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The Wrist: Common Injuries and Management

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Wrist injuries are common in athletes. They may result from a single, traumatic force or as a result of repetitive-loading activity. Complex wrist and hand anatomy can make diagnosis of wrist injuries an challenging task. A good understanding of wrist anatomy, as discussed elsewhere in this issue in ‘‘The Wrist: Clinical Anatomy and Physical Examination—an Update’’ by Eathorne, and an awareness of the common presentations of sport-specific injuries will facilitate accurate diagnosis. Labeling an athlete’s injury as a ‘‘wrist sprain’’ without a specific diagnosis may allow a competitive athlete to continue to play through the pain without proper treatment and exacerbate an injury. Management of a wrist injury in the athlete requires that the physician balance the athlete’s objective to return to sport promptly with treatment that allows healing and prevents long-term complications of an injury. It is important for the primary care physician to have an awareness of the broad range of injuries that occur in the athlete’s wrist, to be familiar with appropriate conservative management, and to refer appropriately.

Epidemiology

Child and adolescent athletes suffer relatively more wrist injuries than adult athletes. Three percent to 9% of all athletic injuries involve the hand and wrist [1]. This number is as high as 14% in high school football [2], and 46 to 87% of gymnasts suffer wrist injuries or have chronic wrist pain [3,4]. Injuries of the wrist can be divided into acute traumatic injuries and overuse injuries.

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Acute wrist fractures are common injuries among athletes. In a study of football players aged 9 to 15, 35% of injuries were to the upper extremities, and most were distal radius fractures [5]. Distal radius metaphyseal and physeal fractures are common in skating, football, basketball, and snowboarding. The scaphoid is the most commonly injured carpal bone, accounting for 70% of carpal fractures [2]. An athlete falling on an outstretched hand with the wrist dorsiflexed is a common mechanism. The triquetral bone is the second most commonly injured carpal bone. It typically occurs from a fall on a wrist in ulnar deviation. Pisiform fractures occur due to a direct blow, such as from a pitched ball.

Stress fractures occur in athletes whose sport requires repetitive motion involving wrist compression or twisting. Sports such as gymnastics and weightlifting place large repetitive compressive forces across the wrist. Distal radius physis stress syndrome, avascular necrosis of the capitate, and stress fracture of the scaphoid have been reported in these athletes [4,6]. Reportedly, up to 87% of elite gymnasts sustain distal radial physeal injuries [3]. Hook of hamate fractures have been seen in baseball, golf, and tennis players from the repetitive stress of bat, club, or racquet, respectively [7]. Repetitive stress is also thought to be a cause of avascular necrosis of the lunate or Kienböck's disease.

Soft-tissue injuries may either be due to acute trauma or overuse. Overuse syndromes such as deQuervain's tenosynovitis, extensor carpi ulnaris tendonitis, and sprains of pisotriquetral ligament [8] are associated with throwing and racquet sports. Dislocation of the distal radioulnar joint (DRUJ), midcarpal instability, and triangular fibrocartilage complex (TFCC) tears can occur due to a traumatic fall, or due to repetitive twisting motion as seen in gymnasts. Carpal dislocation typically requires significant force, such as a collision in football or a fall from a height in cheerleading.

General approach to wrist injuries

To begin, be familiar with the most common wrist injuries in active people and the common sport-specific injuries. Obtain a careful history regarding the athlete's wrist complaint, including how the complaint is related to activity and rest. It is important to have good clinical knowledge of the functional anatomy of the wrist in order to maximize the information gathered on examination. The evaluation of wrist complaints requires at least two radiographic views of the wrist (Fig. 1). An oblique view, in addition to a posterior-anterior (PA) and true lateral, is useful in identifying fractures. Special radiographic views of the wrist are also useful and will be addressed further in the discussion of specific injuries (Table 1). Several things are important to consider as treatment is initiated for a wrist injury including: the athlete's sport, his or her desire's regarding return to play, and the impact of injury management on the athlete's future participation in his

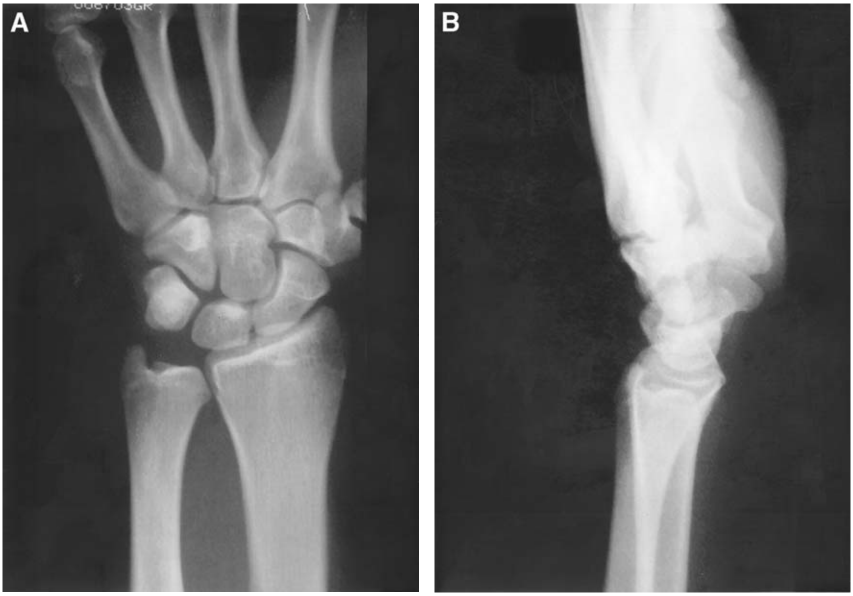


Fig. 1. Routine wrist radiographs. PA view (*A*) and lateral view (*B*).

or her sport. The primary care physician should understand that many injuries have a poor outcome if unrecognized. If the diagnosis is not clear, the athlete's wrist can be protected with a splint and referred for additional evaluation.

Management of all wrist injuries should include rehabilitation of muscles weakened and motion lost by pain, inflammation, and immobilization. Rehabilitation should proceed through five goal-oriented phases. Rehabilitation goals include: (1) decreasing pain and minimizing inflammation and edema; (2) increasing pain-free range of motion; (3) strengthening and improving general condition; (4) increasing sport-specific skill, coordination, and flexibility; and (5) return to sport with prevention of injury, which may include use of protective equipment. Physical therapists and athletic trainers can play a key role the safe and expeditious return to play of the athlete.

Tendonopathies

DeQuervain's tenosynovitis

DeQuervain's tenosynovitis is the most common tendonopathy of the wrist in athletes [9]. DeQuervain's tenosynovitis is inflammation of the tenosynovium of the first dorsal compartment tendons, the abductor pollicis longus (APL) and extensor pollicis brevis (EPB). These tendons course under the extensor retinaculum in a groove along the radial styloid process.

Table 1
Special radiographic views useful in the diagnosis of specific wrist pathology. Evaluation of all wrist injury should include PA, true lateral, and oblique views

Wrist pathology	Radiographic view
Pediatric physeal injury	Bilateral (comparison) views
Scaphoid fracture	Scaphoid view
	45° pronated oblique
	45° supinated oblique
	Clenched fist view in radial deviation
	Clenched fist view in ulnar deviation
Hook of hamate fracture	Carpal tunnel view
	Oblique with wrist extended, arm supinated
Pisiform fracture	Carpal tunnel view
Trapezium fracture	Carpal tunnel view
Distal radius fracture	Measure radial inclination and length on PA
	Measure volar tilt on true lateral
Scapholunate dissociation	Clenched fist view
	PA maximal ulnar deviation
	PA maximal radial deviation
Carpal instability	Scapholunate angle measured on true lateral
Carpal tunnel syndrome	Carpal tunnel view rule out osseous compression

Abbreviation: PA, posterior-anterior.

Repetitive wrist motion causes shear stress on the tendons in their small compartment, which results in inflammation of the tenosynovium. DeQuervain's tenosynovitis is common in racquet sports, fishing, and golf. On examination, the athlete will be tender over the APL and EPB, and will have pain with Finklestein's test (Fig. 2). Fibrous thickening of the tendon sheath and a ganglion cyst may be present in chronic cases. Acute deQuervain's tenosynovitis responds best to corticosteroid injection into the tendon sheath (Fig. 3). Results of a recent meta-analysis of treatments for deQuervain's tenosynovitis showed that there was an 83% cure rate with injection alone. This rate was much higher than any other therapeutic modality (61% for injection and splint, 14% for splint alone, and 0% for rest or nonsteroidal anti-inflammatory drugs [NSAIDs]) [10]. If conservative treatment fails, surgical decompression of the first dorsal compartment should be considered. Surgical candidates should expect 7 to 10 days of postoperative splinting, followed by rehabilitation and return to sport in 6 to 9 weeks [9].

Intersection syndrome

Intersection syndrome is a painful inflammatory condition located at the crossing point of the muscles of the first dorsal compartment (APL and EPB) and second dorsal compartment tendons. (extensor carpi radialis longus [ECRL] and extensor carpi radialis brevis [ECRB]). The site of crossover is 6 to 8 cm proximal to the radial-carpal joint in the dorsal

Fig. 2. Demonstration of Finkelstein's test. The forearm is stabilized with one hand while gently forcing the wrist into ulnar deviation.

forearm (Fig. 4). This site is tender and may be swollen. There is often a palpable crepitus at the intersection with moving the wrist through flexion and extension, leading to the name "squeakers syndrome." It is seen in athletes who play sports requiring forceful, repetitive wrist flexion and extension (rowing, weight lifting, gymnastics, and racquet sports). The pathophysiology is still unclear, but it is thought to be a tenosynovitis of the second dorsal compartment tendons, or inflammation of an adventitial bursa between the APL and ECRB due to friction at the intersection. This syndrome responds well to conservative treatment of rest, local icing, and NSAIDs, with a gradual return to sports. Splinting with a thumb spica splint in 15° of wrist extension for 2 weeks is helpful to rest the muscles [11].

Fig. 3. First dorsal wrist extensor compartment of cadaveric model. Injection site for deQuervain's tenosynovitis is demonstrated.

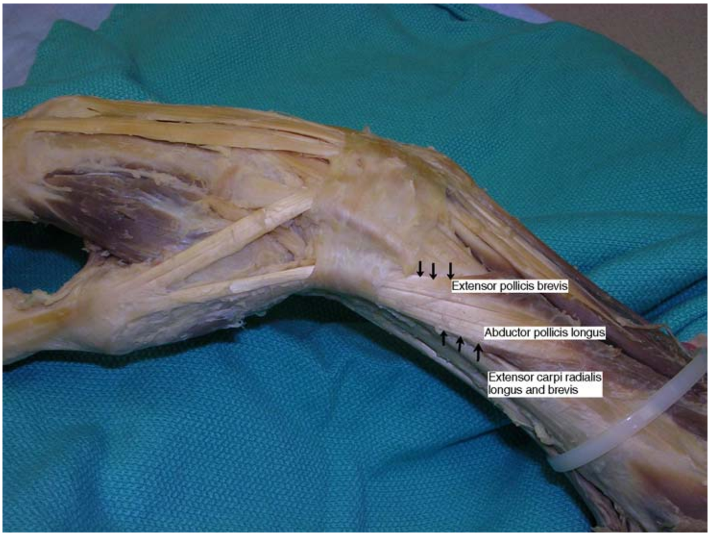


Fig. 4. Intersection of first and second dorsal compartments (*arrows*). Tendons labeled.

Injection with local anesthetic and steroid may be needed if symptoms do not resolve with NSAIDs and rest [12]. Range-of-motion and strengthening therapy should follow splinting before return to sports. Surgery is rarely needed, but cases recalcitrant to conservative therapy for greater than 6 weeks may undergo release of the second dorsal compartment and debridement of inflammatory tissues [9].

Extensor carpi ulnaris tendonopathy

Extensor carpi ulnaris (ECU) tendonitis is the second most common sports-related overuse injury of the wrist [13]. This should be included in the differential diagnosis of an athlete with ulnar wrist pain. It is commonly seen in racquet sports, rowing, and squash [14]. Patients present with the complaint of dorsal-ulnar wrist pain after repetitive activity. Diagnosis is made by physical examination. There is tenderness and swelling over the ECU tendon sheath, dorsal to the ulnar styloid. Pain is reproduced with resisted dorsiflexion with the wrist in ulnar deviation and forearm supination [11]. Wrist radiographs are negative. Treatment includes rest, splinting, and NSAIDs [9]. If not improved after 2 weeks of conservative therapy, corticosteroid injection often resolves symptoms. Injection of the ECU tendon sheath requires good knowledge of the wrist anatomy, so as not to damage the dorsal sensory branch of the ulnar nerve (Fig. 5). Lastly, surgery may be required to decompress the sixth dorsal compartment.

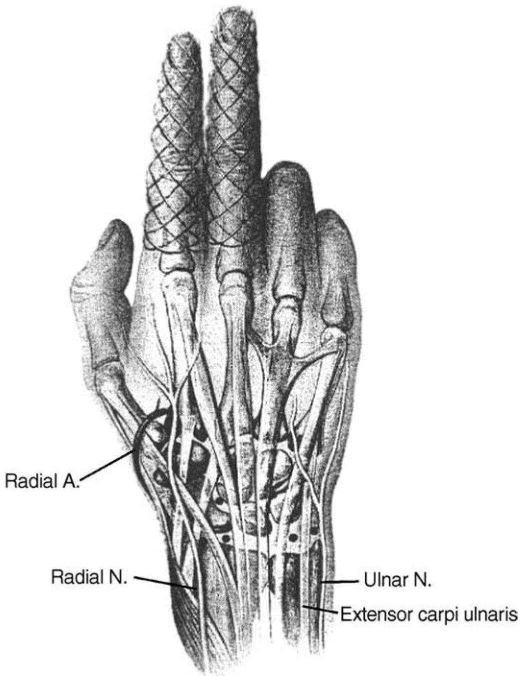


Fig. 5. Relative anatomy of extensor carpi ulnaris and the dorsal sensory branch of the ulnar nerve. A, artery; N, nerve. (*From* McCue FC, Bruce JF, Koman JD. The wrist in the adult. In: DeLee JC, Drez D, editors. Orthopedic sports medicine: principles and practice. 2nd edition. Philadelphia: WB Saunders; 2003. p. 1343; with permission.)

ECU subluxation is a less common injury, but is important to consider in the differential diagnosis of chronic ulnar wrist pain. ECU subluxation occurs with forceful supination, palmar flexion, and ulnar deviation of the wrist [15]. This injury is seen in tennis players hitting a low forehand, or in the trailing hand of a baseball player at the end of a swing [14]. It may also occur after a fall on an outstretched hand (FOOSH) [15,16]. Patients typically complain of dorsal ulnar wrist pain and "snapping" that are aggravated by forearm rotation [15]. Tenderness and swelling are elicited over the ECU in the area of the ulnar head. Marked pronation or supination may reproduce the "ping" as the tendon subluxes out of its groove. Wrist radiographs are normal. A 6-week period of immobilization in a long arm cast may be tried [9]; however, in several case reports [15,16] this conservative therapy has not been successful. For symptomatic patients, surgical repair of the ruptured tendon subsheath is recommended [17,18], followed by 4 to 6 weeks of immobilization, with return to sport anticipated 8 to 10 weeks following surgery [9].

Flexor carpi ulnaris tendinopathy

Flexor carpi ulnaris (FCU) tendonitis presents with palmar-ulnar side wrist pain, and is seen in racquet sport athletes. Examination reveals tenderness along the FCU and pain with wrist flexion. Dorsal wrist splinting with 25° of flexion for 1 to 2 weeks and a short course of NSAIDs typically resolve symptoms [14]. Corticosteroid injection is considered for recalcitrant cases. Excision of the pisiform and Z-plasty lengthening of the FCU has been described for chronic cases [14].

Flexor carpi radialis tendinopathy

Flexor carpi radialis (FCR) tendonitis presents with pain in the palmar-radial wrist with repetitive wrist flexion. Tenderness is over the FCR at its insertion on the base of the second and third metacarpals, and pain is reproducible with resisted wrist flexion. As with FCU tendonitis, treatment is rest with brief splinting, NSAIDs, and stretching, and if symptoms are prolonged, surgical release may be indicated.

Distal radioulnar joint and triangular fibrocartilage complex

DRUJ and TFCC injuries are often discussed together, due to closely related anatomy and frequently overlapping symptoms. The DRUJ is located between the distal radius and the head of the ulna. Five structures are important in ensuring the stability of the DRUJ: (1) the triangular fibrocartilage (TFC), (2) the ulnocarpal ligament complex, (3) the infratendinous extensor retinaculum (ie, the ECU tendon sheath), (4) the pronator quadratus muscle, and (5) the interosseous membrane [19]. Intimately related to the DRUJ is the TFCC. The TFCC (Fig. 6) is composed of the semicircular biconcave fibrocartilage or articular disc called the TFC, the palmar and dorsal distal radioulnar ligaments, a meniscus homolog, and the ulnolunate and ulnotriquetral ligaments [20]. The distal radioulnar ligaments arise from dorsal and palmar edges of the distal radius and are often indistinguishable from peripheral fibers of the TFC.

Distal radioulnar joint instability

Because of the intimate relationship and overlapping structures of the DRUJ and TFCC, injury to either can occur by a similar mechanism, such as traumatic axial load with rotational stress (eg, FOOSH). Both injuries typically present with ulnar-sided wrist pain. Because the TFCC adds stability to the DRUJ, an injury to the TFCC can result in DRUJ instability; however, DRUJ instability can also occur as a result of other injuries, such as a distal radius fracture or disruption of any of the five

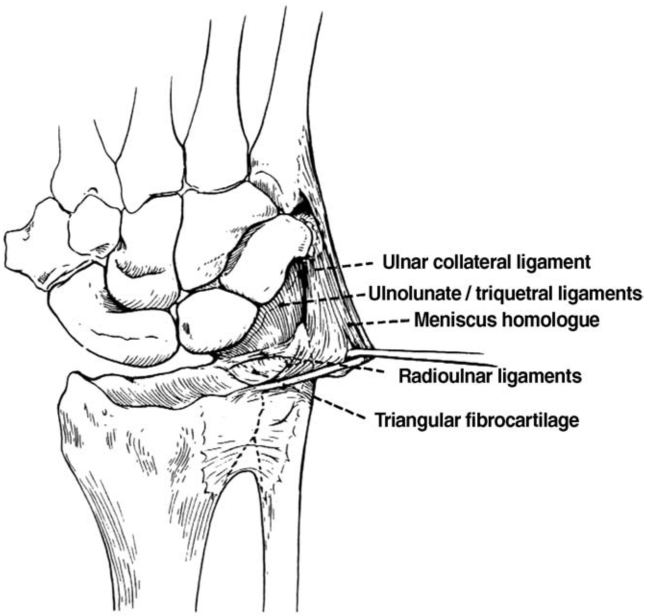


Fig. 6. Schematic components of the triangular fibrocartilage complex. (*From* Dell PC. Distal radioulnar joint dysfunction. Hand Clin 1987;3:564; with permission.)

stabilizers mentioned above (eg, distal radioulnar ligaments or interosseous membrane).

DRUJ injuries may present acutely at dislocation or with chronic ulnar wrist pain due to instability. A patient who has an acute DRUJ dislocation without associated fracture usually complains of pain over the ulnar aspect of the wrist accentuated by pronation and supination [19]. On examination, there is moderate swelling and tenderness over the DRUJ. In dorsal dislocations, there is a prominence of the distal ulna dorsally when the wrist is flexed. In palmar dislocations, the normal prominence of the ulnar head at the wrist may be obscured by soft-tissue swelling. DRUJ dislocation can be difficult to diagnose with plain radiography. A true lateral radiograph may demonstrate the dorsal or palmar displacement of the distal ulnar relative to the radius. PA radiographs may show a greater than normal gap between the head of the ulna and distal radius if the ulna is dorsally dislocated. In palmar DRUJ dislocations, the ulna and radius may be superimposed on the PA view [19]. Bilateral wrist comparison views may be helpful. If concern for DRUJ injury exists and radiographs are inconclusive, CT or MRI may be warranted.

Isolated acute DRUJ dislocations need to be reduced and immobilized in a long arm cast with forearm neutral for 6 weeks [19]. If there is an associated injury (eg, TFCC tear) and the soft tissue is interposed between the radius and ulna, healing with closed reduction may be unsuccessful.

DRUJ dislocations with associated fractures are generally not amenable to nonoperative management [19].

DRUJ subluxation is a cause of chronic ulnar wrist pain. The ulnar head is prominent in pronation as it rides onto the dorsal lip of the radius. Supination may then be restricted, often followed by a distinct snap during forearm rotation [19]. The "piano key sign" indicates distal radioulnar joint instability [1], which allows subluxation of the ulna on the radius. This sign is elicited by having the patient place both palms on the examining table and forcefully press downward. There is exaggerated dorsal-palmar translation of the distal radius compared with the opposite side. Alternatively, this sign can be elicited by depressing the ulnar head while supporting the forearm in pronation; the ulnar head springs back like a piano key, indicating laxity of the DRUJ [21]. Patients who have chronic subluxation may receive temporary relief with a distal forearm splint that exerts a relocating force on the ulnar head. Definitive treatment for the symptomatic athlete, however, is typically surgical [19].

Triangular fibrocartilage complex injury

The TFCC is a cartilaginous and ligamentous structure important in the stabilization of the distal radial ulnar joint (as mentioned above). The articular disc of the TFCC separates the ulna and the proximal carpal row, and carries about 20% of the axial load from wrist to forearm [22]. There is a relative lack of blood supply to the central portion of the TFCC, leading to poor healing of tears [23]. Injuries to the TFCC occur with repetitive ulnar loading (eg, bench press, racquet sports) or acute traumatic axial load with rotational stress (eg, FOOSH). Most injuries to the TFCC have a component of hyperextension of the wrist and rotational load. Ulnar-sided wrist pain made worse with ulnar deviation, wrist extension, or heavy use is the common complaint of an athlete who has a TFCC injury. TFCC injuries are more commonly seen in such sports as gymnastics, hockey, racquet sports, boxing, and pole vaulting [24].

The TFCC is palpated in the hollow between the pisiform, FCU, and ulnar styloid. It is most easily palpated with the wrist in pronation. Injury to the TFCC is indicated by tenderness on palpation of the TFCC, with or without distal radioulnar joint instability. TFCC compression by forced ulnar deviation and axial compression with repeated flexion and extension will impact the ulnar styloid and TFCC. This will result in pain or clicking if the TFCC is involved [3]. The "press test" reproduces the patient's pain when the patient lifts herself out of a chair while bearing weight on the extended wrists [25]. The "supination lift test" has also been described for localized tear to the peripheral, dorsal TFCC. With this test, pain is reproduced when the patient attempts to lift the examination table with the palm flat on the underside of the table [26] This forces a load across the

TFCC with the wrist supinated and extended, causing dorsal impingement, and is useful in the diagnosis of peripheral, dorsal TFCC tear.

Radiographs are usually normal in TFCC injuries. The PA view may, however, demonstrate positive ulnar variance, which is a risk factor for TFCC injury. Ulnar variance is the relationship of the length of the radius and ulna. This relationship, which is categorized as positive (long ulna relative to radius) or negative (short ulna relative to radius), influences the distribution of compressive force across the wrist. Most forearms are within 2 mm of ulnar positive or 4 mm ulnar negative. Pathologic conditions are more prevalent at the extremes of ulnar variance [27]. Positive ulnar variance is associated with a thinner TFCC [28] and increased forces transmitted across the TFCC [29], making it more prone to injury. High-resolution MRI and MR arthrogram may detect TFCC tears. CT scan of the wrist in neutral, pronation, and supination may reveal distal radioulnar joint instability that may be due to TFCC injury [1]. Rest, activity modification to remove the inciting force of injury, ice, splint immobilization for 3 to 6 weeks, and subsequent physical therapy may be effective for some TFCC injuries [1,3]. Buterbaugh et al [26] recommend a trial of 6 weeks of splinting and NSAIDs for patients presenting with ulnar-sided wrist pain, normal plain films, and suspected TFCC injury. Failure of conservative treatment necessitates further imaging or arthroscopy. For high-level athletes (elite high school, collegiate, or professional) who have negative initial imaging and persistent symptoms limiting participation, diagnostic (and potentially therapeutic) arthroscopy may be indicated after as little as 2 to 3 weeks of splinting [1]. Arthroscopy is used to debride central tears and repair peripheral tears. Some injuries require open surgery with an ulnar shortening procedure. Return to sport after surgery ranges from 6 to 12 weeks following arthroscopic debridement to 6 months after an open procedure [29].

Our knowledge of ulnar-sided wrist pain, including TFCC injury and DRUJ instability, is advancing with MRI and arthroscopic technology. The complexity and variability of these injuries is becoming more evident. The TFCC may be injured centrally or peripherally. There may be other associated injuries or fractures. The type of injury and extent of the injury determines the efficacy of conservative treatment. Ninety percent good-to-excellent results have been reported from arthroscopic repair of central or peripheral TFC tears with a stable DRUJ [1].

Fractures

Distal radius fracture

Distal radius fractures are very common in sports. This injury typically occurs with a FOOSH with hyperextension, impacting the distal radius. The athlete presents with pain, swelling, ecchymosis, and tenderness about the wrist. Initial radiographs should include PA, lateral, and oblique views of the wrist. The examiner needs to determine the type of distal radial fracture and assess displacement, shortening, and intra-articular involvement. The goal of treatment is to correct and maintain radial inclination, palmar tilt, length, and congruity of the distal radial articulations (carpal and ulnar).

A Colles' fracture, the most common distal radius fracture, is a closed fracture of the distal radial metaphysis in which the apex of the distal fragment points in the palmar direction and the hand and wrist are dorsally displaced (Fig. 7). This fracture usually occurs within 2 cm of the articular surface. Colles' fractures are common in adults and rare in children, because children tend to sustain injuries through the distal radial physis.

Stable distal radius fractures may be managed in a short arm cast. All others should be referred for reduction and fixation. A stable distal radius fracture is extra-articular, without comminution, and with minimal or no displacement, which, when reduced to anatomical alignment, does not redisplace back to the original deformity [30]. For optimal outcome, it is important that anatomic alignment of the radius is maintained (either at presentation or with reduction); however, authors differ slightly on the definition of acceptable anatomical alignment. Certainly, fractures must be referred for orthopedic consultation if there is greater than 20° dorsal tilt, loss of radial inclination (20° to 30° need to be maintained), articular step-off greater than 2 mm, or radial shortening greater than 5 mm (Fig. 8) [31]. Maintaining radial inclination of 20° to 30°, 4° to 8° palmar tilt, and radial shortening no greater than 2 mm is recommended by Rettig and Trusler [32]. Some texts report that less than 20° of dorsal tilt is stable for closed reduction of a Colles' fracture [30,33]; however, the reduction needs to be

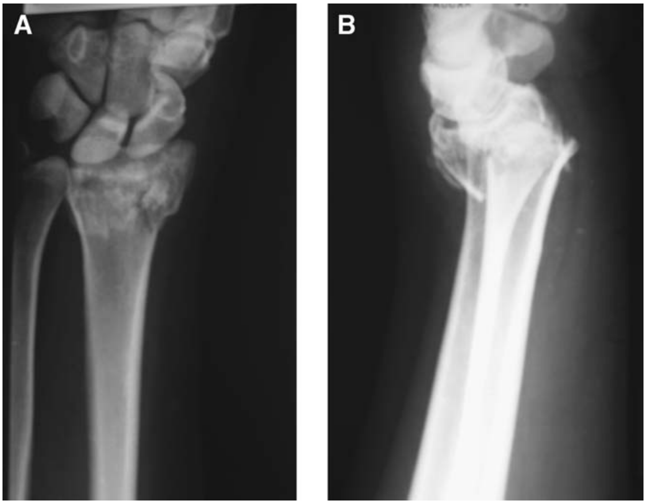


Fig. 7. Colles' fracture. PA view (*A*) and lateral view (*B*).

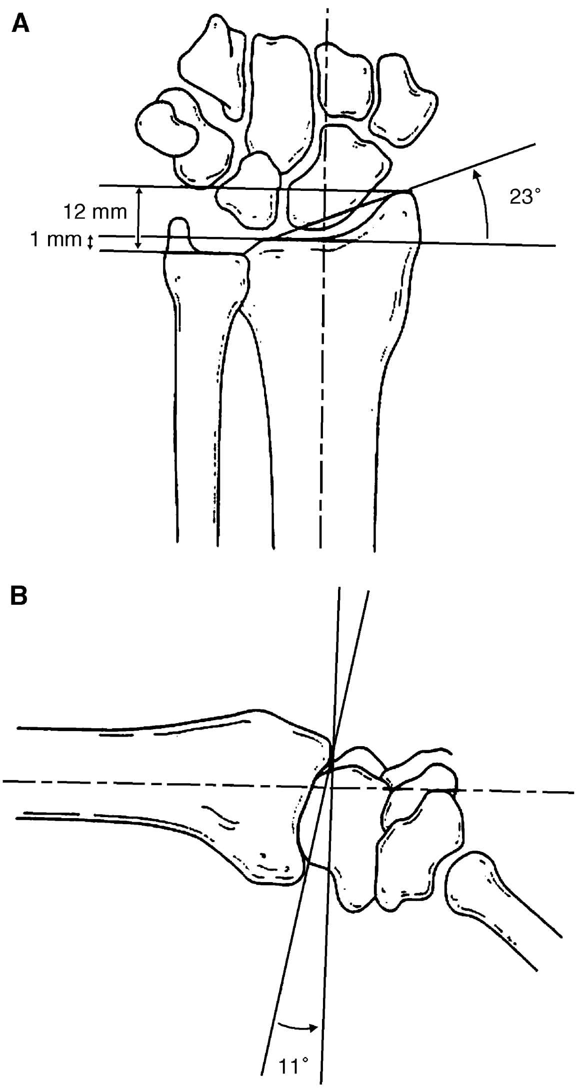


Fig. 8. (*A*) Measurements of radiographic parameters of the distal radius and ulna. Radial inclination, measured off the perpendicular to the radial shaft, averages 23°. Radial length is the difference in length between the ulnar head and the tip of the radial styloid (average 12 mm). Ulnar variance depicts the difference in length between the ulnar head and the ulnar aspect of the distal radius (shown as 1 mm ulnar negative). (*B*) Volar tilt is measured off the perpendicular to the radial shaft on lateral radiograph. (*From* Cohen MS, McMurty RY, Jupiter JB. Fractures of the distal radius. In: Browner BD, Levine AM, Jupiter JB, et al, editors. Skeletal trauma: basic science, management and reconstruction. 3rd Edition. Philadelphia: WB Saunders; 2003. p. 1316; with permission.)

close to anatomic alignment. Laboratory studies demonstrate that alteration of palmar inclination by 20° or more can cause dorsal shift in the scaphoid and lunate, leading to decreased range of motion and high pressure areas on the distal radius [34]. In an individual who normally has 11° of palmar tilt, the maximum acceptable alteration in palmar inclination is 9° of dorsal tilt. Clinical studies also demonstrate that patients who have excessive dorsal tilt are more likely to have poor outcome. McQueen and Jaspers [35] reported on 30 patients who had a Colles' fracture at 4 years follow-up. Patients who had as little as 10° dorsal tilt were much more likely to have pain, stiffness, weakness, and poor function.

Fractures may "settle" or displace in the cast. If healing occurs with a displaced fracture fragment, wrist range of motion will be compromised. A distal radius fracture that is considered stable is managed with a short arm cast, but must be followed with weekly radiographs for at least 3 weeks to ensure that the fracture does not displace in the cast. If cast immobilization is not able to maintain less than 10° of dorsal radial inclination and less than 5 mm radial shortening, internal fixation is recommended [30].

Some surgeons are electing to manage even traditionally stable distal radius fractures with internal fixation. The reason seems to be twofold. The closer to anatomical alignment the fracture is maintained, particularly in palmar tilt, the better the outcome. Also, "stable" fractures may displace with cast immobilization, termed "secondary instability," and require internal fixation. In a prospective radiological study performed on 170 Colles' fractures that were treated with closed reduction and cast immobilization [36], 29 fractures displaced, requiring further reduction and external fixation. Seventeen additional fractures suffered malunion, with significant increase in radial angulation and decrease in radius length.

Common distal radius fractures in children include torus, greenstick, and physeal fractures. A torus fracture occurs when the tough periosteum, while remaining intact, buckles circumferentially at the fracture site. If one side of the periosteum buckles but the other side breaks, it is called a "greenstick" fracture. Physeal injuries are typically classified radiographically using the Salter-Harris classification. Type I fracture is a disruption of the physis. Type II is a fracture through the physis extending obliquely through the metaphysis. Type III is an intra-articular fracture through the epiphysis that extends across the physis to the periphery. Type IV fractures cross the epiphysis, physis, and metaphysis. Type V fractures are compression injuries of the physis, typically diagnosed retrospectively due to growth disturbance. Type III and IV fractures are also at risk of growth disturbance, and frequently require surgical fixation. Stable distal radius fractures (eg, torus fracture, Salter I or II fractures) may be treated in a short arm cast for 4 to 6 weeks, followed by protective splinting and rehabilitation [31]. A protective splint should be used upon return to sports for at least 2 weeks. Intra-articular, comminuted, angulated, or shortened fractures, or those that demonstrate loss of radial inclination, may require operative treatment and should be managed by an orthopedist. Salter-Harris III–V injuries require orthopedic consultation.

A related injury, a stress injury to the distal radius physis, has been reported in high-level gymnasts. This stress fracture should be suspected in the athlete who presents with dorsal wrist pain made worse by stress loading, such as vaulting or hand-walking. There is no history of acute trauma or loss of motion, and examination reveals tenderness over the distal radial epiphysis. Radiographs may be normal or may demonstrate widening or haziness of the epiphysis [37]. Treatment is immobilization, followed by wrist range-of-motion and strengthening rehabilitation. Noncompliance or inappropriate treatment places the athlete at risk for growth disturbance of the distal radius.

Scaphoid fracture

Clinicians must have a high index of suspicion for scaphoid fracture when presented with the complaint of radial wrist pain in any contact-sport athlete. The scaphoid bone is unique for two reasons. First, it spans both the proximal and distal carpal row, making an intact scaphoid imperative for carpal stability. Second, the scaphoid relies on an interosseous blood supply from branches of the radial artery that enter the scaphoid distal to the middle third and provide the sole blood supply to the proximal pole [38]. Therefore, fractures through the proximal third disrupt the blood supply and are prone to osteonecrosis and nonunion.

Scaphoid fractures are most common in those aged 15 to 30 years, and are rare under the age of 10 [39]; however, among wrist injuries in children, the scaphoid is the most commonly fractured bone, accounting for over 70% of all carpal fractures [3]. FOOSH while skating, skateboarding, and bicycling is often the mechanism of injury. Physical examination may reveal tenderness over the scaphoid in the ‘‘anatomic snuff box,’’ and tenderness over the scaphoid tuberosity in the palm or at the scapholunate area distal to Lister’s tubercle dorsally. Scaphoid compression tenderness may be elicited by applying axial pressure to the scaphoid via the first metacarpal. Usually there is no swelling or ecchymosis. Wrist range of motion may be only slightly decreased. Initial wrist radiographs should include PA in neutral position, PA in ulnar deviation (scaphoid view), lateral with wrist in neutral, 45° pronated oblique, 45° supinated oblique, and anteriorposterior clenched fist. The ulnar deviation performed for the scaphoid view (Fig. 9) distracts unstable fracture fragments, allowing visualization of the fracture. Clenched-fist views allow assessment of the scapholunate gap, which is useful in excluding associated scapholunate dissociation.

Most simply, fractures are divided into anatomical location: distal pole, middle third, and proximal pole. There are several more complex classifications of scaphiod fractures based on location and stability for healing.

Fig. 9. Scaphoid view. No fracture.

One example is the Herbert Classification, outlined in Box 1 [40]. Rüsse [41] also proposed that, in addition to location, the obliquity of the fracture relative to the long axis of the scaphoid has a role in healing. Adults most commonly sustain middle-third fractures, and children most commonly fracture the distal pole or middle third (Fig. 10) [3,38]. Distal fractures heal most rapidly, often within 6 weeks. In contrast, proximal fractures, due to the tenuous blood supply as described above, may take 6 months [38].

If the patient has scaphoid tenderness without radiographic evidence of a fracture, the wrist is immobilized in a short arm thumb spica cast, with the wrist in mild extension and the thumb interphalangeal joint free, for 10 to 14 days. Follow-up radiographs at 2 weeks may reveal bone resorption adjacent to the fracture site, or early callus formation if occult fracture was present. Often athletes require a more urgent diagnosis to facilitate return to play. A bone scan, CT, or MRI may be considered for additional imaging. A

Box 1. The Herbert Classification of scaphoid fractures

Type A: stable acute fractures
- A1. Fracture of tubercle
- A2. Incomplete fracture of the waist (middle third)

Type B: unstable acute fractures
- B1. Distal oblique
- B2. Complete or displaced waist fracture
- B3. Proximal pole fracture
- B4. Trans-scaphoid perilunate dislocation fracture
- B5. Comminuted fracture

Type C: delayed union

Type D: established union
- D1. Fibrous nonunion (stable)
- D2. Displaced nonunion (unstable)

Adapted from Herbert TJ, Fisher WE. Management of the fractured scaphoid using a new bone screw. J Bone Joint Surg Br 1984;66:114–23.

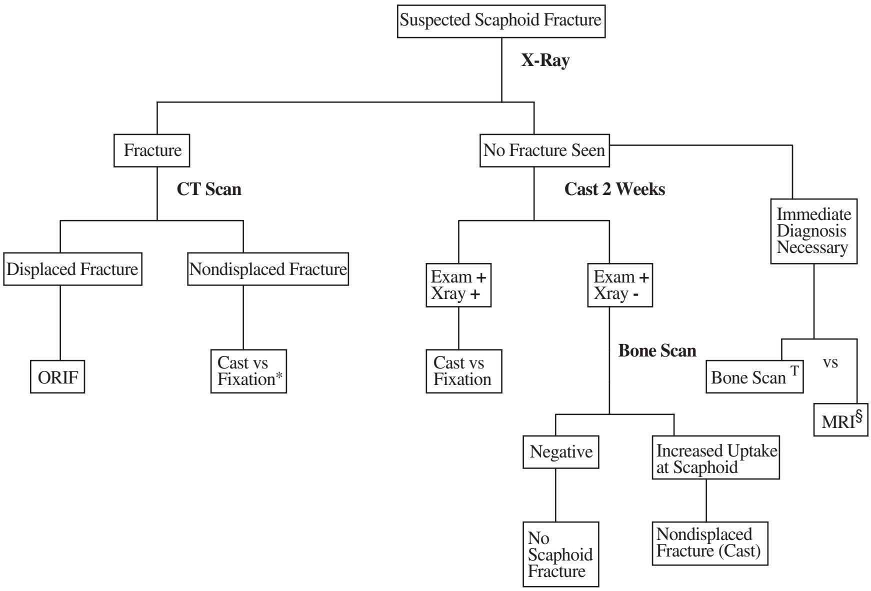
bone scan may be positive 24 hours after the injury; however, it can take 4 days for abnormal uptake to appear at the fracture site. A normal bone scan 4 days after injury is accurate in excluding scaphoid fracture [38,42]. MRI is very sensitive and will have abnormal bone marrow signal 48 hours post-fracture [43]; however, it may not clarify fracture displacement. CT scan gives clearer fracture visualization, and is more accurate for determination of displacement [43]. The evaluation and treatment of scaphoid fractures is controversial and continues to evolve. One method of evaluating suspected scaphoid injury is outlined in Fig. 11.

Treatment of an acute scaphoid fracture in an athlete depends on the location and stability of the fracture, as well as the sport and the desires of the athlete. A scaphoid fracture is considered displaced and unstable if displacement is 1 mm or greater, or if a step-off is visible on any radiograph view [38]. Displacement of fractures may be difficult to recognize on standard radiography alone; CT may be required to better define the fracture anatomy. Although a complete, nondisplaced scaphoid fracture may heal with cast treatment, internal fixation may be more appropriate for the athlete because less time is required in a cast (some greater than 10 weeks casted, versus 5 to 6 weeks if primarily surgically repaired [44]). Non-displaced fracture of the distal pole and transverse incomplete fractures of the middle third of the scaphoid are the most stable scaphoid fractures, and the most amenable to cast treatment [45]. Some middle-third scaphoid

Fig. 10. Scaphoid fracture.

fractures, particularly vertical oblique fractures, are less stable, take greater than 12 weeks to heal, and have a higher rate of nonunion. These are primarily fixed by some surgeons [45]. Displaced fractures and proximal pole fractures, which have a greater risk of nonunion and malunion (see below), should be referred for operative treatment Fig. 12.

A nondisplaced distal scaphoid fracture or incomplete fracture may be immobilized in a short-arm thumb spica cast for 4 to 8 weeks, with follow-up visits and radiograph every 2 weeks until radiographic union. Healing time is typically 6 to 8 weeks. Nondisplaced middle-third fractures are treated with long arm cast for 3 to 4 weeks, followed by a short arm cast for another 6 to 8 weeks [1]. Healing takes 9 to 12 weeks, with a minimum of 3 months out of sport. Ninety to 100% of transverse, nondisplaced, middle-third fractures will heal with casting if treatment is started within 3 weeks of



* Specialist's preference.

T 4 days post-injury, if bone scan is negative there is no scaphoid fracture.

§ Within 48 hr post-injury, MRI demonstrates fracture.

Fig. 11. Algorithm for one method of suspected scaphoid fracture management. ORIF, open reduction, internal fixation.

injury [46]. Delay in immobilization beyond 3 weeks from fracture has a higher incidence of nonunion, and should be referred to an orthopedic surgeon [47]. For some sports, such as football and soccer, a playing cast may be used after the initial 4 weeks of casting; however, one study noted a higher nonunion rate (39%), ultimately requiring surgery, with playing casts, compared with a rate of 15% with traditional casting and no sports participation [1].

Open reduction and internal fixation has become standard for proximal pole fractures, and is required for unstable fractures. It is also becoming more accepted to surgically repair minimally displaced or nondisplaced middle-third fractures, particularly for earlier return to sport, when a playing cast is not an option [44,48]. Inoue and Shionoya [44] compared cast treatment of nondisplaced middle-third scaphoid fractures with internal fixation in laborers, and noted return to work in an average of 10.2 weeks in the cast group and 5.8 weeks in the internal fixation group, with nearly 100% union in both groups. Another study [41] compared the effectiveness of immediate open reduction and internal fixation with the Herbert screw versus nonoperative treatment with a playing cast, in an athletic population. Return to sport was earlier in the cast-treated group (4.3 weeks) than in the surgical fixation group (8.0 weeks); however, a subsequent study [49]

Fig. 12. Scaphoid malunion.

demonstrated that return to sport averaged 5.8 weeks for acute midthird scaphoid fractures. Both treatment methods yield union rates comparable with those in other studies. The athletes in this study did not have increase risk of nonunion secondary to participation in sports. A playing cast is an acceptable option for a stable fracture after an initial 4 weeks of immobilization. Internal fixation of an acute scaphoid fracture allows safe and early return to sports between 5 to 6 weeks [1,38,44,49], when a playing cast is not an acceptable option and when an athlete accepts the risks of surgery.

To summarize, patients who have proximal, displaced, angulated, or complex scaphoid fractures (scaphoid fracture associated with distal radius fracture, open fracture, or perilunate fracture dislocation), or those who have delayed diagnosis or nonunion should be referred for surgery.

Consider referral for any athlete or manual laborer, because many surgeons offer percutaneous-screw fixation techniques to these patients in order to decrease the time of cast immobilization [1,38,44,49]. Following prolonged immobilization, referral to a physical therapist will help regain motion and strength. Return to sport after healing and rehabilitation should include use of a protective rigid splint for 3 months.

Kienböck's disease

Acute isolated fracture of the lunate is rare, because it is well enclosed in the large lunate fossa of the distal radius; however, avascular necrosis of the lunate, Kienböck's disease, is seen in the young adult population. It generally affects the dominant wrist and is unilateral [3]. This lesion presents with dorsal wrist pain and swelling, decreased grip strength, and decreased range of motion, particularly in extension [50]. Typically, there is no apparent history of trauma. Pain may be produced in the lunate region by an axial strike at the distal end of the extended third digit. Plain radiographs are useful in making the diagnosis of Kienböck's disease (Fig. 13). The precise etiology of Kienböck's disease is unknown, but several causes have been proposed. Vascular compromise from repetitive trauma (in such sports as handball, volleyball, golf, gymnastics, tennis, and martial arts) is thought to cause microfractures and excessive stress on the microscopic architecture [3,50]. Individuals who have increased risk are those who have ulnar negative variance. The shortened ulna is thought to increase shear force across the lunate and cause vascular insufficiency.

The natural history of Kienböck's disease is progressive sclerosis, fragmentation, and arthrosis [51]. Kienböck's disease advances through

Fig. 13. Kienböck's disease. MRI demonstrates avascularity of the lunate.

four radiographic stages: (1) normal on plain radiographs, but the lunate is abnormal on bone scan, consistent with microfracture; (2) lunate sclerosis without collapse; (3) lunate fragmentation and collapse; and (4) perilunate arthritic changes. Functional disability may not always be progressive. Several studies suggest that some patients who have Kienböck's disease can have minimal pain and dysfunction for years with no treatment or intermittent immobilization [52,53]. Others report disappointing results with conservative treatment: worsening pain, limited motion, and progressive arthrosis on radiographs [54]. It is difficult to know which patients will have delayed dysfunction and which will have rapid progression. Conservative treatment will not change the natural history of the disease, but may allow the patient to recover from an acute flare of arthritic synovitis. Surgery is the only definitive treatment for Kienböck's disease. With more advanced disease, there are fewer surgical options [51]. Early surgical management involves unloading the lunate, which may require changing the length of the ulna or radius. Bone grafting and revascularization are newer techniques being investigated [51]. Once the disease has progressed to arthrosis, surgical options tend to be limited to wrist fusion. Individuals who have Kienböck's disease being managed conservatively need to be re-evaluated periodically for pain and dysfunction. They should be made aware of the disease progression and treatment options. Early orthopedic referral is ideal.

Hamate fractures

Hamate fractures occur in the body or hook. Both fractures present with ill-defined pain in the ulnar aspect of the wrist, and may have associated ulnar paresthesias. Most commonly, such injuries present late, due to chronic pain, rather than acutely at time of injury. Palmar palpation of the hook produces tenderness if a hook fracture is present. Body fractures are tender dorsally. Hook of the hamate fractures are most common in sports involving gripping a stick, bat, or racquet. Injury occurs by sporting equipment repeatedly compressing the hook of the hamate, causing fracture, or by acute trauma [50]. Routine wrist radiographs with the addition of a carpal tunnel view are helpful to demonstrate a hook fracture (Fig. 14). Flexor digitorum function of the ring and little fingers, as well as ulnar nerve function, should be assessed, because both structures are in close proximity to the hamate and can be injured with a fracture [38]. Cast immobilization may permit healing of acute hook fractures; however, nonunion is common, occurring in up to 46% of cases [7,55]. In the athlete who has an acute hook fracture, excision of the fracture fragment is the treatment of choice. This successfully resolves symptoms and allows return to sport 6 to 10 weeks after surgery [1,31,55]. Nonunions are also treated with excision of the hook. Isolated hamate body fractures are rare. Nondisplaced body fractures may

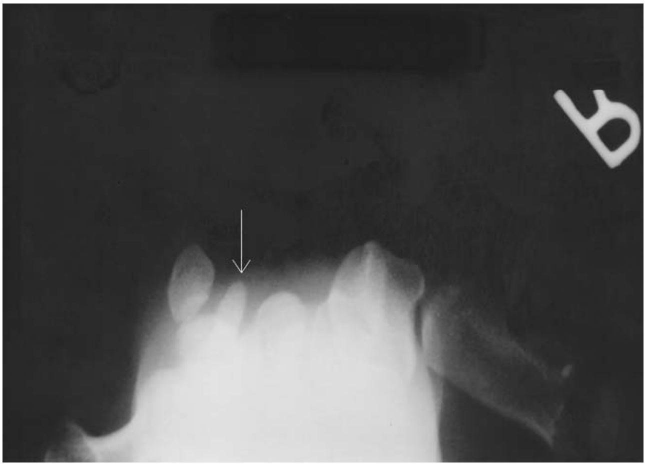


Fig. 14. Carpal tunnel view. Hook of hamate intact (*arrow*).

be treated with short-arm cast immobilization for 4 to 6 weeks. Displaced fractures require open reduction, internal fixation (ORIF).

Pisiform fractures

The pisiform is a sesamoid bone contained within the flexor carpi radialis tendon. Pisiform fractures are uncommon and, as with other carpal bones, tend to occur with a FOOSH injury. Examination reveals tenderness over the pisiform. If routine wrist films do not reveal the fracture (Fig. 15),

Fig. 15. Pisiform fracture (*arrows*) demonstrated on lateral view.

a carpal tunnel view may be useful. Most fractures heal with 3 to 6 weeks of short arm cast immobilization; however, if nonunion occurs, the pisiform can be excised [50].

Other carpal fractures

Triquetral and capitate fractures are typically the result of significant traumatic force through the wrist (Fig. 16). Triquetral avulsion fractures can heal with immobilization for 4 weeks, but body fractures of both the triquetral bone and the capitate are associated with severe ligamentous injury, requiring surgical repair [50]. These fractures should be referred. Trapezium fractures (Fig. 17) tend to be unstable and to easily displace [50]. These injuries usually require surgical fixation.

Ligamentous injury

Carpal instability is due to the disruption of the interosseous ligaments that connect and stabilize the carpal bones. These severe carpal disruptions are injuries that are frequently missed. It is important to recognize that all wrist pain is not a "wrist sprain," and to appropriately diagnose and properly treat suspected carpal instability injuries. Carpal instability is a continuum of disorders that can result from an acute trauma or from

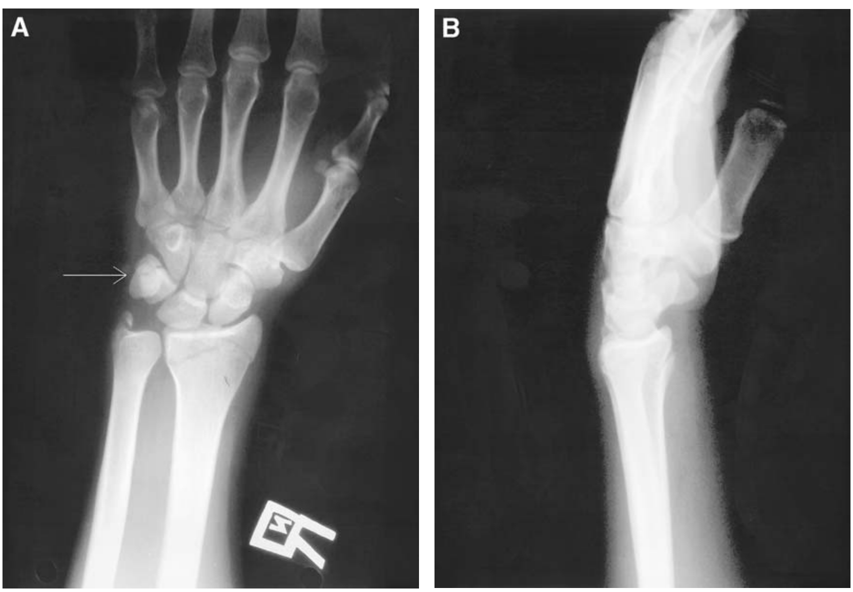


Fig. 16. Triquetral fractures (*arrow*). Trauma to the wrist demonstrated by associated injuries: distal radius fracture and ulnar styloid fracture. PA (*A*) and lateral (*B*).

Fig. 17. Trapezium fracture.

repetitive injury. Multiple ligaments may be torn in an acute traumatic event, causing complete lunate dislocation. Alternatively, minor trauma or repetitive events may disrupt individual ligaments, which if left untreated will progress along the continuum of instability disorders, resulting in post-traumatic arthritis with pain and dysfunction [56]. Clinical suspicion of these injuries and arming oneself with appropriate diagnostic skills will facilitate early diagnosis and appropriate treatment.

Scapholunate injuries result from a fall on a hand in which the wrist is extended and ulnar deviated. There typically is swelling, decreased range of motion, and dorsal wrist tenderness in the area of the scaphoid and lunate. A positive scaphoid shift test or Watson's sign (see anatomy section of the article on wrist anatomy and examination by Eathorne elsewhere in this issue) indicates a scapholunate tear. A positive scaphoid shift test reproduces pain and elicits a ''pop'' when the distal pole of the scaphoid is loaded dorsally and the wrist is moved from ulnar to radial deviation.

Scapholunate dissociation is diagnosed radiographically as a widening (>3 mm) between the scaphoid and lunate [33]. This may be difficult to see on the standard PA view, depending on the degree of ligamentous injury (Fig. 18). Stress views are helpful for diagnosis, because they elicit a widening between the carpals if there is a ligament injury. Useful stress views include clenched-fist view (an PA view of the wrist with a clenched fist), PA maximal radial deviation, and PA maximal ulnar deviation. Left untreated, the scapholunate dissociation widens, the capitate shifts down into the gap, and the carpal rows collapse. This is known as a SLAC (scapholunate advanced collapse) wrist [57]. If this is not evident on plain radiographs, MRI may demonstrate a complete scapholunate tear. MRI is unreliable for the diagnosis of incomplete tears. Arthroscopy has become

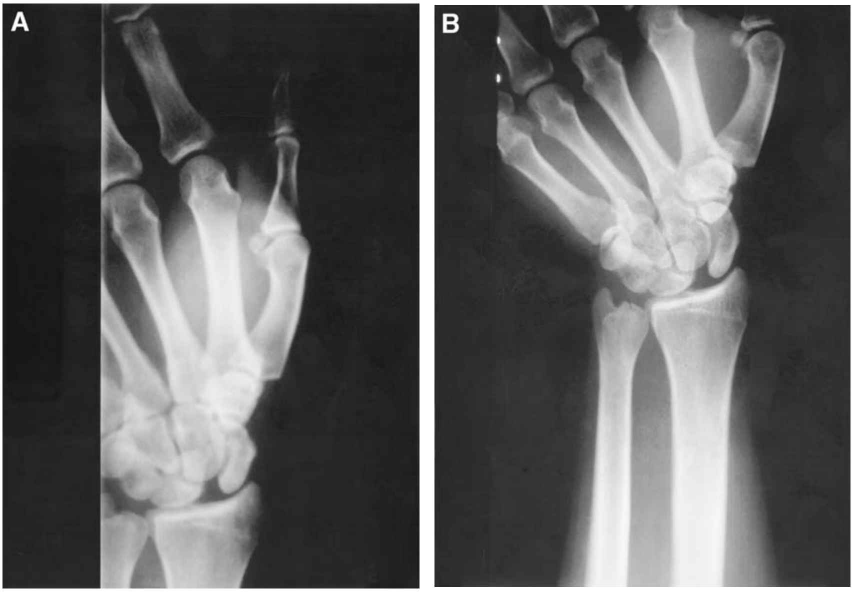


Fig. 18. Scapholunate dissociation. Greater than 3 mm widening between the scaphoid and lunate on PA view (*A*) is abnormal, indicating ligamentous injury. Scaphoid view (*B*) accentuates widening.

the standard method of diagnosing intercarpal ligament injuries [1]. Small tears in the scapholunate ligament may not result in carpal instability, but are a common cause of chronic wrist pain associated with synovitis or ganglion cyst formation. Large tears of the scapholunate ligament cause instability (ie, scapholunate dissociation). Any scapholunate ligament tear that demonstrates dissociation or instability on imaging requires surgical repair [11,58]. Small, partial tears that do not demonstrate static separation of the ligaments on imaging may respond to a 3-month trial of conservative therapy [11]. Conservative therapy includes activity to a pain-free level and splint immobilization, followed by rehabilitation and progressive exercise. The decision to proceed with arthroscopy and the length of conservative therapy depend largely on the athlete. A high-level athlete whose sport cannot tolerate wrist immobilization and who may miss an entire season may proceed more quickly to arthroscopy.

Lunotriquetral tears also result from a FOOSH, but are much less common than scapholunate tears. Lunotriquetral tears present with ulnar-sided wrist pain, weakness, and possibly clicking. There is tenderness over the area of the lunotriquetral ligament. Dorsal pressure over the pisiform and palmar force on the lunate may produce a painful click. Plain radiographs are usually normal. Clinically correlated arthrography, with radiocarpal and midcarpal injection, can be useful for diagnosis. Bone scan may be obtained to rule out an occult fracture. MRI may be of benefit to rule out other ulnar-sided pathology, such as TFCC injury, but is not yet reliably sensitive for diagnosis of lunotriquetral ligament injury [1,59]. Lunotriquetral injuries are treated with immobilization and NSAIDs. Immobilization results in lunotriquetral ligament healing in 80% of cases [60]. If symptoms persist following 4 to 6 of immobilization, the patient should be referred for diagnostic and potentially therapeutic arthroscopy [1,32]. Because most lunotriquetral tears do not cause instability, they usually do not lead to progressive arthrosis.

In addition to stress radiographs mentioned above, careful evaluation of the true lateral view is important in the evaluation of carpal instability. On the normal true lateral view there is colinearity of radius, lunate, and capitate. These three bones should be lined up, appearing as stacked cups. If the lunate is grossly dislocated, it rotates so the concavity tips palmarly, termed the ‘‘spilled teacup sign’’ (Fig. 19A) [61]. Perilunate dislocation is also the result of gross ligament disruption. The lunate and radius are in proper alignment, but the remaining carpal bones are dislocated dorsally (Fig. 19B). Measurement of the scapholunate angle on the lateral film will aid assessment of scapholunate instability, which often presents with subtle radiographic findings. To measure this scapholunate angle (Fig. 20), draw a line through the long axis of the scaphoid on the true lateral and a second line through the center of the concavity of the lunate and radial shaft.

Fig. 19. (*A*) Lunate dislocation is demonstrated by the spilled teacup sign. The lunate is dislocated and tipped volarly. (*B*) Perilunate dislocation.

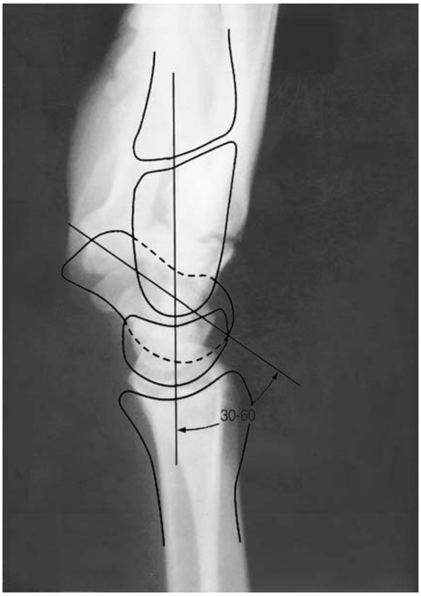


Fig. 20. Measurement of the scapholunate angle.

Measure the dorsal angle created by these lines. Normal scapholunate angle is 30° to 60°. An angle of less than 30° indicates that the lunate is volarly (palmarly) angulated, indicating a volar intercalated segment instability (VISI). Greater than 60° dorsal angulation of the lunate indicates dorsal intercalated segment instability (DISI). Knowledge of wrist ligamentous anatomy assists one in understanding these injuries. First, dorsal and ventral refer to the position of the lunate. Second, the scapholunate ligament is attached to the volar (palmar) aspect of the lunate, and the lunotriquetral ligament is attached to the dorsal aspect of the lunate. A rupture of the scapholunate ligament, which is volarly attached, allows DISI. A rupture of the lunotriquetral ligament, which is dorsally attached, may allow VISI; however, although scapholunate tears frequently cause DISI, lunotriquetral tears rarely cause VISI, due to other stabilizing ligaments. If there is significant force, several ligaments may rupture, leading to perilunate dislocation. The capitate is displaced dorsally on the lunate on true lateral radiograph. If the lunate is dislocated, it is the displaced volarly into the carpal tunnel, resulting in the spilled teacup sign. Both injuries require surgical repair.

Due to the potentially poor outcome of carpal instability, whenever a physician suspects a carpal sprain and is unable to exclude significant ligament injury, referral is recommended. The patient should be splinted and seen in consultation within a few days.

Wrist ganglia

Ganglia are common about the wrist. Thick, clear, fluid leaks through a tear (degenerative or traumatic) in the joint capsule or tendon sheath to form a ganglion cyst. Common locations include the dorsum of the wrist directly over the scapholunate joint, and the volar radial aspect. Dorsal wrist ganglia arise from the scapholunate joint, and volar ganglia typically arise from the radiocarpal joint, scaphotrapezial joint [62], or FCU tendon. Ganglion cysts may or may not be painful. Typically there is no history of wrist trauma. If pain or limitation of function mandates, the ganglion can be aspirated or excised. In a recent study of children who had asymptomatic wrist ganglia, 79% resolved spontaneously within 1 year [63]. Therefore, observation, particularly in children, is preferred. In a recent prospective study of different treatment methods in adults (aspiration versus excision) for volar wrist ganglia, similar recurrence rates were demonstrated [64]. At 5-year follow up, recurrence rates of a volar wrist ganglion were 42% after excision and 47% after aspiration. Fifty-one percent of untreated ganglia had disappeared spontaneously.

Dorsal wrist ganglia also tend to recur after aspiration. One study reported a cure rate of 13% after single aspiration [65], whereas another study reported an 85% cure rate if three or more aspirations were performed [66]. Recurrence rates are unchanged by cortisone injection following aspiration [67]. Recurrence rate of dorsal ganglia after cyst excision is approximately 13% to 40%; however, with careful excision of the cyst's stalk, recurrence rates decrease to 4% [68].

Occult dorsal wrist ganglia can produce chronic wrist pain, which may be constant or activity related [62]. Localized dorsal wrist tenderness, maximum aggravation of pain during wrist flexion, decreased range of motion, and weak grip on examination may indicate an occult dorsal wrist ganglion. Initial examination and imaging should exclude scapholunate instability. MRI may help identify an occult ganglion and differentiate it from a scapholunate ligament tear. Conservative therapy of occult dorsal wrist ganglia, including corticosteroid injection followed by immobilization in a cock-up wrist splint for 7 to 10 days, may be tried initially [62]. Definitive diagnosis and treatment is surgical exploration and excision.

Compressive neuropathies

Upper extremity compression neuropathies are relatively uncommon in athletes, particularly at the wrist; however, direct contusion of the tissue overlying peripheral nerves or repetitive activity causing tissue swelling can cause neuropathic symptoms. Neuropraxia is the type of nerve lesion most commonly seen in athletes. This is a conduction block along the nerve, typically from compression or impingement, with nerve elements intact.

Compression of radial, median, distal posterior interosseous, and ulnar nerves at the wrist has been seen in athletes. It is important to consider the cervical spine and elbow as other sites of impingement. With early diagnosis, rest, splinting, and activity modification often lead to symptom resolution and return to sport.

Median nerve

Carpal tunnel syndrome (CTS) is the most common neuropathy seen in athletes. It is common in cyclists, gymnasts, throwing athletes, wheelchair athletes, and those who participate in sports that require gripping [69]. The median nerve is entrapped as it passes through the nonyielding carpal tunnel (see the anatomy section of the article on wrist anatomy and examination by Eathorne elsewhere in this issue). A history of paresthesias affecting the radial three and one-half digits and nighttime pain are typical. Phalen's test is often positive, and Tinel's sign, thought to be less sensitive, may also be present. Electromyography (EMG) and nerve conduction studies (NCS) are helpful in assessing ongoing denervation. It has been generalized that approximately 80% of patients who have carpal tunnel syndrome initially respond to conservative treatment; however, symptoms recur in 80% of these patients after 1 year [70]. One effective, noninvasive, short-term therapy is night wrist splinting. A study [71] found that among patients who had improvement with night splint use for at least 6 weeks, 31% still had symptom improvement at 12 months.

A recent systematic review [72] of randomized, controlled trials of conservative treatments for CTS found that NSAIDs, diuretics, and pyridoxine are no more effective than placebo in relieving the symptoms of carpal tunnel syndrome. Both oral corticosteroid therapy and local corticosteroid injection have been shown to be effective in short-term therapy (2 to 4 weeks) for electrophysiologically confirmed carpal tunnel syndrome [72–75]; however, the optimal oral corticosteroid dosage and duration of treatment remains to be determined [73]. Additionally, at 8 to 12 weeks post-treatment, symptom improvement was seen only with local corticosteroid injection [75]. One double-blind, placebo-controlled trial found that 77% of patients given a local corticosteroid injection had significant symptom improvement, compared with 20% in the control group [76]. Yet another study [77] demonstrated that only 11% of patients who had initial improvement with corticosteroid injection had relief of symptoms at 12 months post-injection.

Surgical treatment has significantly better long-term outcomes than conservative therapy [78]. DeStefano et al [79] reported that patients who had CTS and who underwent surgical release were six times more likely than those treated nonoperatively to have resolution of symptoms. Carpal tunnel release surgery should be considered in patients who have prolonged symptoms that do not respond to conservative measures, and who have progressive slowing of nerve conduction. Those patients who respond to conservative therapy tend to show improvement of symptoms within 8 to 12 weeks [80]. Most patients who will respond to steroid injection do so by 4 weeks post-injection [72–75]. Patients who have severe nerve entrapment, as evidenced by nerve conduction studies, thenar atrophy, sensory loss, or motor weakness, should referred for surgical release of the flexor retinaculum. A 7.0-millisecond or greater delay of the median nerve distal latency represents severe compression of the median nerve [81]. To prevent permanent nerve damage, these individuals should be referred for surgery without delay.

Ulnar nerve

"Cyclist's palsy" is an ulnar neuropathy caused by compression of the relatively superficial distal ulnar nerve, and it can be caused by wrist position during prolonged bicycling. It has also been reported in racquet sports and weight lifting, and in hockey goaltenders [82]. Ulnar nerve compression at Guyon's canal (see the anatomy section of the article on wrist anatomy and examination by Eathorne elsewhere in this issue) usually presents with pain and paresthesias of the small finger and the ulnar half of the ring finger. Symptoms depend on the location of compression relative to Guyon's canal (ie, ulnar tunnel). Sensation and motor function of the ulnar nerve should be assessed. If radiographs, including carpal tunnel views, exclude bony pathology, then rest, splinting, and NSAIDs can be initiated. Upon return to sport, padding over the palmar-ulnar aspect of the wrist may prevent recurrence. Replacing handlebar padding or cycling gloves and having body weight properly distributed on the handlebars by appropriate bike fitting may remedy a cyclist's problem. Patients who do not respond to conservative treatment may require additional studies (eg, MRI, EMG) to rule out space-occupying lesions and evidence of denervation.

Distal posterior interosseous nerve syndrome

Athletes such as weight lifters and gymnasts may present with complaints of pain with wrist extension. If there is no evidence of mass or carpal instability, distal posterior interosseous nerve syndrome should be suspected. This purely sensory nerve can be entrapped where it passes over the distal radius and enters the wrist capsule, due to fibrosis that can occur with repetitive, forceful wrist extension [83]. Splinting and corticosteroid injection are the initial treatments. Surgery may be required for symptomatic relief.

Radial nerve

Wartenberg's syndrome is radial nerve compression in the forearm. The nerve runs subcutaneous between the brachioradialis and extensor carpi radialis longus, and is subject to irritation by wristbands and gloves [69]. Patients present with pain and decreased sensation over the dorsoradial hand, dorsal thumb, and index finger. There is no motor loss. Conservative treatment of activity modification is generally effective.

Summary

Primary care physicians not only have an important role in the diagnosis and initial treatment of wrist injuries, but also play a key role in the education of families about prevention. Children and adolescents are often competitive in sports throughout the year. Periods of rest can be important in prevention of overuse injuries in the very active, developing athlete. Protective gear such as wrist guards, used during activities such as inline skating and snowboarding, has been shown to prevent acute injuries that often require surgery or lead to prolonged disability [84,85].

A primary care physician will often be the first health care provider to assess most wrist complaints. The intent of this article is to familiarize the primary care physician with the most common wrist injuries in active people, and to demonstrate that many injuries can have poor outcomes if unrecognized. It is important to have good clinical knowledge of the functional anatomy of the wrist in order to maximize the information gathered on examination and to narrow one's differential diagnosis. The athlete's sport and desires regarding return to play, and the impact of the timing of injury management on his or her further participation in sport are important to consider. A highly active person may be referred to a musculoskeletal specialist for advanced testing or surgical repair earlier in the evaluation of certain injuries than a less active one. Armed with good clinical knowledge of anatomy and an understanding of common wrist injuries, primary care physicians can successfully manage many wrist complaints.

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