–156

36.4.2 Description

Anatomy As the name implies, there is a slight curvature in the hook, with the arc traveling from ulnar to radial as the bone progresses more volarly. This creates a smooth concave radial surface that allows for smooth gliding of the ulnar-sided finger flexors as they pass through the carpal tunnel. The hook is an ulnar attachment point for the transverse carpal ligament and the piso-hamate ligament. Similar to the scaphoid, the blood supply of the hook places it at risk for avascular necrosis. The more prominent vessels are at the radial base of the hook.

Hamate fractures are subdivided into body and hook fractures. In this section, we will detail the hook of hamate fractures (Figs. 36.8 and 36.9). The hook of the hamate is a bony prominence that projects volarly from the body of the hamate. These are uncommon carpal bone fractures, accounting for 2–4% of all carpal fractures [40, 41], and are difficult to diagnose given the often-delayed presentation and the lack of sensitivity of conventional wrist X-rays. Due to the vascular supply and biomechanical factors, complications include avascular necrosis, nonunion, ulnar-sided finger flexor tendonitis, and tendon rupture. Treatment options include immobilization alone, which rarely results in union, surgical excision, and open reduction and internal fixation [41, 42]. Differential diagnosis for the hook of hamate fracture is presented in Table 36.4.

36.4.3 Clinical Presentation

Acute fractures of the hook of the hamate result from either direct or indirect trauma. Direct injuries result from a fall, crush injury, or direct blow to the hook. Patients will describe vague pain in the hypothenar area of the palm or occasionally dorsally, aggravated by finger flexion or grip. In athletic activities that require the use of a handled object such as a racket, bat, or golf club, the butt of the handle can result in a fracture during a swing as a single event or from repetitive microtrauma [44]. Indirect injuries result from force transmission through its muscular and ligamentous attachments during a fall or from sudden wrist extension and ulnar deviation. Finally, forceful contraction of the ulnar finger flexors (small and ring finger) can cause a shear force at the base of the hook, thereby resulting in a fracture. Failure of healing is related to the tenuous blood supply and the repetitive stress of the ring and small finger flexor tendons against the radial side of the hamate hook.

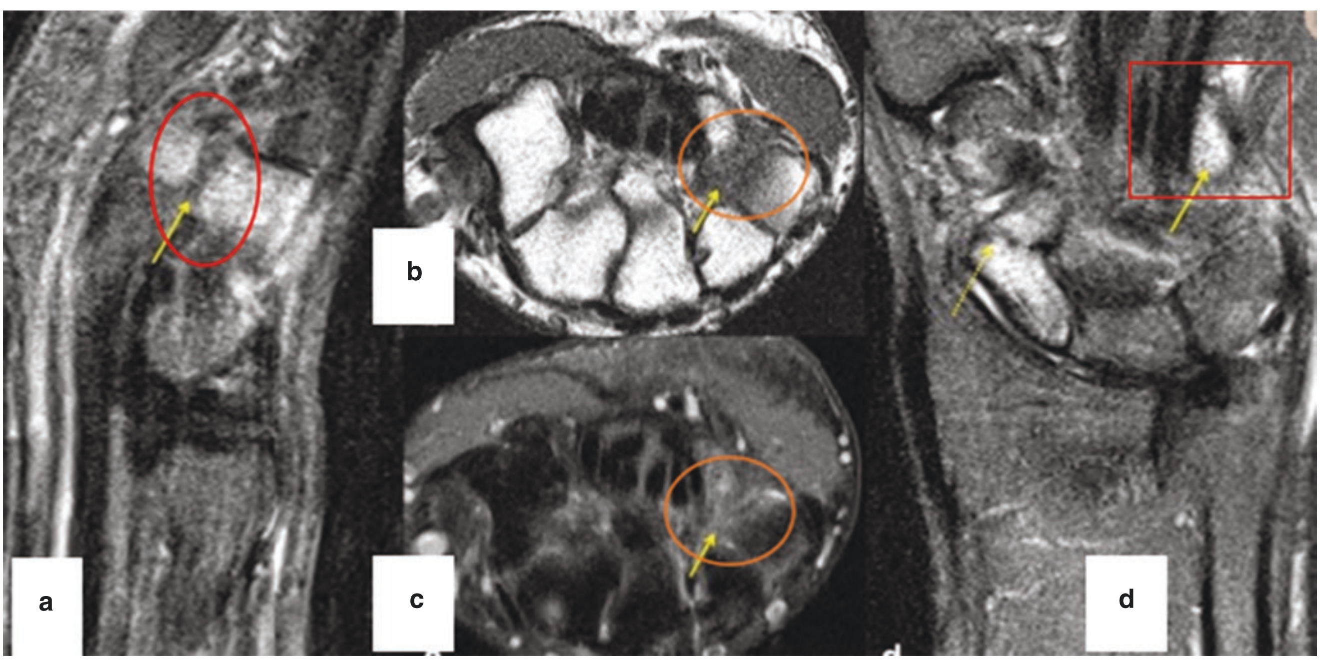

Fig. 36.8 MRI images of hook of hamate fracture and concomitant left scaphoid fracture. (**a**) Sagittal STIR shows significant marrow edema involving the hook and body of the hamate. (**b**) Hook of hamate fracture on axial T1. (**c**) Corresponding axial STIR sequences. (**d**) Coronal STIR sequences demonstrate marked edema with angulated fracture of the distal scaphoid pole (star) and marrow edema of the hook of hamate. (Image adopted and modified. Used with permission from Springer publication, Skeletal Radiology, 2018.47 (4) 505–510)

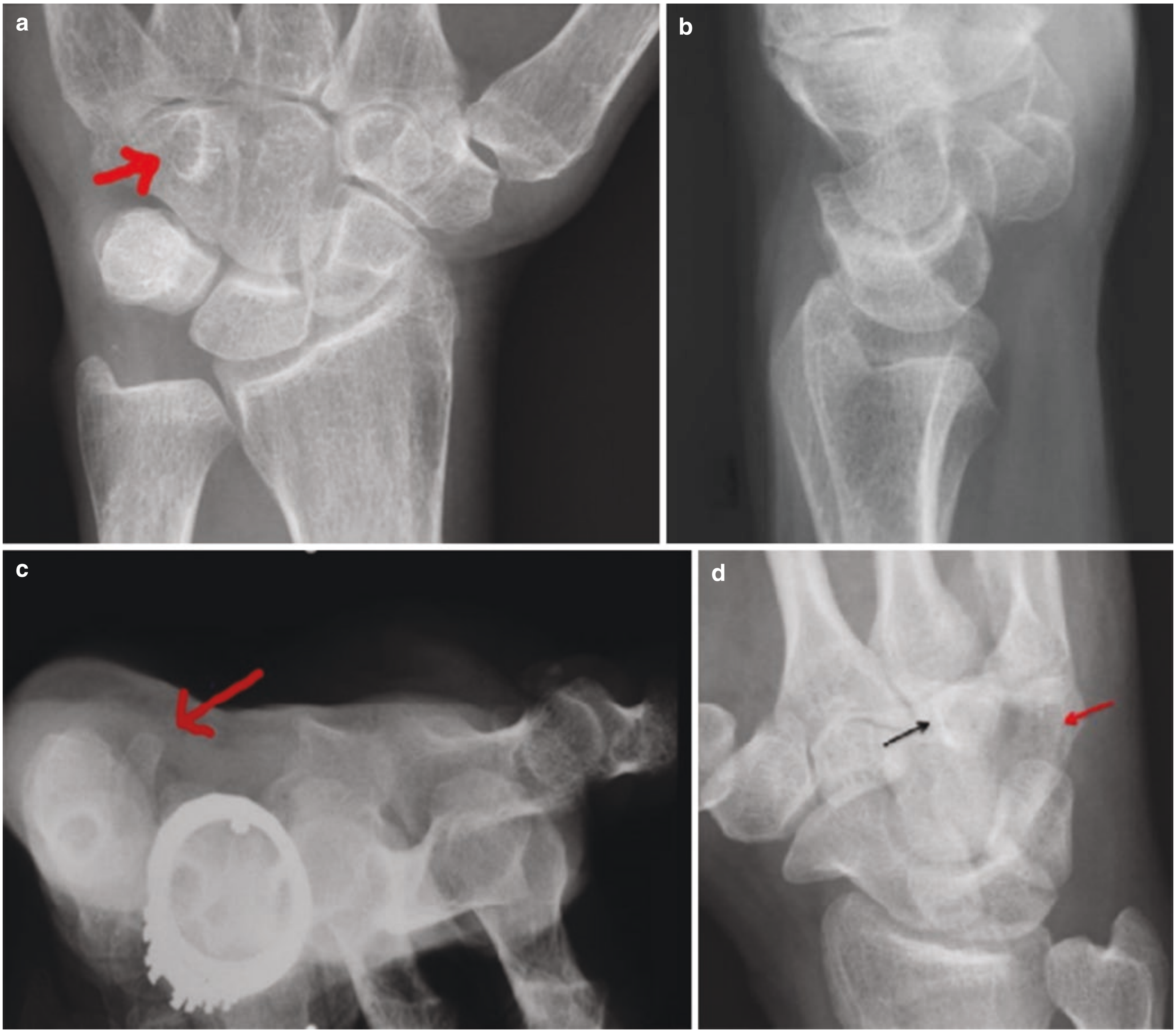

Fig. 36.9 (**a**) Shows posteroanterior (PA) view and (**b**) shows lateral wrist and carpal tunnel radiographs of a subtle hook of hamate fracture. The red arrow on the PA view demonstrates a "ring sign" or discontinuity of the cortical ring of the hook of hamate. The hook of hamate is difficult to visualize on the lateral radiograph. Although the hamate hook (arrow) is seen on the carpal tunnel view (**c**) the fracture is not apparent. (**d**) demonstrates a lucency projecting over the hamate in the expected location of the hook of hamate, i.e., "ghostly shadow" (red arrow). The black arrow in **d** shows the displaced hook of hamate. (Figures from author's library.)

Table 36.4 Differential diagnosis for the hook of hamate fracture

Pisiform fracture
Lunotriquetral tear
Triquetral fracture
Ulnar artery thrombosis
FCU tendinitis
Ulnar neuropathy

36.4.4 Physical Examination

Hamate hook fractures are usually isolated injuries. In the setting of crush injuries, however, there may be multiple fractures that deserve attention.

Inspection In athletes, there may be a callous in the palm directly overlying the hamate hook, the result of chronic pressure from the handle of a baseball or softball bat or hand-held racket. With acute trauma, there may be swelling, ecchymosis, and possibly damage to the overlying skin.

Palpation The location of the hamate hook in the palm is at the intersection between a line drawn along the fully abducted thumb and a line along the ring finger ray. Palpation in this area may demonstrate tenderness.

Sensation Patient may report paresthesias in the ulnar nerve distribution and, less commonly, the median nerve distribution.

Fig. 36.10 Axial and sagittal CT images of a patient with subacute fracture of the tip of the hamate hook. (Figures from author's library)

Strength Strength can be decreased due to pain, especially in the ulnar-sided finger flexors. On rare occasions, the deep motor branch of the ulnar nerve can be injured, resulting in intrinsic weakness.

Range of motion Wrist motion is usually preserved, except in cases of acute severe trauma. Chronic injuries can result in rupture of the flexor tendons to the small and ring fingers.

Special Test

Hook of hamate pull test: With the hand in an ulnarly deviated position and the wrist supinated, the patient is asked to flex the ulnar two digits against resistance. Since the hook of the hamate acts as a pulley for the ulnar digital flexors, this maneuver may gap the fracture site, resulting in pain [40, 42, 45].

36.4.5 Diagnostic Workup

Radiographs

Fracture of the hook of the hamate is often missed on standard radiographs [41]. If there is a strong suspicion for a hook of hamate fracture, a carpal tunnel view should also be obtained. There are many radiographic signs on X-ray that may suggest a hook of hamate fracture. These include the "ring sign" and "ghostly shadow," which refer to discontinuity of the hook of hamate cortical ring and non-visualization of the hook of hamate with a lucency in its expected location (Fig. 36.1), respectively. [2] "Diffuse sclerosis" can be seen in chronic hook of hamate fractures (Fig. 36.9).

Computed Tomography

CT scans are obtained in cases where there is a high suspicion of hook of hamate fractures, as plain radiographs may miss the fracture initially. Further, CT scan can give more details to the location and displacement of the fracture (Fig. 36.10).

Magnetic Resonance Imaging

MRI allows for definitive diagnosis and for the determination of any complications such as avascular necrosis. Further, MRI can be useful in diagnosis of stress fractures that may occur in swinging athletes. [41] Despite its limited utilization, MRI has the highest imaging detection rate (100%) compared to CT (92%), carpal tunnel view (43%), and plain radiographs (10%) [42].

36.4.6 Treatment

Management of hook of hamate fractures is controversial, and treatment options range from immobilization alone to fragment excision, open reduction, and internal fixation. Acute fractures resulting from severe trauma are usually treated initially with immobilization, and in contrast, chronic injuries in athletes are usually treated with hamate hook excision.

Medical Management

Unless there are associated flexor tendon ruptures, a trial of immobilization is appropriate for most of the hook of hamate fractures. Complications include persistent pain, nonunion, stiffness, delayed return to sport, and flexor tendon rupture. [46]

Surgery

Early surgery, usually involving hamate hook excision, is indicated for competitive athletes and chronic fractures associated with flexor tendon rupture [42]. Surgical options are described in the Chap. 37.

Rehabilitation

Following hamate hook excision, patients are generally able to return to competitive athletics at about 6 weeks postoperatively. The surgical site may be tender, and a silicone gel pad and alteration in grip of the racket or bat may be necessary in the short term.

36.5 Metacarpal and Phalangeal Fractures

36.5.1 Synonyms

Hand fractures, finger fractures, boxer's fracture

36.5.2 ICD-10 Codes

S62, multiple codes depending on which finger and/or phalanx

36.5.3 Description

Anatomy The five metacarpals articulate proximally with the distal row of the carpus and distally with the proximal phalanges of the digits. These bones are tubular and have a dorsal convexity. The second and third carpometacarpal joints have significantly less mobility than the fourth and fifth [1]. The wrist extensors insert into the bases of the second, third, and fifth metacarpals. These attachment points produce deforming forces in certain metacarpal fractures. Distally, the metacarpals serve as attachment points for a portion of the pulley system on the volar aspect that keeps the flexor tendons from bowstringing. The extensor tendons run dorsally along the metacarpal. The deep transverse metacarpal ligaments connect the volar plates of the metacarpophalangeal joints, forming a thick fibrous transverse arch linking the metacarpal heads.

The index, middle, ring, and small fingers each have three phalanges that form three articulations: the metacarpophalangeal (MCP) joint, proximal interphalangeal (PIP) joint, and distal interphalangeal (DIP) joint. The thumb has two phalanges that form two articulations: MCP and interphalangeal (IP) joint. There are numerous muscles, ligaments, and tendons that attach to the phalanges in the hand. The extensor tendons continue dorsally along the phalanges to their terminal insertion at the base of the distal phalanx of the index through the small fingers. The flexor digitorum superficialis and profundus tendons insert at base of the middle phalanx and distal phalanx, respectively.

Table 36.5 Differential diagnosis for metacarpal and phalangeal fracture

CMC, MCP, or PIP dislocation
Collateral ligament tear
Volar plate injury
Finger pulley rupture

Metacarpal and phalangeal fractures are common, accounting for 40% of upper extremity fractures [46, 47]. The proximal phalanx is the most common phalanx fracture, while the fifth metacarpal is the most common metacarpal fracture. [48] They result from direct or indirect trauma to the hand such as sports, industrial accidents, or falls from standing height. Management options include immobilization and surgical repair. Complications are common and include residual stiffness, malunion, nonunion, contracture, malrotation, loss of knuckle prominence, arthritis, and extensor lag. Differential diagnosis for metacarpal and phalangeal fracture is presented in Table 36.5.

36.5.4 Clinical Presentation

Clinical presentations for metacarpal or phalangeal fractures are variable but involve direct or indirect trauma. Patients may present after a fall on an outstretched hand, a direct blow from an object, or a punch to another object/individual. It is important to obtain an accurate history and mechanism of injury in the case of open wounds near the metacarpal head as these can reflect wounds from another person's tooth and change management as discussed below.

36.5.5 Physical Examination

Depending on the mechanism of the injury, there could be multiple hand fractures or associated ligament injuries. Therefore, a thorough assessment of the entire injured hand is imperative.

Inspection Swelling, ecchymosis, and skin damage may be present. The loss of knuckle contour, malrotation, or gross deformity may be present with angulated or rotated (Fig. 36.11). Nail bed injuries may disguise an open distal phalanx fracture. A break in the skin overlying the metacarpal head is suggestive of a "fight bite." [50]

Palpation Tenderness will be present in the area of the fracture or dislocation and bony crepitus may be palpable.

Sensation Sensation to the hand is normally intact although patients may report vague numbness or paresthesias in the affected finger. In penetrating, open, or crush injuries, there may be numbness indicating digital nerve injury.

Vascular Capillary refill should be assessed, and if there is a concern for decreased perfusion, the digital arteries should be assessed via Doppler. This is especially important in penetrating, open or crush fractures.

Strength Strength is decreased due to pain.

Range of motion Both passive and active range of motion can be decreased due to pain particularly in the affected finger although neighboring digits may also be affected. Cascade of the fingers should be examined. Rotational deformity can be assessed by asking the patient to make a fist or passively extending the wrist and observing for any abnormal finger overlap, non-parallel nails among the fingers, or any flexion and angulation not seen on the uninjured side [4]. Malalignment is poorly tolerated in these fractures [51]. Extension and flexion of each finger and individual joint should be assessed to determine any concomitant ligamentous injury.

36.5.6 Diagnostic Workup

Radiographs

Standard radiographs include PA, oblique, and lateral views (Figs. 36.11 and 36.12). When there is a concern for a fracture or dislocation of a phalanx, dedicated views of that finger alone can help better determine the degree of displacement or presence of any joint dislocation or subluxation.

Computed Tomography (CT)

CT scans are reserved for intra-articular fractures to better characterize the degree and location of joint involvement. Also, CT of severely comminuted fractures may help dictate management and surgical approach [51].

Magnetic Resonance Imaging (MRI)

MRI is rarely utilized in metacarpal or phalanx fractures except in cases where this is suspected ligamentous or tendinous injury such as in the base of the thumb ulnar collateral ligament (UCL) injuries. Plain radiographs are oftentimes unable to differentiate a purely bony avulsion fracture versus an associated ligamentous injury in these cases.

36.5.7 Treatment

Medical Management

Metacarpal fractures that have no rotational deformity and are extra-articular are amenable to non-surgical management with immobilization. Generally, metacarpal fractures that are more ulnar and distal can tolerate more degrees of angulation and are, thus, more amenable to immobilization. For example, metacarpal shaft fractures of the ring and small fingers can tolerate 30 and 40 degrees of angulation, respectively, while the index and middle fingers can tolerate 20 degrees of angulation [52]. In general, immobilization includes the fractured metacarpal and the neighboring digits to provide further stability. However, the literature varies drastically on the need to immobilize the wrist and the recommended degree of flexion of the metacarpophalangeal joint. Studies have shown equivalent outcomes regardless of the immobilization technique. [52]

If the fracture is displaced (typically apex dorsal), a reduction is performed using the Jahss technique, whereby the metacarpophalangeal joint and proximal interphalangeal joint are held in 90° degrees flexion while applying a dorsally directed pressure. Similarly, phalangeal fractures that have no rotational deformity and do not have significant articular involvement can be managed with immobilization. Depending on the finger and phalanx injured, immobilization can range from a finger splint to the neighboring digits or an intrinsic plus splint including the wrist/hand. For any dislocation, a reduction should be performed followed by immobilization and repeat imaging to determine the adequacy of the reduction.

Rehabilitation

Loss of digital motion can significantly impair function following hand fractures. Consequently, it is imperative to encourage the patient to move all joints that are not included in the splint or cast. The safe position for PIP immobilization is in full extension, whereas the safe position for the MCP joint is in full flexion, or the "intrinsic plus" position tendon gliding exercises are important in combined injuries. Supplemental splints, such as static progressive or dynamic finger extension splints, are often prescribed to restore PIP joint extension.

Surgery

The indications for operative treatment of metacarpal fractures include any rotational deformity, greater than 5 mm of metacarpal shortening, greater than 1 mm of articular step-

Fig. 36.11 Hand pain following a twisting injury to the middle finger. Inspection (**a**) demonstrates subtle ulnar deviation and pronation of the digit, which is magnified by tenodesis or passive extension of the wrist (**b**). (**c**) PA radiograph of the right hand demonstrates a spiral fracture of the third metacarpal. (**d**) Oblique radiograph of the patient demonstrates both a fracture-subluxation of the proximal interphalangeal joint and a distal phalanx "bony mallet" fracture

Fig. 36.12 Radiographs of a normal fifth metacarpal bone as compared to a fifth metacarpal fracture with angulation. (Images courtesy of Ali Mostoufi, MD)

off, or greater than 25% of articular involvement. Additionally, patient-specific factors are considered. Surgical options are described in the Chap. 37.

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