Injuries of the Fingers and Thumb in the Athlete

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Hand and injuries are common in athletes, accounting for up to 9% of all sports injuries [1]. Injuries to the hand are common in athletes, probably because the hand is characteristically in front of the athlete in most sports and frequently absorbs the initial contact. Furthermore, the hand is used most sports in one way or another. In many competitive team sports, the fingers and thumb are the areas most often injured [1]. Sports-related injuries to the hand can be debilitating and sideline athletes of all levels for considerable time periods. Severe hand injuries may even have a lasting effect on long-term function of the hand and wrist.

Although the hand is the most active portion of the upper extremity, it is the least well protected and therefore at high risk for injury during sports activity [2]. Sports-related hand injuries range from apparently minor problems to those whose severity is immediately apparent, such as a fracture or dislocation of a finger. Finger and thumb injuries usually result from accidents and therefore are difficult to prevent. Depending on the sport, the percentage of injuries involving the hand can vary greatly. Finger and thumb injuries are common in sports that have a high risk for falling, such as skiing, biking, in-line skating, and gymnastics [1]. Football also results in a high percentage of hand and wrist injuries, accounting for 15% of all injuries [3].

IMAGING TECHNIQUES

Imaging evaluation of sports-related injuries should begin with radiographs [4]. Radiographs can be obtained rapidly and are cost efficient. Radiographs can be obtained of the entire hand; if pathology is limited to the digits, dedicated radiographs of the fingers and thumb may be obtained. The initial radiographic examination should include three views: posteroanterior (PA), lateral, and oblique [4]. Lateral views of the digits require isolation from the adjacent digits [4]. Proper positioning is critical to obtaining quality radiographs. Meticulous attention to proper positioning is necessary, and radiographs with suboptimal positioning should be repeated.

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CT remains the best modality for evaluation of the bony architecture. CT is able to assess for subtle fractures that may not be evident on radiographs and can also be useful to assess fracture healing better than conventional radiographs [4]. Multidetector CT scanners allow high-quality multiplanar reformatted images. Three-dimensional (3D) reformatted and volume-rendered images allow 3D visualization of the osseous structures, which can be useful for surgical planning. Collimation and slice thickness should be minimized, typically between 0.5 and 1.0 mm, to optimize multiplanar and 3D reconstructions. Narrow slice thickness allows isotropic viewing, with creation of multiplanar reformatted images with the same resolution as the original sections.

MRI is the preferred modality for evaluating the soft tissue structures about the fingers and thumb, such as the ligaments and tendons [5]. Osseous abnormalities can also be evaluated well with MRI. Innovations in MRI continue to improve, allowing higher-quality imaging with smaller fields of view (FOV). These innovations include improved gradient strength and speed, specialized coils providing favorable signal-to-noise ratios, larger bore magnets, and higher field strength magnets. Coil selection is critical to quality imaging of the fingers and thumb. Dedicated wrist coils allow excellent imaging of the proximal hand. Dedicated small upper extremity or elbow coils allow excellent versatility in positioning and provide excellent signal-to-noise ratio, even for small FOV. Small extremity coils allow precise positioning of the hand within the center of the coil and are large enough to be used to image several digits in cases of more diffuse hand injuries. Digit coils or small loop coils allow for small FOV imaging, which is optimal for evaluation of individual joints and digits.

FRACTURES
Sports-related fractures of the hand are common. Fractures of the metacarpals or phalanges result from rotation, bending, direct blows, indirect forces, or any combination of these forces [5]. There are several osseous injuries that are seen commonly in athletic injuries. Radiographic detection and characterization of fractures are vitally important, because this guides treatment for the clinician. Characterization of fractures includes the location and direction of the fracture line, the presence or absence of comminution, displacement of the fracture, articular involvement, and associated soft tissue injury. Fractures often are divided into extra-articular and intra-articular fractures. Nondisplaced extra-articular fractures often can be treated with buddy taping or splinting, whereas intra-articular fractures often require surgical treatment [5]. Displaced fractures of the hand have a tendency to angulate volarly because of attachments of the interosseous muscles. Marginal fractures or avulsion fractures involving the metacarpals or phalanges can be sentinels of more serious associated soft tissue injuries [5].

PHALANGEAL FRACTURES
Phalangeal fractures are problematic, in that an isolated fracture can affect the function of the entire hand [4]. Digital function can be impaired by the fracture
deformity and by associated soft tissue injuries [4]. There are many variations of phalangeal fractures involving various locations. Fractures involving the shaft may be transverse, oblique, spiral, or comminuted [6]. Displacement and angulation of phalangeal fractures are common and typically result from a combination of two main factors: the mechanism of injury and the deforming forces placed on the fractured bone. The mechanism of injury determines the nature of the fracture. A direct blow to the finger often results in a transverse or comminuted fracture, whereas a twisting injury of the digit often results in an oblique or spiral fracture [4]. Oblique or spiral fractures may also be associated with malrotation. No malrotation is acceptable for phalangeal fractures, because this leads to overlap and malalignment of the digit. Displaced or malrotated fractures should be reduced either by closed or open techniques. Acceptable reduction is less than 6 mm of shortening, less than 15 degrees of angulation, and no rotational deformity [4]. Nondisplaced phalangeal fractures can be treated conservatively. Nondisplaced fractures result in less than 10 degrees of angulation and have no rotational deformity [4]. Nondisplaced phalangeal fractures often can be treated with buddy taping and splinting with good results.

Injuries of the terminal tuft of the phalanges are not uncommon in sports (Fig. 1). These injuries often occur from a crushing force, often when a finger is stepped on by an opponent’s cleats [4]. The middle finger or thumb is most commonly affected, because they tend to be more exposed than other digits [4]. Most tuft fractures are stable; however, injury of the tuft often includes injury to the nail or nail bed. A subungual hematoma should be evacuated if greater than 50% of the nail plate is involved [4]. The nail may need to be removed entirely and often takes many months or longer to regenerate.

![Fig. 1. Terminal tuft fracture. PA (A) and lateral (B) radiographs of the long finger depict a comminuted fracture of the third distal phalanx. The finger was crushed by an opponent’s cleat while playing softball and was associated with a small subungual hematoma.](image-url)
Interphalangeal (IP) dislocations are common injuries in athletes (Fig. 2) and are often reduced on the sidelines and then taped or splinted. Any injury with a force significant enough to cause joint dislocation almost assuredly results in ligamentous injury or tear. Most IP joint dislocations involve the proximal interphalangeal (PIP) joint [6]. The PIP joint is susceptible especially to forced abnormal motion produced in ball sports and in sports resulting in axial loading of the digit [6]. Most IP joint dislocations are dorsal, with dorsal dislocation of the middle phalanx and disruption of the volar plate [7]. Volar or lateral dislocations also occur but are less common. Urgent reduction is necessary and is often performed by the athlete or the coach, hence the term “coach’s finger” [7]. Reduction often is achieved by traction and flexion of the middle phalanx [7]. Once reduced, the digit should be placed in a splint [6]. Associated fractures also must be treated appropriately.

**MALLET FINGER**

The terminal portion of the extensor mechanism of the finger crosses the dorsal aspect of the distal interphalangeal (DIP) joint. This extensor mechanism is responsible for active extension of the DIP joint. Mallet finger injury is caused by a flexion force on the tip of the finger while the DIP joint is extended [8]. This force results in tearing of the extensor tendon or an avulsion fracture at the tendinous attachment on the dorsal lip of the distal phalangeal base (Fig. 3) [8]. With mallet finger, the active extension power of the DIP joint is lost and the joint rests in an abnormally flexed position. The classic mechanism of injury is an extended finger struck on the tip by a softball, baseball, basketball

![Fig. 2. IP joint dislocation of the thumb sustained while playing flag football. (A) PA radiograph of the thumb demonstrates complete dislocation of the IP joint. (B) Reduction radiograph was obtained after reduction was performed with traction in the emergency room. No fracture fragments were identified.](image-url)
or volleyball [8]. The middle finger or long finger is most commonly injured, although any digit can be involved, including the thumb. Patients present with pain and swelling of the digit with inability to actively extend the DIP joint, although passive extension is possible.

Radiographs are helpful in identifying a small avulsion fracture at the extensor tendon attachment on the base of the distal phalanx. Nonoperative treatment is preferred if the avulsion fragment is small or if there is no osseous involvement [7]. Treatment typically consists of splinting the DIP joint in extension for 6 to 8 weeks [7]. Operative therapy is reserved for severe injuries or fractures involving greater than one third of the articular surface of the DIP joint [7,8]. Operative repair also can be considered for failure of conservative therapy, whereby there is persistent subluxation despite splinting.

Unfortunately, patients with mallet finger often do not present for immediate medical attention. Fractures tend to heal within weeks, and old osseous injuries without significant functional deficits are best left alone [8]. The injury often remodels over time, even in the presence of continued volar subluxation, and rarely leads to significant functional deficit. Late osteoarthritis of the DIP joint following a mallet finger injury is uncommon.

**JERSEY FINGER**

Another common sports injury involving the hand is jersey finger. Jersey finger is the term used to describe disruption of the flexor digitorum profundus (FDP) tendon from the volar aspect of the distal phalangeal base [7]. This disruption occurs when tackling and attempting to grab someone by the jersey [7]. The finger is pulled or forced into extension while the DIP is being flexed.
The ring finger is involved in up to 75% of cases, although any digit may be injured [7]. Patients clinically present with localized tenderness and pain with swelling and inability to flex the DIP joint [7]. Pain or fullness proximally along the course of the flexor tendon may occur, because there may be tendinous retraction after rupture [7]. Radiographs may depict an avulsion fracture of the volar aspect of the distal phalangeal base at the site of attachment of the FDP.

In contrast to mallet finger, early surgical referral is the treatment of choice for jersey finger [7], especially in the acute setting. Full functional outcome is likely with early surgical intervention, and best results are seen with intervention within 7 to 10 days [7]. In the chronic setting, the functional impairment fortunately is minimal or negligible, and benign neglect often is the treatment of choice [7]. Operative intervention is an option but is less successful with chronic deformities than with acute injuries (Fig. 4).

**FLEXOR TENDON TEARS**

Flexor tendon tears of the fingers commonly result from sports-related injuries. Treatment of flexor digitorum profundus or flexor digitorum superficialis (FDS) tendon injuries depends on the degree of injury. Often flexor tendon tears are difficult to diagnose clinically. MRI provides a noninvasive method to identify the site of tear, the degree of retraction of the torn fibers, and other associated soft tissue injuries (Fig. 5).

Types of flexor tendon injuries include tenosynovitis, partial tear, and rupture. Flexor tendon tenosynovitis is not infrequently seen with MRI of the finger in athletes. Tenosynovitis is an inflammatory response within the tendon sheath that often is related to repetitive stress [9]. Patients present with pain and swelling along the palmar surface of the digit, and sometimes have extension into the

**Fig. 4.** Jersey finger. Sagittal MR image of the index finger depicts a nondisplaced fracture at the base of the distal phalanx at the attachment of the flexor digitorum profundus (arrowhead).
palm or forearm. Passive flexion of the finger typically is normal, but active flexion is limited [9]. MRI depicts increased signal within the tendon sheath on fluidsensitive sequences with enhancement on post-gadolinium images.

Partial tear or rupture of the flexor tendons may occur anywhere along the course of the tendons, and may present with inability to flex one or both of the IP joints, depending on the site of rupture. Pain or fullness proximally along the course of the flexor tendon may be seen, because the torn flexor tendon may retract proximally after rupture. Jersey finger is often used to describe disruption of the flexor digitorum profundus from the volar base of the distal phalanx, as described previously. This disruption occurs when the finger is pulled or forced into extension while the DIP is being flexed [7]. Volar plate injury occurs with rupture of the FDS tendon at the PIP joint. This rupture has a similar mechanism of injury as jersey finger, with forced PIP hyperextension during active PIP flexion. Volar plate injuries also may be associated with avulsion fractures at the base of the middle phalanx (Fig. 6). Patients present with inability to actively flex the PIP joint, although passive extension is possible [7].

**BOUTONNIERE DEFORMITY**

Another uncommon injury involving the finger is the boutonniere deformity (Fig. 7). Normally, the central slip of the extensor tendon of the finger inserts...
on the middle phalanx [8]. With forced flexion of the PIP joint or volar dislocation of the PIP joint, disruption of this central slip of the extensor tendon can occur [8]. The lateral bands of the extensor tendon at the PIP joint are initially dorsal to the joint. With chronic disruption of the central band, however, the lateral bands retract and displace laterally and volarly, resulting in the characteristic boutonniere deformity. Injury is usually caused by a blow to the dorsum of the middle phalanx while the athlete is actively extending the finger, forcing the PIP joint into flexion [8]. Splinting of the digit in full extension for 6 to 8 weeks is the typical treatment for boutonniere deformity; however, surgical treatment may be necessary for severe or chronic injury [7].

Fig. 6. Volar plate injury. Oblique radiograph of the hand demonstrates fractures of the volar bases of the third and fourth middle phalanges (arrows) at the attachments of the flexor digitorum superficialis tendons. Fractures were sustained while playing football.

Fig. 7. Boutonniere deformity. Softball player injured his finger while sliding into a base. PA (A) and lateral (B) radiographs of the hand depict the characteristic fixed flexion deformity of the PIP joint with mild hyperextension of the DIP joint, compatible with boutonniere deformity.
FLEXOR TENDON PULLEY SYSTEM INJURY

Another finger injury that can occur in athletes is disruption of the flexor tendon pulley system. The flexor tendons pass through fibro-osseous canals from the heads of the metacarpals to the DIP joints, known as the flexor tendon pulley system (Fig. 8) [10,11]. The fibro-osseous canals of the pulley system are composed of focally thickened areas of the flexor tendon sheaths that are lined by synovium [10]. The pulleys accurately track the flexor tendons and keep them close to the bone during flexion and extension [10,11]. They also provide a fulcrum to transfer the linear force of the muscle and tendon into the rotation and torque needed to flex the distal phalanx [10]. The flexor tendon pulley system is composed of five annular pulleys and three cruciform pulleys [10]. An intact pulley system is crucial for proper flexion of the digits, and the A2 pulley is most important to flexor tendon function [10]. Injury typically initiates at the A2 pulley followed by the A3 and A4 pulleys. The A1 pulley rarely is injured [10]. Flexor tendon pulley injuries are seen in rock climbers and athletes in other sports that result in forced extension of a flexed finger [11].

MRI can diagnose ruptures of the A2 and A4 pulleys (Fig. 9). The diagnosis of pulley rupture can be made by direct visualization of the torn pulley; however, diagnosis more commonly is made with indirect signs [10]. Visualization

Fig. 8. The flexor tendon pulley system, with five annular and three cruciform pulleys. (From Berquist TH, Peterson JJ, Bancroft LW, et al. Trauma. In Berquist TH, editor. MRI of the hand and wrist. Philadelphia: Lippincott; 2003. p. 80; with permission)
of a gap between the bone and the flexor tendon with the finger in flexion allows diagnosis of pulley rupture. This gap is referred to as the bowstring sign. Disruption of the A2 pulley can be made with imaging of the finger in flexion by detecting a bowstring deformity of the flexor tendon, which extends to the base of the proximal phalanx [10].

**METACARPAL FRACTURE**

Metacarpal fractures account for up to one third of all hand fractures [4]. The most common fracture of the hand is fracture of the fifth metacarpal, accounting for approximately 50% of all metacarpal fractures and 20% of all fractures of the hand [4,10]. The mechanism of injury is either a direct blow to the hand or an indirect force from torsion or bending of the distal finger [10]. Dorsal apex angulation is common with metacarpal fractures. The more distal the fracture, the greater the degree of angulation that can be tolerated. Metacarpal fractures involving the ring and middle fingers inherently are more stable than those involving the index and fifth fingers, because there is dual support from the deep transverse intermetacarpal ligaments on the radial and ulnar sides [10].

Metacarpal fractures can be subdivided into distal fractures, fractures of the metacarpal neck, metacarpal shaft fractures, fractures of the metacarpal base, and fractures involving the base of the thumb. Distal metacarpal fractures by definition are intra-articular and therefore require urgent attention [5]. Most result from axial loading of the metacarpal by the tension exerted by the collateral ligaments [5]. Because distal metacarpal fractures are intra-articular fractures, they often are associated with soft tissue injuries, such as disruption of the collateral ligaments of the MCP joints.

Metacarpal neck fractures most commonly involve the fifth digit and are referred to as boxer’s fractures (Fig. 10). These fractures usually result from
punching a hard object, such as a wall or another person [10]. The fracture occurs just below the metacarpal head and the metacarpal head is displaced in a volar direction. The distal fifth metacarpal takes the brunt of the impact and breaks through the narrowest area near the neck, typically resulting in apex dorsal angulation or displacement at the fracture site [4]. Casting or splinting is helpful to avoid further instability and to promote healing with stability at the fracture site. Apex dorsal angulation up to 40 degrees is acceptable for non-operative management [7]. Fractures in this location often heal with residual apex dorsal angulation, which typically is not problematic. Fractures that are markedly comminuted or angulated occasionally may require open reduction and internal fixation.

Metacarpal shaft fractures are not uncommon sports injuries (Fig. 11). Their propensity for displacement is related directly to the extent of surrounding muscle and periosteal damage that occurred at the time of injury [5]. Rotation of a metacarpal shaft fracture is a great concern, because even a small degree of rotation can create a substantial degree of deformity at the fingertip [5]. Most fractures of the metacarpals and phalanges are low energy and result in simple fracture patterns that can be treated conservatively [10]. Minimally displaced, transverse or oblique, midshaft fractures are treated most frequently with closed reduction. Greater deformity is tolerated in the fourth and fifth fingers versus the second and third fingers [10]. Up to 50 degrees of apex dorsal angulation is tolerated in the fourth and fifth metacarpals, although only 30 degrees is tolerated in the second and third metacarpals [10]. Open reduction is reserved for high-energy trauma, fractures with excessive angulation, or multiple fractures.

**Fig. 10.** Boxer’s fracture. PA (A) and oblique (B) radiographs depict a fracture of the fifth metacarpal neck with volar angulation of the distal fragment. This fracture was treated conservatively with splinting with adequate results.
Fractures of the metacarpal base should be evaluated carefully for involvement of the adjacent carpometacarpal (CMC) joint, which occurs commonly [5]. Fractures of the metacarpal base occurring most commonly involve the fourth and fifth metacarpals. Fractures in this location often are reduced easily, but have a tendency to re-subluxate and often are treated operatively with percutaneous pinning [5].

**BENNETT FRACTURE**

An important subset of metacarpal injuries involves the base of the thumb. These injuries result from an axial load applied to the thumb [5]. The most
common is the Bennett fracture, named after Edward Hallaran Bennett, MD, who first described the fracture pattern in 1882 [12]. The original description was that of a fracture involving the base of the first metacarpal; however, the current definition of a Bennett fracture is an intra-articular fracture or dislocation involving the base of the first metacarpal (Fig. 12) [7]. With these fractures, the small fragment of the first metacarpal continues to articulate with the trapezium [10], whereas the remainder of the first metacarpal shaft is retracted laterally by the action of the abductor pollicis longus muscle [10]. The mechanism is classically an axial load to the flexed and adducted thumb [7]. Injuries such as this commonly occur in throwing athletes, such as a quarterback who strikes an object (eg, a helmet or the ground) on followthrough [7]. Early diagnosis and treatment are imperative to prevent loss of function of the first carpometacarpal joint [13]. Bennett fractures are unstable fractures, and unless properly recognized and treated this intra-articular fracture subluxation may result in an unstable arthritic first CMC joint [10]. Bennett fractures are treated most commonly with closed reduction with a thumb cast and immobilization of the first CMC joint. Open or closed reduction combined with internal fixation frequently is required [5]. If the fracture involves less than 20% of the articular surface, closed reduction with pinning generally is adequate. For fractures with more than 1 mm of articular incongruity after closed reduction, open reduction and fixation are indicated [4].

**ROLANDO FRACTURE**

A Rolando fracture is similar to a Bennett fracture, except it results in a comminuted intra-articular fracture of the base of the first metacarpal (Fig. 13) [7]. The fracture was originally described as Y-shaped, with a three-fragment fracture that extended to the CMC joint surface [14]. Today the eponym is used widely for any comminuted intra-articular fracture at the base of the thumb [7]. The
Rolando fracture occurs secondary to axial loading that crushes the articular surface of the first metacarpal. The Rolando fracture can be associated with significant posttraumatic arthritis if there is significant incongruity at the articular surface of the base of the first metacarpal. Marked decrease in hand function can result if proper fixation is not achieved; therefore, significant joint incongruity requires operative reduction [7].

GAMEKEEPER’S THUMB
Another common athletic injury involving the base of the thumb is disruption of the ulnar collateral ligament (UCL) of the first MCP joint as a result of an acute radial or valgus stress on the thumb [15]. Injury can occur in the form of an avulsion fracture, an isolated ligament tear, or combined fracture and ligament rupture [15]. The historical eponym refers to Scottish gamekeepers who repeatedly dispatched small animals by using their thumbs to push forcefully on the back of the animals’ heads, breaking their necks [15]. Today this injury commonly is referred to as skier’s thumb, because it is seen most commonly in snow skiers. Skier’s thumb results from a fall while holding a ski pole, causing forced abduction and extension of the thumb [7].

Radiographs may depict a small avulsion fracture fragment at the ulnar aspect of the base of the first metacarpal, at the attachment of the UCL (Fig. 14). Stress radiographs may demonstrate instability and widening of the ulnar aspect of the first MCP articulation, with greater than 30 degrees difference between the stress and neutral positions [7,14]. MRI or MR arthrography may be helpful in cases of suspected gamekeeper’s thumb by accurately depicting the osseous and soft tissue structures about the MCP joint, including the UCL and other ligaments and tendons (Fig. 15) [16]. If the fracture fragment is
nondisplaced, conservative therapy with splinting of the thumb may lead to healing and restoration of stability in select patients [7,14]. Surgical repair is preferable in most patients, however [14].

Stener lesion is an abnormality occasionally seen with gamekeeper’s thumb, in which there is an abnormal folded position of the torn end of the ulnar collateral ligament superficial to the adductor aponeurosis [17]. Spontaneous ligament healing is inhibited by the interposition of the thumb extensor mechanism between the torn fragments of the ulnar collateral ligament [15]. Stener lesion is suspected when the MCP joint is grossly unstable, or when there is a persistent

![Gamekeeper’s thumb. Middle-aged patient injured his finger in a skiing accident. PA radiograph of the hand shows a small avulsion fracture of the ulnar aspect of the base of the first proximal phalanx at the distal attachment of the ulnar collateral ligament (arrow).](image1)

![Ulnar collateral ligament tear of the first MCP joint. Short tau inversion recovery (STIR) image of the first MCP joint using a digit or small loop coil precisely depicts rupture of the ulnar collateral ligament (arrow) at its attachment on the base of the first proximal phalanx.](image2)
firm mass on the ulnar aspect of the first metacarpal head. Stener lesions have been reported to occur in up to 29% of patients with UCL injuries [16]. MRI can demonstrate both the UCL and the extensor aponeurosis and can depict Stener lesions accurately [6]. If a Stener lesion is present, only operative intervention allows apposition and healing of the traumatically displaced ligament in an anatomic position [15].

SUMMARY

In conclusion, injuries of the fingers and thumb in the athlete are common. Mallet finger, jersey finger, boutonniere deformity, Bennett and Rolando fractures, and gamekeeper’s thumb are just a few of the injuries that can occur in athletes. A thorough understanding of the mechanism of injury, osseous and soft tissue abnormalities, imaging features, and treatment is important in the care of athletes. Prompt and accurate diagnosis is important and may help minimize outcomes of malunion, posttraumatic arthritis, and debility.

References