Fractures of the Hand

76

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Overview
The hands and fingers are common sites of trauma and fractures. These fractures are almost never life-threatening, but the hands are essential for many occupations and daily tasks; thus, hand trauma is often associated with significant disability and costs. Due to these factors, swift identification and management of any hand fracture or dislocation are critical to persevere function and ensure the best possible outcome.

76.1 Introduction

The bones of the fingers and hands are relatively fragile structures and very common sites of musculoskeletal trauma. Given the importance of the hands and fingers to the patient's livelihoods, prompt identification and correct management of finger and hand fractures are vital to avoid disability and retain function.

When there is a suspicion for hand fracture from history and physical exam, the radiograph is almost always the first-line modality for identification. Trauma radiographs should always be performed with at least two different views (generally PA and lateral) as one view is seldom optimal to determine the presence or the displacement of the fracture and preferably three views. Furthermore, it may also be beneficial to obtain radiographs for the ipsilateral wrist and forearm as the mechanism of injury for many hand fractures is concomitant with fractures in the proximal upper extremity. While radiographs are normally sufficient, there are some scenarios where obtaining a CT or MRI is the correct course of action. CT is often useful in the evaluation of fractures of the carpal bones as the multiple overlying structures in that area can make identifying fractures difficult by radiograph. Another common reason to obtain CT exams in hand trauma is for operative planning. MRI is also becoming increasingly relevant in the evaluation for fractures. Fractures can be radiographically occult, and MRI is the most sensitive modality for identification of fractures; however, its high cost prevents routine use.

Once radiographs are obtained, the first thing one should evaluate is the adequate positioning/quality and if the correct structures are profiled; for example, a common scenario is two fingers being buddy taped together, which severely limits evaluation of the clinical area of interest on the lateral radiograph. Another consideration is ensuring that the correct views are obtained, such as obtaining scaphoid views if there is a concern for scaphoid pathology. Once the quality of the

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UG. Longo, V. Denaro (eds.), *Textbook of Musculoskeletal Disorders*,
https://doi.org/10.1007/978-3-031-20987-1_76

scan is evaluated, many like to ascertain an overall sense of the pathology: Are there obvious fractures and diffuse soft-tissue swelling? Is the bone mineralization appropriate? After that, look at the mechanism of injury if available.

On frontal and oblique views, trace each of the bone cortices and check for small bone fragments. Then evaluate for the contour of the carpal bones and specifically the scaphoid, which should be smooth on these projections. On lateral radiographs, look for osseous fragments at the dorsal aspect of the hand, which may be seen in triquetral fractures and small osseous fragments about the digits, which should increase suspicion for avulsion injury. When evaluating for fractures, it is also important to note that nondisplaced fractures are easily overlooked and to be very suspicious of any abnormal lucencies or irregularities when trauma is involved. One common pitfall is that the most commonly missed fracture is the second one. If a fracture is identified, do not fall victim to "satisfaction of search" and be particularly vigilant for additional fractures or dislocations.

After assessing for fractures, assess for dislocations. On PA views, trace the three carpal arcs of Gilula (Fig. 76.1e). Assess for any abnormal overlap, such as those seen in carpometacarpal dislocations, and for loss of the clear joint space and disruption of the double-M-shaped pattern between the carpals and metacarpals. Assess the carpal bones to ensure that there are no abnormalities in shape. Look at the scapholunate interval, which should be less than 3 mm in adults. On lateral views, evaluate the shape of the scaphoid again, as these are commonly missed fractures, and ensure that there are no lunate or perilunate dislocations. Assess for dorsal or volar dislocations or abnormal angulations. Aside from assessing for fractures and dislocation, one should also evaluate for secondary signs of injury, such as soft-tissue swelling, subcutaneous gas, or deformities.

Scaphoid: Of the carpal bones, the scaphoid is the most common significant fracture in the setting of trauma. Its elongated structure bridges both the proximal and distal rows, which makes it particularly vulnerable to mechanical forces. In particular, the scaphoid bone is classically injured after a "fall onto outstretched hand" (FOOSH) where the wrist is hyperextended and deviated radially. It has an unusual blood supply where the perforating arteries enter the bone distally and flow proximally, which makes the proximal pole particularly vulnerable to osteonecrosis. Thus, it is critical to properly identify fractures in this location. Unfortunately, its oblique orientation relative to the remainder of the carpus causes fractures to be difficult to evaluate on standard PA and lateral radiographs (Fig. 76.1a–c). Even with dedicated scaphoid views, these fractures are often occult and require CT or MRI to identify (Fig. 76.1d).

Lunate and perilunate dislocation: Another commonly missed but potentially devastating injury of the carpal bones is a lunate dislocation. This happens commonly after high-energy trauma resulting in dorsiflexion of the hand. The lunate is dislocated volarly and primarily identified on the lateral radiograph (Fig. 76.2). These injuries require prompt management and surgical repair as the lunate can compress the median nerve when dislocated, causing neuropathy. Perilunate dislocation and perilunate fracture-dislocations (not to be confused with lunate dislocation) occur when there is a volar dislocation of the other carpal bones, usually the capitate, relative to the lunate, which remains in normal alignment with the radius (Fig. 76.3). These also happen in high-energy traumas with hyperextension of the hand with ulnar deviation (as opposed to radial deviation, which is associated with lunate dislocations).

Hook of hamate and trapezial ridge: Fractures of the hook of the hamate (Fig. 76.4) can be seen with direct blows to the hamate, which is most commonly seen in athletes such as golf or baseball players. These fractures are important to identify due to the adjacent Guyon's canal, which contains the fibers of the ulnar nerve and can result in ulnar neuropathy if damaged. Similar to the hook of the hamate, the ridge of the trapezium also extends volarly from the body and can also be injured from direct blows to the volar surface (Fig. 76.5). Both the hook of the hamate and trapezial ridge fractures are commonly over-

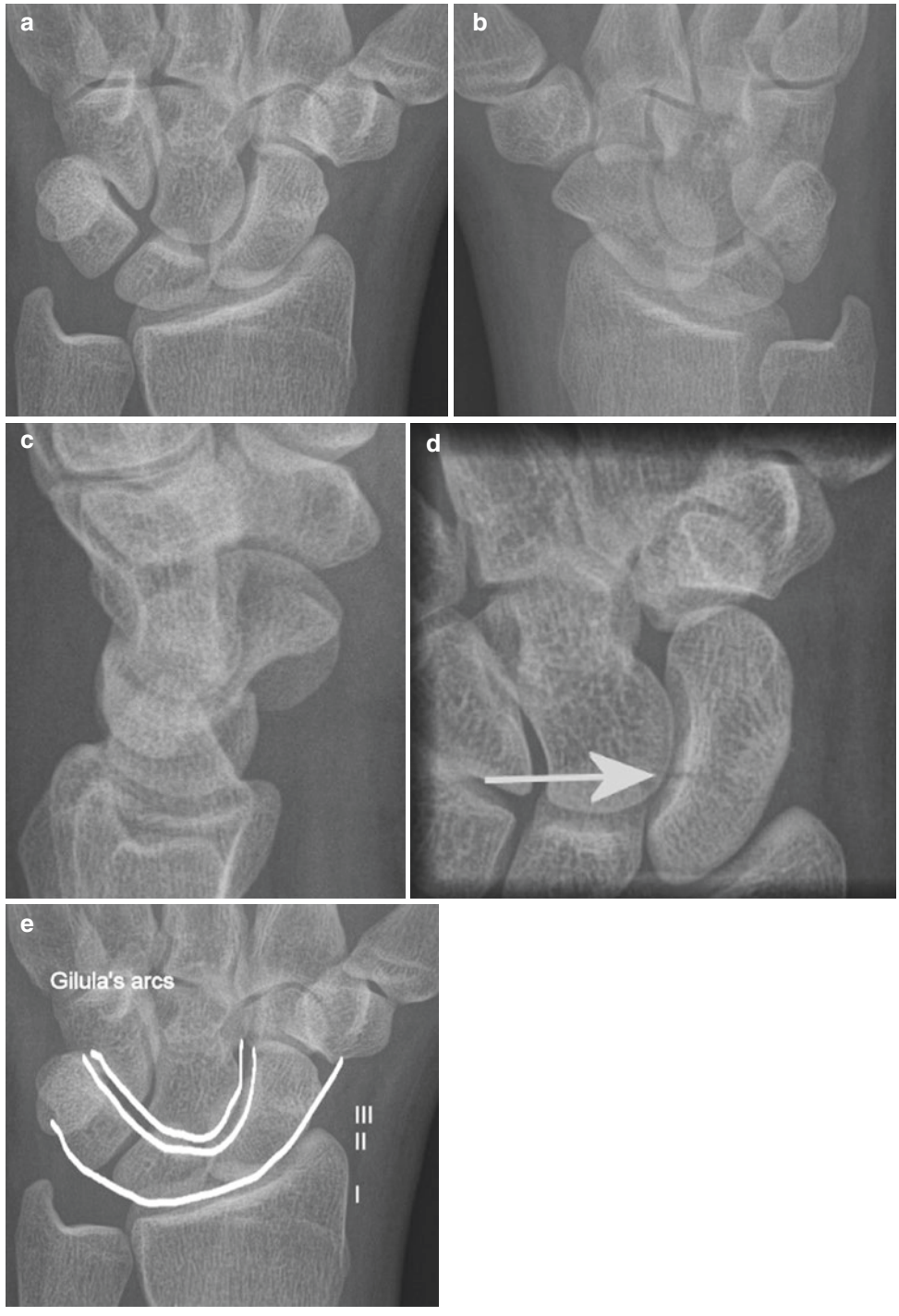

Fig. 76.1 Scaphoid fracture in a 19-year-old female. Traditionally, there are three views of the wrist, PA, oblique, and lateral (**a–c**). This example well demonstrates the need for a coned-down ulnar deviation view (**d**), which is the only view in which the proximal waist of scaphoid fracture is well demonstrated (white arrow). On PA view, one can follow the three carpal arcs of Gilula (**e**)

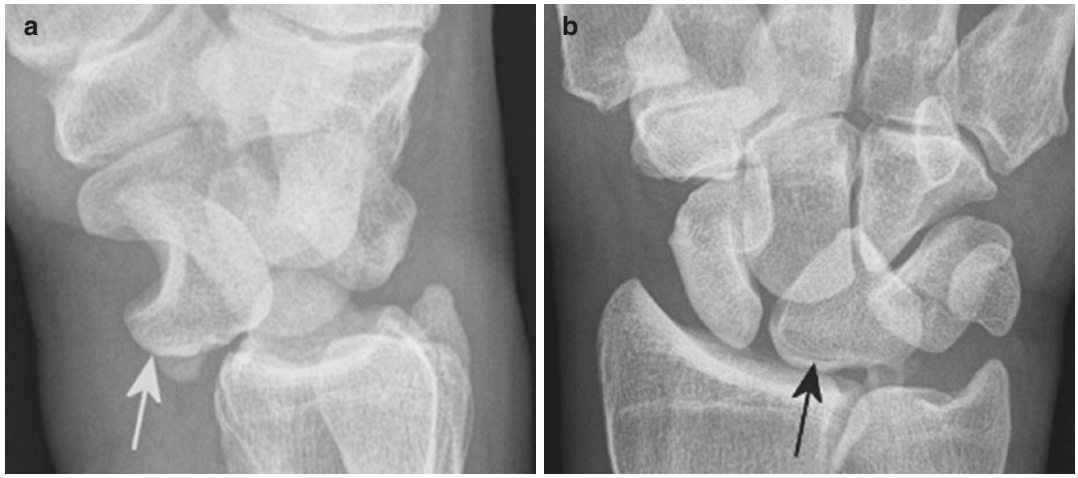

Fig. 76.2 Lunate dislocation. This is sometimes overlooked, because no fracture is seen, and the usually volar displaced lunate (white arrow) is mistaken for another carpal bone such as the pisiform (**a**). On the PA view (**b**), there is loss of the normal carpal rows and the usually lentiform shape of the lunate takes on a triangular shape (piece-of-pie sign, black arrow)

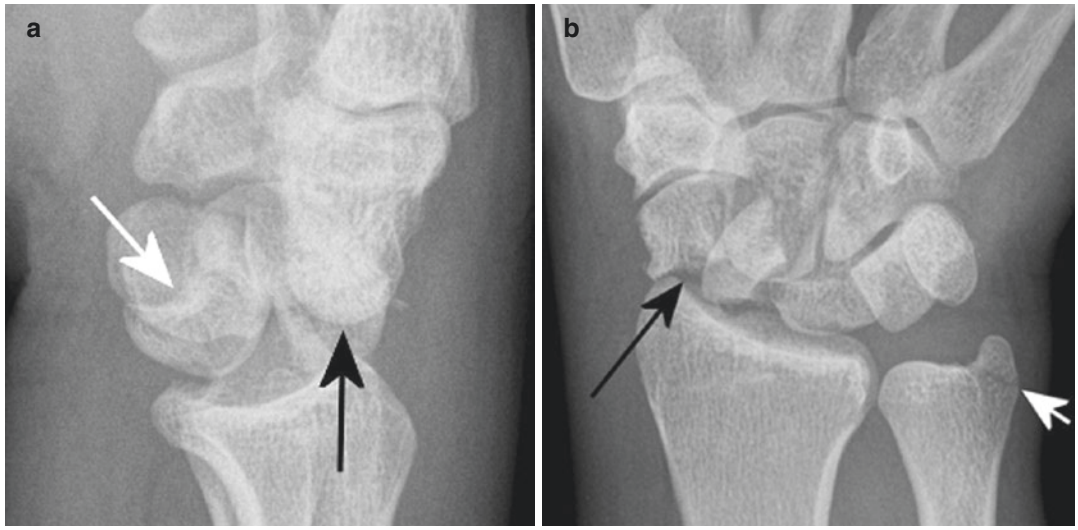

Fig. 76.3 Trans-scaphoid perilunate fracture dislocation in a 32-year-old man. The lateral view (**a**) shows the capitate (black arrow) dislocated posteriorly from the lunate (white arrow). On the PA view (**b**), the additional fractures of the ulnar styloid (white arrow) and waist of scaphoid (black arrow) are demonstrated, making this a greater arc injury

looked on routine radiographs. If there is clinical concern, a dedicated carpal tunnel radiograph should be obtained, which involves dorsiflexion of the wrist, so these structures are better profiled as the metacarpals and carpal bones will not overlap them on this view. Even with dedicated radiographs, these fractures can be difficult to see and a CT scan may be required.

Dorsal triquetral avulsion: After the scaphoid, the triquetral bone is the second most commonly injured bone in the carpus. The usual mechanism of injury is again fall onto out-

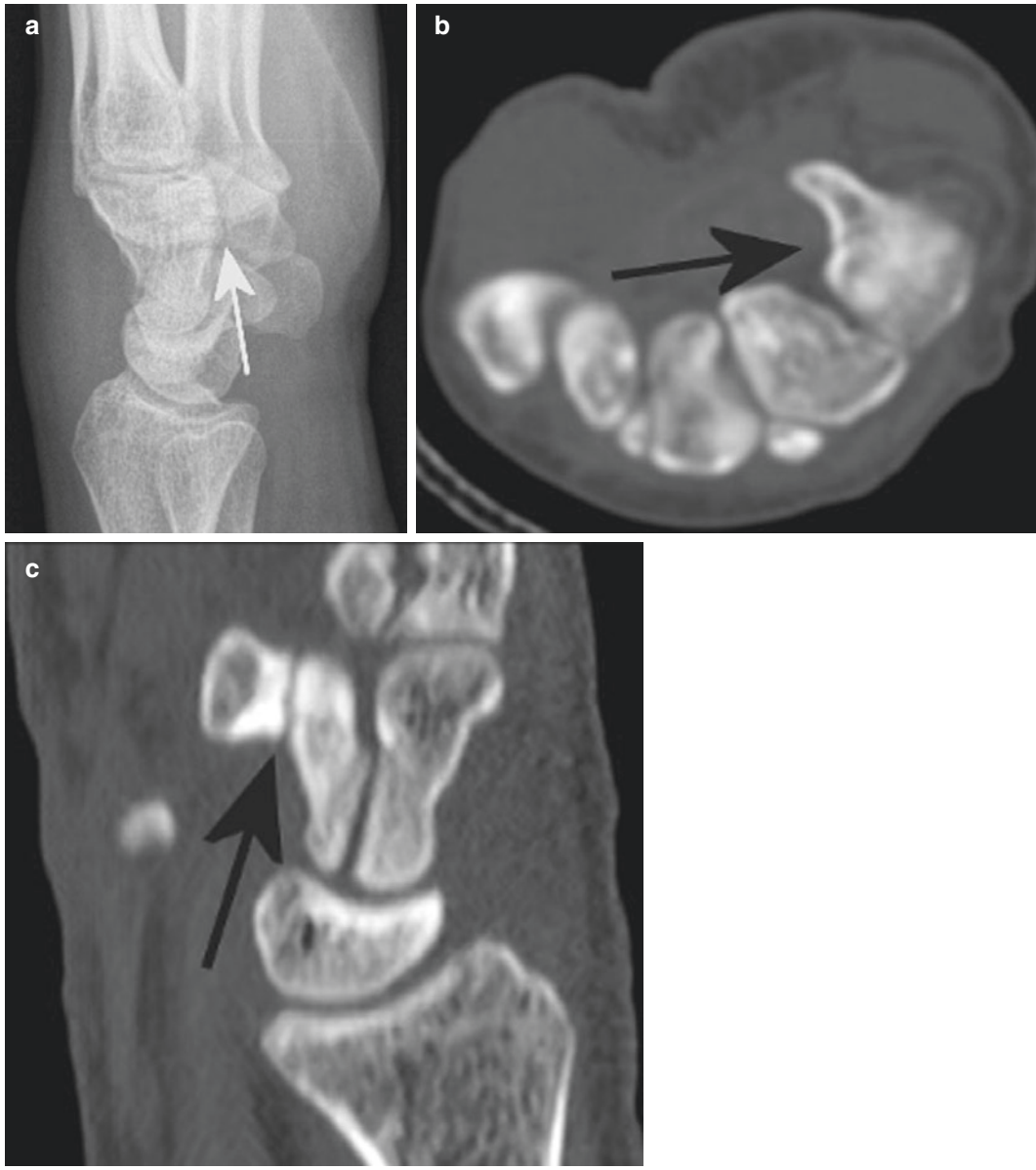

Fig. 76.4 Hook of hamate fracture. These fractures can be very difficult to see on conventional radiographs (**a**, white arrow) including carpal tunnel views, which are technically difficult. CT more clearly shows these on the axial (**b**, black arrow) or sagittal (**c**, black arrow) planes

stretched hand with hyperextension of the hand or less commonly a direct blow to the dorsum of the hand. Lateral radiographs are used to identify this avulsion fracture, where an avulsed flake of bone is seen lying posteriorly to the triquetral bone (Fig. 76.6). While surgical intervention is rarely required, these avulsion fractures can cause persistent (and painful) symptoms in some patients.

Base of thumb, Bennett, Rolando, and beak ligament avulsion: Given that opposable thumbs are one of the defining features of our species, it is not a surprise that the thumb is a common source of musculoskeletal injury. The majority of

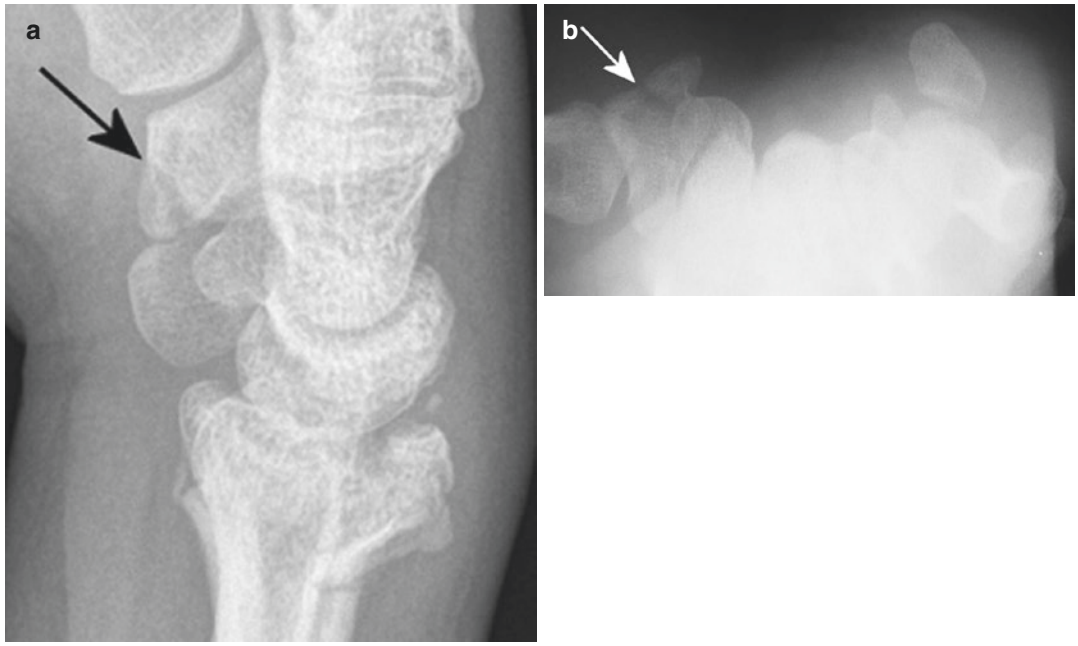

Fig. 76.5 Trapezial ridge fracture. Another fracture that may be difficult to identify. The lateral view (**a**) shows the fracture (black arrow), confirmed on the carpal tunnel view (**b**, white arow). Also note the distal radius fracture

Fig. 76.6 Dorsal triquetral avulsion fracture. A small fracture fragment is seen on the dorsum of the midcarpal region (black arrow)

thumb fractures have involvement of the metacarpal base. For example, a Bennett fracture is a fracture of the base of the first metacarpal after forced abduction. It is a two-piece fracture with intra-articular involvement where the small fragment of the first metacarpal remains attached to the anterior oblique ligament (beak ligament) and articulates with the trapezium while the shaft of the first metacarpal becomes retracted laterally by the now unopposed abductor pollicis longus tendon (Fig. 76.7). While usually the treatment consists of spica splinting, a large or unstable fracture may require surgical fixation. A Rolando fracture is a three-part fracture that involves a volar fragment remaining in place and articulated with the joint, while the main dorsal fragment subluxes dorsally and radially due to the unopposed pulling of abductor longus tendon. It is often thought of as a comminuted Bennett fracture where the fracture lines form a T or Y (Fig. 76.8). The mechanism of injury is typically an axial blow to the flexed first metacarpal, classically from a fistfight, which explains the significant young male predominance who present with

Fig. 76.7 An uncomminuted intra-articular Bennett fracture at the metacarpal base of the thumb (black arrow)

Fig. 76.8 Comminuted intra-articular Rolando fracture at the metacarpal base of the thumb (black arrow)

Fig. 76.9 Beak ligament avulsion. Similar to a very small Bennett fracture only avulsed by the deep anterior oblique ligament. These can be hard to see (black arrow)

this fracture. The anterior oblique ligament (beak ligament) can also be involved in a small isolated avulsion fracture, which can be hard to identify (Fig. 76.9).

Fourth and fifth carpometacarpal joint fracture dislocations: Carpometacarpal joint (CMCJ) fracture-dislocations are uncommon but very important factures to identify. They are usually associated with hand pain and swelling after throwing a punch, so they are commonly found in the young male demographic; however, they can be associated with falls as well. Loss of the clear joint space, disruption of the M-shaped joint space pattern between the carpals and metacarpals, and soft-tissue swelling on PA radiographs should increase suspicion for this pathology, which can then be confirmed on oblique or lateral radiographs, which should show abnormal positioning of the carpal metacarpal bones (Fig. 76.10). They are commonly associated with the base of the metacarpal fractures and less commonly hamate fractures. Once a dislocation is identified, it requires reduction and usually inter-

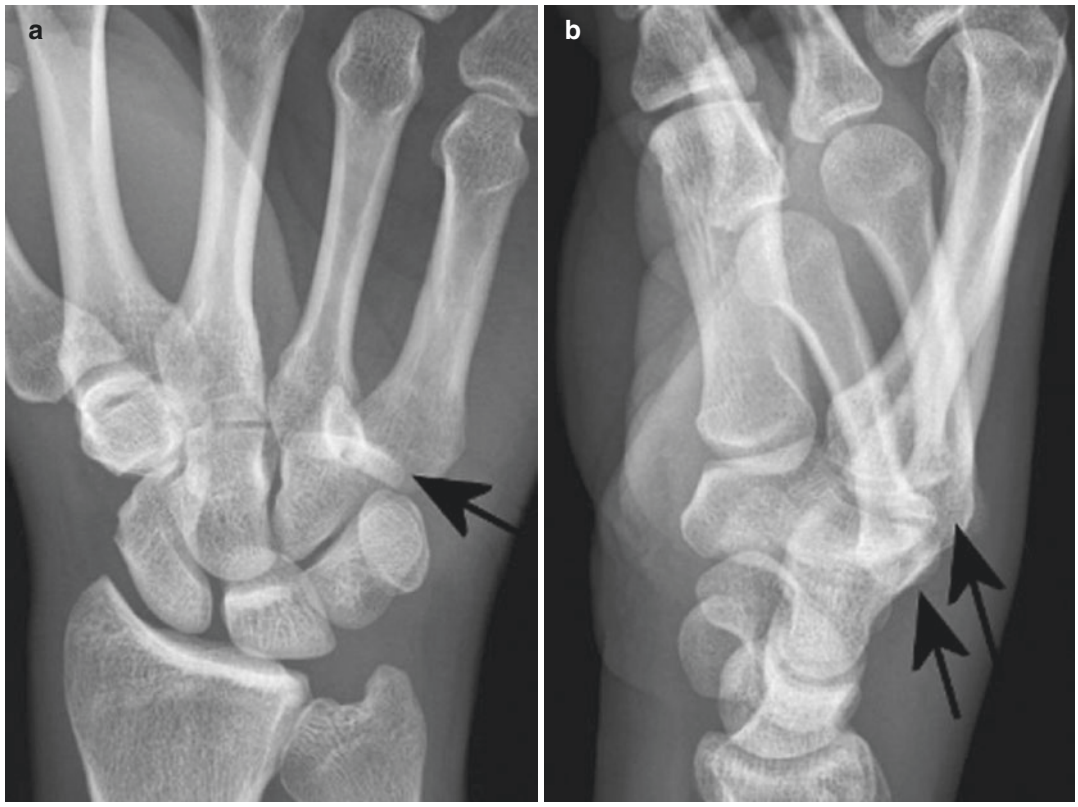

Fig. 76.10 Fourth and fifth carpometacarpal dislocations. Sometimes difficult to see on the PA (**a**) view, unless the overlap of the hamate and fourth and fifth metacarpal bases is appreciated (black arrow). On the lateral view (**b**), the loss of parallelism of the fourth and fifth metacarpals (black arrows) with the second and third metacarpals is a big clue that the fourth and fifth are dislocated. Look for the commonly accompanying dorsal hamate fracture

nal fixation as they are often unstable even after reduction. If it is associated with a metacarpal base fracture, the fracture will require reduction and possibly internal fixation.

Boxer's fracture: Among fractures of the metacarpals, the boxer's fracture, a minimally comminuted transverse fracture of the fifth metacarpal neck, is the most common. It is an impaction fracture that occurs after a direct blow to a solid surface (usually a face or wall) with a clenched fist, which causes axial loading and fracture of the fifth metacarpal, hence the fracture's namesake. It unsurprisingly has a predominance with the young male population. The fracture is usually easily identified on standard radiographs, but careful attention is given to other associated fractures, the degree of displacement, the amount of angulation of the fracture fragment, and the fracture planes (with transverse being the most common) (Fig. 76.11). These factors will determine if surgical management is required.

Fig. 76.11 The boxer's fracture (better described as a brawler's fracture due to poor technique) is a transverse fracture of the fifth metacarpal neck (black arrow), usually with volar and radial deviation of the head on the shaft, from a glancing blow contacting a hard surface, be it victim or wall

76.2 Gamekeeper's Thumb and Skier's Thumb

Damage to the ulnar collateral ligament (sometimes with a bony avulsion (Fig. 76.12)) of the metacarpophalangeal joint of the thumb has different names depending on the etiology of the injury. If the injury is from chronic/repetitive overuse, the injury is referred to as "gamekeeper's thumb" as gamekeepers would repeatedly break the neck of game using their thumb and index finger, eventually causing overuse and eventual tearing of the ligament. As its popularity waned, break dancers and then finally skiers became the most common population to have this injury, where skiers would fall with the pole straps in hand and accidentally cause hyperabduction of the thumb. These injuries can involve either partial- or full-thickness tears of the ulnar collateral ligament with or without an accompanying avulsion fracture. If no avulsion fracture is present, the patient may only have widening of the ulnar portion of the metacarpophalangeal joint on radiographs. If there is significant instability, displacement, or a Stener's lesion (interposition of the adductor pollicis muscle aponeurosis between the ruptured ulnar collateral ligament and its site of insertion on the base of the proximal phalanx, diagnosed with MRI or ultrasound), surgery may be required.

Phalangeal shaft, intra- and extra-articular: Fractures of the phalangeal shaft are an extremely common fracture type, with the distal phalanges and fifth digit being the most common. Everyone reading this book has had experience where they have had their finger jammed in a car door or had something dropped on their fingers. Notably, these fractures are common in workplace accidents and can result in significant disability. Once a fracture is identified, one should pay careful attention to the degree of displacement, the amount of angulation, and whether there is intra-articular involvement (Fig. 76.13). If there is significant displacement and intra-articular involvement, these fractures often require operative intervention.

Volar plate, without and with finger dislocations: The volar plate, particularly the volar plate attachment of the proximal interphalangeal joint (PIP), includes areas that are vulnerable to fracture with hyperextension of the distal finger. This hyperextension causes avulsion by the volar plate at the base of the middle phalanx (Fig. 76.14). Usually, there is instability and risk of dorsal dislocation due to much of the stabilizing collateral ligaments of the interphalangeal joint being attached to the avulsed fragment. When characterizing these fractures, the Eaton classification is often used, which evaluates the size of the avulsed fragment (specifically the portion of articular surface), degree of impaction, and direction of dislocation. Depending on these factors, surgical management may be required.

Mallet fractures: In contrast to volar plate fracture, mallet fractures are avulsion fractures

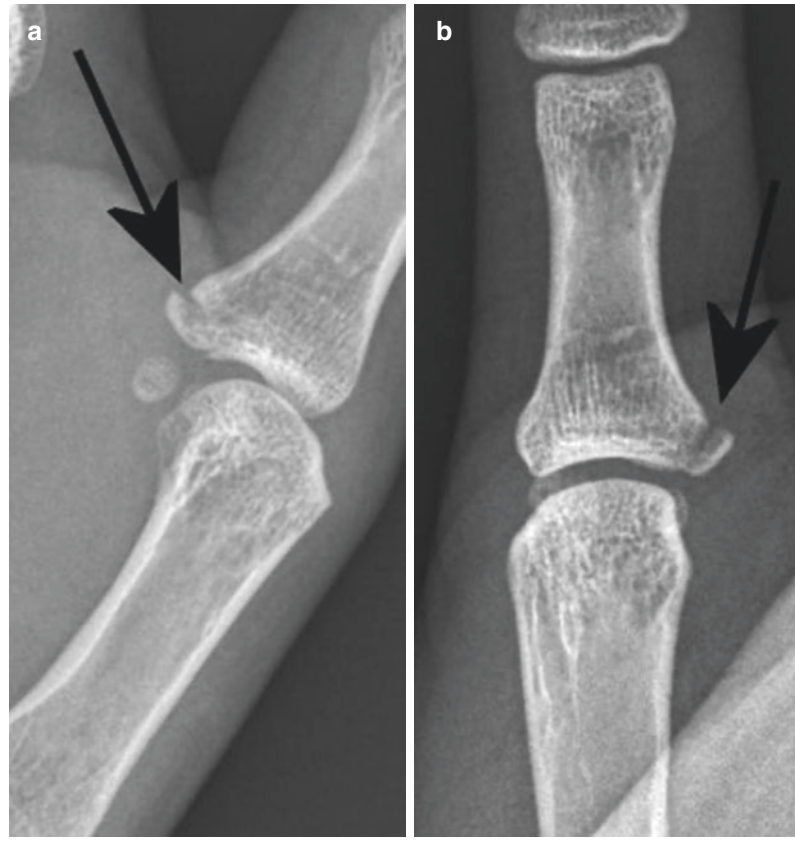

Fig. 76.12 Ulnar collateral ligament avulsion of the thumb metacarpophalangeal joint. The ulnar/medial collateral ligament is prone to injury with repetition (gamekeeper's thumb) or acutely (skier's thumb). 40% of the time, a bony avulsion will occur, usually from the proximal phalangeal base (a Lat, b PA). When undisplaced, this will heal well. When proximally displaced to the medial side of the adductor aponeurosis, surgical reduction is necessary

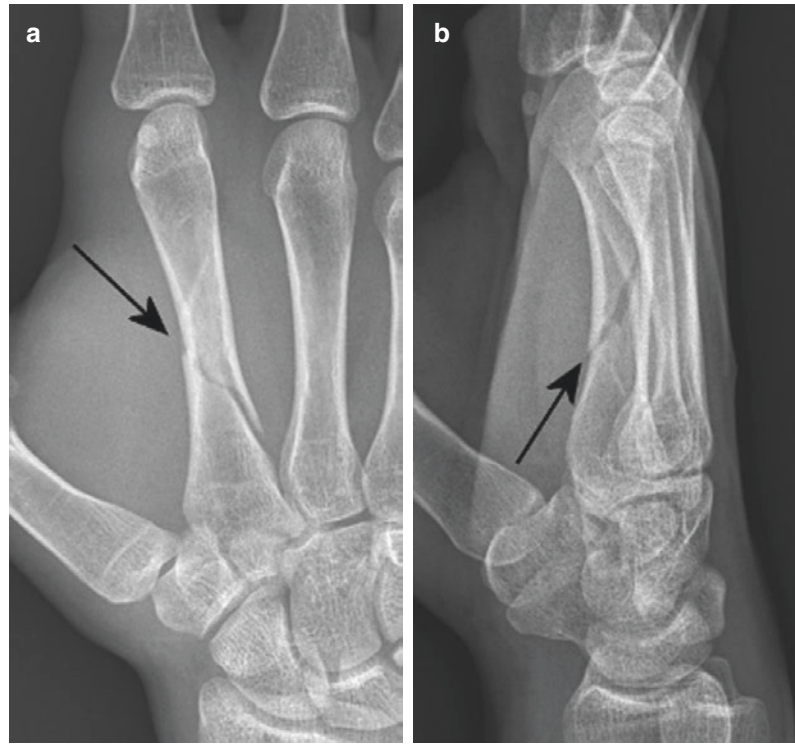

Fig. 76.13 Spiral fracture of the metacarpal shaft. A spiral fracture is one which is oblique on two views at right angles to one another (a PA, b lateral). The main thing to look for is extension into an adjacent joint, which may require surgical anatomic reduction

Fig. 76.14 Volar plate avulsion fractures from the bases of the fourth and fifth middle phalanges (black arrows). These occur when forced extension happens during clenching of the fist. They can be multiple as in this case, so adjacent fingers should be carefully interrogated for additional fractures

involving the extensor mechanism, where the dorsal portion of the base of the distal phalanges is avulsed off. These commonly occur with direct axial or flexion injury to the associated digit and are commonly associated with sports injuries. This injury is characterized by inability to extend the finger and slight resting flexion, which results in the finger resembling a mallet, hence its namesake. These fractures are most often identified on lateral radiograph (Fig. 76.15). Of note, patients with this clinical presentation will sometimes have isolated tendinous injuries without any associated fracture. These injuries are called "mallet finger" and can usually be diagnosed via ultrasound. Mallet injuries usually do not require

Fig. 76.15 Mallet fracture at the base of distal phalanx. These occur due to sudden forced flexion, often when a ball strikes the tip of the finger. They can be difficult to see on the PA view (**a**) but are usually obvious on the lateral (**b**). Look for secondary volar subluxation of the major fragment

operative management unless there is significant displacement, or in the management of chronic injuries.

76.3 Terminal Tuft Fractures

Fractures of the distal phalanges (Fig. 76.16) are the very common hand fractures, accounting for nearly half of all hand fractures. Notably, these fractures are common in workplace accidents, such as direct blunt trauma, for example striking the tip of the finger with a hammer that can result in significant disability. These are often associated with damage to the associated nail bed. Patients commonly have formation of a subungual hematoma, which is often more painful than the fracture itself and requires drainage, often with electrocautery, and usually provides immediate relief to the patient. Findings such as soft-tissue destruction and subcutaneous gas can suggest an open fracture, which usually has significant disruption of the underlying nail bed and pulp and can progress to osteomyelitis. Luckily,

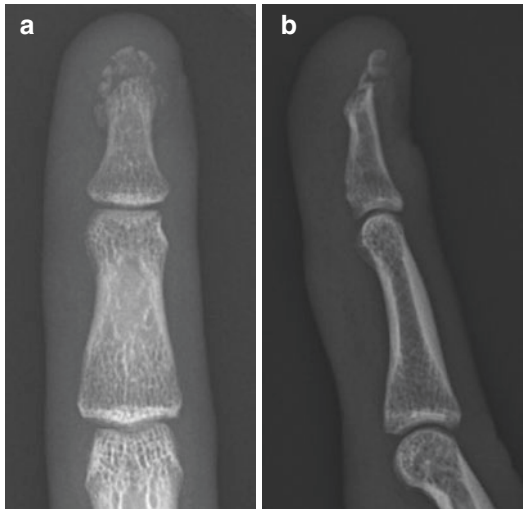

Fig. 76.16 Terminal tuft fracture. These are usually caused by direct blunt trauma such as striking the tip of the finger with a hammer (**a** PA and **b** lateral). Look for loss of the nail or gas under the nail, which could indicate an open fracture

surgical fixation is rarely required for these injuries as re-opposition of the tissues is normally adequate.

Take-Home Message

- When obtaining radiographs, one should obtain at least two different views (PA and lateral) and ideally a third view (oblique).
- In certain instances, such as when a scaphoid fracture is suspected, special views such as the scaphoid view can be obtained.
- Or, in the case of a hook of hamate or trapezial ridge fracture, carpal tunnel radiographs can also be obtained, which profiles the hook of the hamate and trapezial ridge. Despite getting additional radiograph views, certain fractures like a scaphoid fracture can still be occult on radiograph and can only be seen on cross-sectional imaging such as a CT or the more sensitive MRI. In addition to fractures, dislocations are also a serious concern. Lunate and perilunate dislocations can be seen on lateral radiographs of the wrist and are critical to identify as they can cause compression of the median nerve and potentially permanent nerve damage if treatment is delayed.
- The thumb is also a common source of fracture and ligamentous damage, as seen with the ulnar collateral ligament damage seen with gamekeeper's thumb or base of the first metacarpal fractures, such as the Bennett and the more severe Rolando fracture. Sports and fistfights are also a common source of hand injuries, particularly with fracture-dislocations of the fourth and fifth carpometacarpal, hence the apt name boxer's fracture (minimally comminuted transverse fracture of the fifth metacarpal neck). Careful attention should be given to the lateral radiographs when examining the more distal portions of the fingers, where mallet fractures (avulsion fractures involving the extensor mechanism at the base of the distal phalanges) and volar plate fractures (particularly the attachment of the proximal interphalangeal joint) with or without dislocations are most easily identified. Work-related injuries (especially with hammers) or simple everyday life injuries, such as having a car door closed on one's finger, commonly cause fractures to the terminal tuft (with or without possible damage to the nail bed). Given the commonality of hand fractures, the variety of fractures and dislocations, and the difficulties identifying these fractures, clinicians must have an in-depth understanding of where to look for fractures, what imaging to obtain when there is a suspicion, and prompt management when a fracture is identified.

Summary

The hands are vital for everyday life, and their ubiquitous use and versatile function make them a particularly common location of fractures and pathology. This same complexity also makes them vulnerable to complications and associated disability if pathology in this area is not identified correctly and in a timely manner. In the setting of trauma, one should always keep a high suspicion for fractures in the hand. In order to identify these fractures, a thorough physical exam and radiographs in at least two views (PA and lateral), and ideally oblique (as many fractures are only visible on one view), should be obtained first. Any irregularity or lucency on radiograph should also be thoroughly interrogated as non-displaced fractures are easy to be overlooked. If there is suspicion for a fracture, particularly in the carpal bones, have a low threshold for obtaining dedicated/specialized radiographs such as carpal tunnel view/scaphoid view, or obtaining a CT scan or MRI, which is more sensitive for detecting fractures. Once a fracture is identified, one should evaluate the amount of displacement, fracture plane (i.e., transverse vs. spiral vs. comminuted), degree/direction of angulation of fracture fragments, and whether there is any intra-articular involvement. Most importantly, if a fracture is identified, one should be careful not to fall victim to the "satisfaction of search." If a patient has one fracture, there is a good chance that they have additional fractures, which are commonly missed. Proper identification and description will then affect the proper management (conservative versus surgery), which will result in the greatest chance of recovery with persevered function.

Questions

Multiple correct answers are possible. Answers available in the book back matter.

1. A patient presents the day after a fall on an outstretched hand and is having parethesia of the volar first, second, and third digits. What single radiographic view would be the most important to obtain?
   (a) PA radiographs
   (b) Oblique radiographs
   (c) Lateral radiographs
   (d) Scaphoid view
   The clinical concern is for median nerve compression, which can be caused by a lunate dislocation, best seen on a lateral view.
2. There is concern for fracture of one of the carpal bones after a fall. What is the most sensitive way of identifying that facture?
   (a) MRI
   (b) Standard radiographs
   (c) Scaphoid view radiographs
   (d) CT scan
   Although CT has good specificity, MRI is more sensitive for fractures.
3. What ligament is responsible for the radial/lateral retraction of bone fragments in a Bennett fracture?
   (a) Abductor pollicis longus
   (b) Ulnar collateral ligament
   (c) Anterior oblique ligament (beak ligament)
   (d) Abductor pollicis muscle
4. Which two main fracture types are best identified on carpal tunnel view?
   (a) Triquetral avulsion fracture and scaphoid fracture
   (b) Hook of hamate and triquetral avulsion fracture
   (c) Trapezial ridge and triquetral avulsion fracture
   (d) Hook of hamate and trapezial ridge
5. After a skiing accident, a patient presents with pain and swelling of the ulnar side of the first MCP joint and laxity on valgus stress. Standard trauma radiographs are obtained (PA, oblique, and lateral) and are negative. What is the most appropriate next step in management?
   (a) Repeat radiographs with a carpal tunnel view
   (b) MRI or ultrasound
   (c) CT scan
   (d) Immobilization for 4–6 weeks

Further Reading

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