Imaging Traumatic Hand and Finger Injuries

Elizabeth Paterson, BS, R.T.(R)(CT)(M)

After completing this article, the reader should be able to:
- Describe hand and finger anatomy and physiology.
- Explain the most common traumatic injuries to hands and fingers.
- Discuss radiography projections and positioning for imaging injuries of hands and fingers and special considerations for portable radiography.
- List methods for minimizing radiation exposure during hand and finger imaging.
- Summarize the roles of computed tomography, magnetic resonance imaging, and sonography in diagnosing and treating traumatic hand and finger injuries.

Hand and finger imaging examinations are 1 of the first and easiest procedures radiography students learn. However, when the anatomy is involved in trauma, these procedures can become difficult. Hand and finger anatomy is complex, consisting of 27 bones and associated tendons and ligaments. Successfully imaging this anatomy when the patient is in pain requires critical thinking skills and knowledge of trauma imaging techniques.

Hand Anatomy

The hand is a complex organization of skeletal features, muscles, ligaments, tendons, nerves, blood vessels, and lymph vessels. Functional components of the hand include power provided by the muscles, stability from the ligaments, and framework from the skeleton.

Skeletal

Including the fingers, the hand is made up of phalanges, metacarpal bones, and carpal bones (see Figure 1). The phalanges work with the metacarpal bones to flex and extend, which lets the hand grasp with strength and precision. The primary skeletal component of the hand is composed of 5 metacarpal bones that articulate proximally with the carpal bones and distally with the phalanges. These bones are cylindrical and slightly concave. Metacarpals are long bones with a distal head, shaft, and proximal body. The metacarpals are numbered 1 to 5 starting at the thumb, and the heads are commonly referred to as knuckles (see Figure 2). The metacarpals appear parallel when viewed in the lateral position but form a transverse arch when viewed axially. The transverse arch makes it necessary to use the oblique hand radiography position to adequately demonstrate the metacarpophalangeal (MCP) and carpometacarpal (CMC) joints.

The first metacarpal is different from the other 4 metacarpals in that it is pronated and its dorsal surface faces...
laterally when the body is in anatomic position. The first metacarpal is shorter and fatter than the others and is the only metacarpal with a saddle-shaped base. Typically, the second metacarpal is the longest and has the largest base. The base is bifid, meaning it is divided by a cleft or notch, which allows it to articulate securely with 2 carpal bones. The metacarpal that articulates with the middle finger is usually the second longest and has a small styloid process that extends from the radial side of its dorsal surface, which separates the articular surfaces. The fourth and fifth metacarpals are smaller and narrower than the others.

Soft Tissues

The muscles, tendons, and ligaments of the hand allow for specialized movement and dexterity. The first metacarpal’s 4 muscle attachments give it its varied movement capabilities. The abductor pollicis longus muscle attaches to the metacarpal on a tubercle located on the dorsal surface. This muscle continues into the abductor pollicis longus tendon and inserts into the first metacarpal. The tendon is wide and flat and separates into multiple smaller tendons (see Figure 3). This muscle provides a base of support and structure for first metacarpal movement and attachment to the trapezius. The first dorsal interosseous muscle is bipennate, meaning it attaches to both sides of a tendon, appearing similar to a feather. This muscle is responsible for the pinch motion between the thumb and index finger and plays a role in index finger head abduction. A small portion of the flexor pollicis brevis attaches to the medial palmer of the first metacarpal base. The flexor pollicis brevis flexes and creates the medial rotation motion of the first metacarpal bone pivoting on the first CMC joint. The remaining muscle that attaches to the first metacarpal is the opponens pollicis. This small triangular muscle moves the thumb appositionally. Apposition is the action that enables the tip of the thumb to touch the other finger tips by flexing the first metacarpal at the first MCP joint.

Three muscles attach to the second metacarpal bone shaft: the first and second dorsal interossei and the palmar interosseous. The palmar interosseous attaches
attachment point for the extensor carpi radialis longus tendon of the extensor carpi radialis longus muscle. This muscle is the primary extensor of the wrist joint and enables radial abduction and hand extension.

The third metacarpal has 2 dorsal interosseous muscles that provide the bone with blood supply and attachment to the other metacarpals. The extensor carpi radialis brevis tendon attaches the extensor carpi radialis brevis muscle to the hand on the dorsal surface. The primary function of the extensor carpi radialis brevis involves abducting the hand at the wrist joint. On the fourth metacarpal are insertion points for the third and fourth dorsal interosseous muscles and the second palmar interosseous muscle; the dorsal enables abduction, whereas the palmar enables adduction toward the third digit.

The fifth metacarpal base has an insertion point for the extensor carpi ulnaris, which extends and fixes the wrist during finger flexion and permits ulnar flexion of the wrist. In addition, the opponens digiti minimi has an attachment point on the medial surface of the fifth metacarpal. This muscle flexes the fifth metacarpal at the CMC joint during apposition of the thumb and pinkie finger.

Three sets of nerves innervate the hand with signals from the central nervous system: radial, median, and ulnar. Each set is responsible for sensation, flexibility, and coordinating the complex movements of the hand and fingers. The radial nerve supplies signals to the muscles associated with finger extension and thumb abduction. The ulnar nerve enters the palm of the hand through Gunyon’s canal. The palmar branch of the ulnar nerve provides sensation to the anterior skin and nails, and the dorsal cutaneous branch supplies sensation to the posterior hand and fingers. For muscle motor function, the deep branch of the ulnar nerve supplies signals to the dorsal and palmar interossei. The superficial branch of the ulnar nerve feeds the palmaris brevis muscle, which tenses the palm during grip and deepens the curve of the palm. The median nerve, which enters through the carpal tunnel, innervates the flexors of the wrist and digits, abductors, and opponents of the thumb. The median nerve also supplies sensation for the lateral 3 digits and the posterior tips of the first, second, and third digits.
The primary blood vessels of the hand are branches of the radial and ulnar arteries. The radial artery branches into the princeps pollicis artery, radialis indicis, and the deep palmar arch. The deep palmar arch of the ulnar artery connects with the deep palmar arch of the radial artery and terminates at the superficial palmar arch.

Joints
The hand consists of 27 bones that have multiple joints that perform multiple functions. The saddle-shaped CMC joint is located between the first metacarpal and the trapezium. The base of the first metacarpal has a prominent lip on the palm side, with extensions to the radial and ulnar side, creating the shape necessary for the saddle-shaped joint. This type of joint permits the thumb to move in 2 different planes, allowing for opposition, apposition, and rotation on its long axis at the CMC joint.

The first MCP joint of the thumb includes the head of the first metacarpal and the base of the proximal phalanx of the first digit. The head of the first metacarpal is less rounded, enabling greater stability with its hinge motion while pinching. The thumb does not articulate with any other metacarpal bones.

The second metacarpal articulates with the trapezium, trapezoid, capitates, and third metacarpal. It has the largest base compared with other metacarpal bones, causing its Y shape. Four articular facets form these joints. The intermediate facet is largest and is concave from side to side, creating the joint with the trapezium. The trapezoid articulates with the second metacarpal at the lateral articular facet, which is small, flat, and oval-shaped. The trapezium articulates with the second metacarpal at the lateral articular facet, which is small, flat, and oval-shaped.

On the third metacarpal are 3 articular facets: 1 for the capitate and 1 for each of the adjacent metacarpals. The surface of the base has a concave posterior and flat front that articulates with the capitate. A concave and smooth facet is on the lateral (radial) side for interaction with the second metacarpal and 2 small facets for the fourth metacarpal on the medial side.

Soft Tissues
The digits that start on the anterior forearm and extend to the distal phalanx have 2 long flexors: the deep flexor and the superficial flexor. The deep flexor extends to the distal phalanx and attaches to a bony lip on the anterior side of the scaphoid known as the volar tubercle. The superficial flexor extends to the middle phalanx and attaches to a flat area on the palm side of the bone. These flexors allow the fingers to bend.

The hand extensors start on the posterior forearm and travel distally to attachment points on the dorsal surface of the fingers. These extensors work with a
group of muscles and tendons to create the action of straightening the fingers.13,14 The most distal portion of the extensors attaches to the distal phalanx on a small posterior tubercle.2 On the middle phalanx, the central portion of the extensors attaches near the base. The thumb has 2 separate extensors: the extensor pollicis longus and the extensor pollicis brevis.13 These form portions of the anatomical snuffbox, a flattened surface on the posterior side of the lateral hand near the scaphoid.13,15 The radial artery passes through this area, allowing for detection of the radial pulse.

On each distal phalanx is a crescent-shaped ridge of bone that supports the germinal matrix, which is the tissue that generates the fingernail.1 In addition, the sterile matrix located on the posterior surface of the distal phalanges provides the support that keeps the fingernails in place.2

Joints

Each digit connects with the rest of the hand at the MCP joint. The collateral ligaments attach on each side of the proximal phalanx base and to the head of the associated metacarpal.2 On each metacarpal head are prominences on the bilateral condyle for attachment. This articular surface is wider on the anterior side, which tightens the collateral ligaments and improves stability in the MCP joint when the hand is flexed.3

The proximal and middle phalanges articulate at the proximal interphalangeal joints. On either side of the head of the proximal phalanges are ridges of bone for collateral ligament attachment.2 Condyles on the base of the middle phalanges provide support and stability for the proximal interphalangeal joints, and a palmar extension of the articular surfaces allow more flexion than extension.2

The distal interphalangeal (DIP) joints connect the middle phalanges to the distal phalanges. On the distal surface of the head of the middle phalanges, articular cartilage and condyles are present for ligament attachment.2 Between the condyles is a groove that provides stability and positioning for DIP joint movement.2

Traumatic Injuries

Traumatic hand and finger injuries account for approximately 20% of all emergency department visits.16 Common types of injuries include fractures, dislocations, and soft-tissue injuries caused by a variety of mechanisms, including sports and work-related events.16 When combined, these injuries result in a large financial burden that includes health care costs and cost of lost productivity of the injured person.17 A contributing factor to the high cost of hand injuries is that people aged 20 to 64 years have a higher incidence of these injuries, resulting in missed work, which increases productivity cost.17

Hand Fractures

Metacarpal fractures account for approximately 44% of all hand fractures.18 About 12% of these fractures are associated with the first metacarpal, leaving 88% spread between the other 4 digits.19 In the United States, the incidence of metacarpal fractures is highest at age 30 years in men and 20 years in women.19 The primary mechanisms that cause metacarpal fractures are accidental falls and hitting another person or object.19

Metacarpal fractures have the same classifications as fractures occurring in other long bones, including open or closed and intra- or extra-articular.18 In addition, the fracture line is classified as oblique, transverse, spiral, or comminuted.18 Commonly, these fractures have posterior angulation from the forces exerted by the deep and superficial flexors on the distal fracture fragment.18

Signs of a metacarpal fracture include reduced range of motion, swelling, loss of knuckle contour, or a proximal bony prominence.19,20 On radiographs, shortening or angulation of the metacarpal head indicates fracture.18 The second and fifth digits commonly have shortening associated with metacarpal fractures; the central digits typically have less than 4 mm of shortening because the intermetacarpal ligaments prevent it.18

The metacarpal head is the least likely to fracture.20 With a head fracture, angulation of the metacarpal head can cause dorsal angulation of the digits.19 The degree of metacarpal head angulation influences the type of treatment the patient receives. In the fifth metacarpal, if the angulation of the head is less than 50º, nonsurgical management is preferred.16 Similarly, nonsurgical treatment is suitable for second metacarpal fractures if the angle of the head is 15º or less, for third metacarpal fractures with an angle of 20º or less, and
for fourth metacarpal fractures with angulation less than 30°. Angulation of the metacarpal shaft requires surgical intervention at less extreme angles to ensure proper MCP mobility. The fourth and fifth metacarpal shafts can be treated with immobilization if there is less than 15° posterior angulation, but the second and third metacarpal shafts can have only slight angulation without the need for surgical treatment. Too much angulation of the metacarpal shaft after healing can lead to flexion deformity, interfere with the extensors, and limit the amount of force ability at the proximal interphalangeal joints.

The boxer’s fracture is a common hand injury that affects the neck of the fifth metacarpal. This injury typically is caused by punching a hard surface or person. When the fist hits a hard object, the fifth metacarpal receives the majority of the impact, leading to a fracture in the weakest area of the metacarpal neck. A common sign of this fracture is dorsal angulation caused by displacement at the fracture site. If the angulation is greater than 40°, surgery is often required; angulation less than 40° can be treated with stabilization provided by casting. A high angulation or a comminuted fracture requires surgical operations such as open reduction or internal fixation.

If the fractures involve the articular surfaces, surgery almost always is needed. If the joint moves more than 1 mm or if more than 25% of the articular surface is involved, fixation is needed to maintain joint alignment. In cases of small avulsion fractures, if the joint is stable, treatment without surgery is often sufficient. Because avulsion fractures might be associated with soft-tissue injury, the clinician should perform a thorough investigation.

Hand Dislocations

A Bennett fracture dislocation is an injury to the first metacarpal typically resulting from direct force to the shaft of the first metacarpal. This force often is caused by falling on an extended or abducted thumb or by impact to a closed fist. A patient with this injury presents with acute pain, localized swelling at the base of the first metacarpal, and pain when attempting to move the thumb. In this fracture, a piece of the first metacarpal base is held in its normal position articulating with the trapezium by the deep anterior oblique ligament. The other portion of the base dislocates posteriorly out of the CMC joint. This injury typically requires surgical intervention. A closed reduction with percutaneous pinning commonly stabilizes the fracture. Alternatively, studies show that an open reduction with internal fixation is associated with improved outcomes (see Figure 4). In either case, a hand specialist should be involved to ensure that treatment is satisfactory. Poor treatment can lead to continual dislocation, subluxation, nonunion of the fracture, and increased risk of osteoarthritis.

CMC dislocation usually occurs only from a high energy injury in which the metacarpal dislocates posteriorly from the associated carpal bone. This type of dislocation can be associated with the articular surfaces of the metacarpal and carpal bones, which increases joint instability. Some CMC dislocations can be treated with reduction by applying force to the dorsal surface of the hand with axial traction to the digits. This approach usually is suitable only for isolated dislocation, as this injury typically is unstable and requires surgical internal fixation.

Phalangeal Fractures

Phalangeal fractures occur in the same patterns as other long-bone fractures, including comminuted, displaced, or transverse. When displacement occurs, it indicates associated soft-tissue injuries. Typically, phalangeal fractures occur from crushing, hyperextension, or excessive axial loading (ie, jamming). In addition, a crush to the fingertips can cause tuft fractures, which typically appear with a stellate pattern (ie, resembling a starburst). If a phalangeal fracture is suspected, health care providers should examine the soft tissues for hema
toma, open wounds, point tenderness, or abnormal angulation.
Reluctance to move the affected finger also is a potential sign of fracture.

In addition to tuft fractures, fractures of the distal phalanges are classified as diaphyseal (shaft), epiphyseal (growth plate), articular, or at the tendon insertion point. In the middle and proximal phalanges, fractures typically are transverse, oblique, or comminuted. Transverse phalangeal fractures usually are stable and can be treated with closed reduction and stabilization.
Phalangeal Dislocations

Fractures of the phalanges involving the articular surfaces often result in dislocation or subluxation. Avulsion fractures between phalanges can cause associated dorsal dislocation of the proximal interphalangeal joint. If not treated, this injury can lead to a fixed deformity. Treatment is based on the level of instability and can range from immobilization to open reduction with internal fixation. The goal of any treatment is to restore the joint to anatomic alignment and permit range of motion. The protected motion treatment option allows for movement of the affected joint to the position in which the joint becomes unstable.

When the fractures are oblique, they often are unstable because of angular or axial forces that cause deformity. These fractures often are treated with Kirschner wires (see Figure 5), screws, or plates to stabilize the fracture.
MCP dislocations, which involve the finger dislocating in the posterior direction from the corresponding metacarpal, are classified as complex or simple. A simple MCP dislocation usually can be treated with manual reduction. Complex MCP dislocations require open reduction because they involve soft tissues that become interposed in the joint space, blocking joint reduction. These injuries typically are caused by hyperextension of the MCP joint; patients present with acute pain, swelling, and visible disruption of the joint. The second and fifth digits are most likely to suffer this injury.

Mallet finger is a type of phalangeal fracture or dislocation that involves the DIP joint. This injury is caused by extreme flexion force on the distal phalanx when the joint is in full extension. When this injury occurs, the extensor tendon is torn or the tendon attachment point is forcibly detached from its usual point of insertion, which prevents full extension of the DIP, and the joint remains in an abnormally flexed position.

Soft-Tissue Injuries

The flexor tendons of the fingers can be torn or ruptured during traumatic injury. Depending on where the injury occurs, a patient with this injury might not be able to flex 1 or both of the interphalangeal joints. Clinical signs of this injury include pain and swelling at the injury site or a bump where the tendon retracts after rupture. Gamekeeper’s or skier’s thumb is an acute injury to the ulnar collateral ligament of the thumb’s MCP joint (see Figure 6). This injury occurs when sudden stress pushes the thumb away from the midline of the body. This acute stress can cause an avulsion fracture, ulnar collateral ligament tear, or a combination. A common cause of this injury is a fall while skiing, in which the ski pole causes extreme abduction and extension of the digit.

Jersey finger describes an injury to the flexor digitorum profundus. When the finger is forced into extreme extension while the DIP joint is flexed, the flexor digitorum profundus separates from the base of the distal phalanx. Nearly 75% of jersey finger cases involve the fourth digit. Patients who present with this injury have pain or swelling at the injury site and cannot flex the DIP joint. Typically, surgical intervention is the best approach to treat this injury and stabilize the DIP joint.

Medical Imaging

Imaging plays an important role in diagnosis and in directing management of traumatic hand and finger injuries. Accurate diagnosis of finger injuries can be difficult because of the complicated soft-tissue anatomy of the hand and the diverse spectrum of injuries that
can occur. For the optimal outcome, radiologists must have a comprehensive knowledge of hand anatomy, the array of injury patterns that can occur, the characteristic imaging findings of different injuries, and the most appropriate treatment options for the types of injuries. With this extensive knowledge base, radiologists can recommend the most appropriate imaging study or modality to provide accurate diagnoses, relay clinically relevant imaging findings to the referring physician, and suggest appropriate follow-up examinations. These factors contribute to the best outcome for the patient.

**Radiography**

Radiography is the initial imaging modality of choice for hand and finger injuries. After a traumatic hand or finger injury, patients often visit the emergency department or orthopedic office. The medical provider assesses the injury based on the mechanism of injury and the appearance, function, and sensation of the extremity. Radiography is the modality of choice for the following types of injuries:

- crush
- axial loading
- forced extension of finger during active flexion
- direct blows, hyperextension, or rotation
- foreign bodies (eg, metal or glass)

Radiographs can reveal linear lucencies of various orientations and locations, avulsions, separation and angulation of fractures, dislocations, and the presence of radiopaque foreign bodies. Radiography has the greatest capacity to adapt to different patients, circumstances, and challenges that arise in the daily practice of clinical radiography, making it a valuable diagnostic tool for upper extremity trauma.

**Positioning**

The standard hand and finger radiography study includes 3 projections: posteroanterior (PA) or anteroposterior (AP), oblique, and lateral. It is not uncommon for a physician to order only PA or AP and lateral radiographs after acute trauma. However, studies have shown the oblique projection to be valuable in assessing distal extremity injuries, and 3 projections should be obtained whenever possible. The oblique projection reveals abnormalities and increases the confidence of the final diagnosis when interpreted with the AP and lateral radiographs. Although additional cost and radiation exposure are entailed in adding a third projection, the extra information obtained can help prevent misdiagnosis.

To position the hand for a PA radiograph, pronate the hand so the palm is in contact with the image receptor and the fingers are spread slightly. The central ray should be perpendicular to the image receptor and is directed to the third MCP joint. Approximately 1 inch of light field is allowed around every side, and 1 inch is allowed proximally past the wrist crease to include all anatomy (see Figure 7). For the oblique projection, pronate the hand, and rotate the entire hand and wrist laterally 45° with a radiolucent wedge or step block support, to ensure that all digits are separated and parallel to the image receptor. Aim the central ray at the second MCP joint to allow an even light field on every side. Ensuring the thumb stays within the light field for the oblique view will maintain the centering point, which can shift if any body part is rotated.

The most commonly requested lateral hand projection is the fan lateral, especially when the phalanges are the area of interest. To achieve the fan lateral, rotate the hand and wrist with the thumb side up. Spread the fingers and thumb into a fan position, with each digit supported on a radiolucent block. All digits, including the thumb, are separated and parallel to the image receptor and metacarpals are not rotated. Center the beam to a point midway between the second MCP joint and the thumb; collimate on 4 sides to the outer margins of the hand and wrist. The lateral projection in extension or flexion is an alternative to the fan lateral for localizing foreign bodies in the hand and fingers. This projection also demonstrates anterior or posterior displaced fractures of the metacarpals. In lateral extension, extend the fingers and thumb so that all fingers and metacarpals are superimposed. In lateral flexion, flex the fingers into a naturally flexed position, with the thumb lightly touching the first finger. The lateral natural flexed position might be more comfortable for the patient.

Positioning for the PA, oblique, and lateral projections of digits 2 through 5 is the same. For these fingers, pronate the hand with the fingers extended. Separate
Positioning for the first digit can be awkward and often requires demonstration for the patient. The first projection is performed AP with the hand rotated internally to supinate the thumb. The posterior surface of the thumb should be in contact with the image receptor using the first MCP joint as the center of the image. Other fingers might be immobilized with tape or a positioning aid to isolate the thumb fully, and the thick pad of soft tissue over the fourth and fifth metacarpals should not superimpose the thumb when the palm is folded in this position. If this is unavoidable, externally rotate the patient’s arm outward until the thumb is in a true AP position. The patient will rotate his or her entire body toward the affected side to get the proper external rotation. Collimate the image to include the thumb only, including the first metacarpal. If the patient cannot achieve this position, a PA might...
be performed with the hand in a near lateral position and the thumb resting on a sponge that is high enough so the thumb is not rotated but is in a true PA position. However, the PA view is not advisable as it results in a decrease in definition because of increased object-to-image distance. For the thumb oblique, abduct the thumb slightly with the palm of the hand in contact with the image receptor. The hand should be flat so the thumb is in a true oblique position at 45°. Collimate the image to include the thumb and center to the first MCP joint. The lateral position requires the hand to be pronated and thumb abducted with fingers and hand slightly arched; rotate the hand medially until the thumb is in a true lateral position. The entire lateral aspect of the thumb should be in contact with the image receptor. Direct the central ray to the first MCP joint and collimate on all sides of the digit, including the first metacarpal.

Portable Imaging
Radiologic technologists often encounter trauma injuries that require adaptations in positioning and imaging. The patient might be unable to be transported to the radiology department, making mobile radiography the only means of imaging. Portable imaging requires the ability to work efficiently, adapt to suboptimal patient mobility, and overcome technical challenges and interfering medical devices that cannot be removed. Severe trauma to the hand or fingers might require portable imaging, depending on the patient’s condition, level of consciousness, and comorbidities. If a provider orders a portable hand or finger radiograph, the radiographer should plan for a trip out of the department and bring necessary positioning aids such as tape, positioning sponges, and appropriate shielding devices. On entering the patient’s room, assess the patient’s ability to follow instructions and move the affected body part. In these circumstances, the technologist must be cautious, resourceful, and work in accordance with the patient’s pain tolerance and ability to assist with positioning.

For example, certain modifications in positioning must be made if the patient cannot straighten the fingers. The hand must be radiographed in AP rather than the PA position to take advantage of beam divergence and to maximize the joint opening. Beam divergence is an important concept to master in mobile radiography, especially when imaging multiple joints such as in the hand. Several AP projections might be required to place each phalanx perpendicular to the image receptor. With hands semiflexed, caudal angulation can be increased in increments (eg, 15°, 25°, 35°) to demonstrate each set of phalanges in a true AP position. The wrist also might be pulled up incrementally to place the phalanges in the appropriate position.

Preventing Overexposure and Repeat Imaging
The radiologic technologist controls many factors that affect patient dose. One aspect of unnecessary radiation exposure is repeat imaging. Some repeats are caused by equipment malfunction and patient motion, but most are caused by technologist error. Poor positioning and poor technique—the primary causes of repeat examinations—can be minimized through proper training and attentiveness. In general, the use of high kilovoltage peak (kVp) techniques results in decreased patient dose and should be used whenever possible. Increasing the kVp always is associated with a reduction in milliampere seconds (mAs) to achieve an acceptable optical density, resulting in decreased patient dose. When performing radiography on extremities such as the hands and fingers, prevent the useful beam from intercepting the gonads by positioning the patient laterally to the useful beam and by using a protective apron. Gonadal shielding should be used for mobile radiography as well. Using positioning sponges and other tools can stabilize the body part.

Other Modalities
Although conventional radiography is the primary imaging modality for evaluating suspected fractures and dislocations, other modalities such as computed tomography (CT), magnetic resonance (MR) imaging, and sonography have increasing roles. Losing function in 1 digit can impair overall hand function; thus, early identification of damaged structures is essential. Advances in technology and accessibility make advanced imaging modalities an important extension of radiography and can be crucial for surgical treatment and planning.
Computed Tomography

Multidetector CT can display the extent of carpal and metacarpal fractures easily, even depicting fractures that are indiscernible on radiographs. CT can be a useful tool when results from initial radiographs are negative in patients with suspected fractures, when findings are indeterminate, and when further characterization of radiography findings is required for surgical planning. CT also can prevent unnecessary immobilization of a patient without a fracture, which particularly is important for athletes. CT allows for multiplanar and volumetric reformation, creating a more detailed representation of pathologic conditions and anatomic relationships (see Figure 8). CT can illustrate the complexity and extent of fractures and dislocations not well visualized in 2-D radiography. Another advantage is the ability to overcome positioning challenges in trauma radiography through postproduction image manipulation. Ideal imaging is acquired with the arm extended over the head with the patient supine or prone, depending on local protocols.

Magnetic Resonance Imaging

MR is a useful adjunct imaging modality for evaluating the soft tissues of the hand and fingers. Although not ideal for evaluating fractures, MR imaging is exceptional for depicting the flexor and extensor tendons and ligaments as well as the pulley system. The pulley system is composed of focal thickened areas of the flexor tendon sheaths and facilitates normal finger flexion. Finger flexion is a complex fine motor action that requires the integrity and orchestration of a number of delicate structures that are centered on the flexor tendon system.

A typical MR hand imaging protocol includes at least a T1-weighted sequence in the sagittal plane, fat-saturated T2-weighted sequences in the axial and coronal planes, and a gradient-echo sequence in the coronal plane. Additional imaging might include T1-weighted or fat-saturated T2-weighted sequences in additional planes and proton density-weighted, fat-saturated proton density-weighted, and short T1 inversion-recovery sequences substituted for T1-weighted and fat-saturated T1-weighted sequences. T1-weighted sequences evaluate alignment, bone marrow signal intensity, indiscernible fractures, hemorrhage, and fat-containing lesions. T2-weighted sequences evaluate fluid signal intensity within tendons and ligaments, tendon and ligament disruption, muscle edema, and bone marrow edema. Gradient-echo sequences evaluate ligament integrity. Tendons and ligaments appear as continuous, homogenous bands of low signal intensity on most image series; however, complete tears appear as areas of discontinuity in these bands, often with intervening fluid signal intensity. Strains or partial tears demonstrate increased signal intensity, often in thickened but otherwise intact continuous ligamentous bands on T2-weighted or short T1 inversion-recovery images.

Use the smallest possible field of view to maximize the resolution of small structures such as the collateral ligament and volar plates. A 3 T magnet with a dedicated coil provides better signal-to-noise ratio and resolution than a 1.5 T magnet. The protocol should be designed...
to optimize the signal-to-noise ratio, most often achieved by using continuous sections 2- to 3-mm thick.16

Sonography

Sonography plays a limited role in evaluating specific hand and finger injuries. Depending on the location of the injury, accessibility and positioning can be problematic given the close proximity of other fingers. Sonography can be performed if there is suspicion of volar plate entrapment after a finger hyperextension or dislocation; when the volar plate becomes interposed in the joint space, making the joint irreducible; or with persistent joint space widening on radiographs.16

Sonography also is useful in diagnosing gamekeeper’s thumb and Stener lesions. These injuries involve the deeply positioned ulnar collateral ligament in the MCP joint of the thumb, as well as the adductor pollicis muscle that crosses over the ulnar collateral ligament as a band of fibers on its way to inserting into the base of the thumb.16 Both the adductor aponeurosis and the subjacent torn ulnar collateral ligament can appear similarly heterogeneously hypoechoic on sonograms, but a dynamic examination with ultrasound can delineate these structures.16

Sonography also is especially sensitive to foreign bodies that are not identifiable with radiography. Although metal is 100% identifiable with radiography, glass is apparent 96% of the time, and wood up to 15%.16 Therefore, sonography is a powerful tool and has been shown to be more effective than CT and less expensive than MR imaging.16 Nearly all foreign bodies are hyperechoic, and a large number demonstrate shadowing.16 The body’s response to foreign bodies after 24 hours is a ring of edema and granulation tissue that appears as a hypoechoic rim around the object, further identifying the foreign body under ultrasound.16 In addition, sonography provides real-time imaging guidance for foreign object retrieval.16

Conclusion

The hands and fingers are small features but have an important effect on quality of life. Their design is functional and intricate, making them capable of innumerable tasks and vulnerable to injury. Hand injuries can be disabling, and early diagnosis is vital to minimize long-term impairment. Traumatic injuries should be managed so that evaluation, imaging, and treatment occur early and efficiently. When properly diagnosed and managed, many injuries are followed by a full return of function. Imaging is a vital component of the diagnostic process contributing to long-term patient health.

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Imaging Traumatic Hand and Finger Injuries

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Read the preceding Directed Reading and choose the answer that is most correct based on the article.

1. Phalanges and metacarpals perform which movement that allows the hand to grasp?
   a. twist and rotate
   b. adduct and abduct
   c. flex and extend
   d. pivot and glide

2. The ______ metacarpal is the longest and has a bifid base.
   a. first
   b. second
   c. third
   d. fourth

3. Which muscle allows for apposition of the thumb?
   a. flexor pollicis brevis
   b. opponens pollicis
   c. abductor pollicis longus
   d. trapezium

4. What is another name for the bony lip on the anterior side of the distal phalanx where the deep flexor attaches?
   a. dorsal bony prominence
   b. metacarpal meatus
   c. volar tubercle
   d. hypophyseal fossa

5. In the United States, women aged ______ years have the highest incidence of metacarpal fractures.
   a. 20
   b. 30
   c. 40
   d. 50

6. A common hand injury that is caused typically by punching a hard surface or a person is known as a ______ fracture.
   a. Bennett
   b. boxer’s
   c. Barton
   d. scaphoid

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Directed Reading Quiz

7. Transverse phalangeal fractures usually are treated by:
   a. open reduction internal fixation.
   b. Kirschner wires.
   c. closed reduction and stabilization.
   d. sling and swath.

8. The ______ hand projection greatly increases diagnostic confidence when interpreted with the other standard projections.
   a. anteroposterior
   b. oblique
   c. lateral
   d. posteroanterior

9. What are the primary causes of repeat examinations in radiography?
   a. patient motion and artifacts
   b. equipment malfunction and electrical interruptions
   c. inappropriate shielding and staff interference
   d. poor positioning and technique

10. Strains and partial ligament and tendon tears demonstrate ______ signal intensity in magnetic resonance images.
     a. decreased
     b. homogenous
     c. heterogenous
     d. increased
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Expiration Date: October 31, 2021*
Approved for 1.25 Category A credits

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A passing score is 75% or better.
ASRT must receive this answer sheet before the quiz expires and before the end of the CE biennium for which you want credit.
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ASRT Member ID

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CE Answers Section

USE A BLACK INK PEN. Completely fill in the circles.

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Note: For true/false questions, A=true, B=false.

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