

EVALUATION OF HAND AND WRIST INJURIES IN ATHLETES

MARK D. JACOBSON, MD, and KEVIN D. PLANCHER, MD, MS

Injuries to the wrist and hand are very common in athletes. Timely treatment is very important because these injuries result in short- and/or long-term disability. A correct diagnosis allows treatment, which often requires immobilization, rest, and/or time away from sport, to begin immediately. The key to an accurate diagnosis is a thorough patient history and physical examination. Specific physical signs and appropriate use of additional radiographic and special imaging studies are often used to confirm the diagnosis.

KEY WORDS: hand, wrist injuries, athletes, physical examination, radiographic evaluation

Injuries to the wrist and hand account for approximately 25% of all sporting injuries and occur in a sport-specific nature.¹ Acute injuries that occur in contact sports such as football, may result in a scaphoid fracture. Overuse injuries such as tendinitis or carpal tunnel syndrome may occur in racquet or throwing sports, when an athlete repeats motions hundreds or thousands of times. The patient's history taken by the physician is extremely important in obtaining an accurate diagnosis. The physician taking care of athletes' hands and wrists must develop an understanding of the specific demands unique to the athlete's sport. The clinician should also understand the equipment and vocabulary of the athlete. For example, a pitcher complaining of wrist pain when throwing a curve ball or a tennis player with a similar complaint when trying to hit top spin may lead the physician to a diagnosis based on his or her understanding of the motions involved in that sport. The history should localize the pain and note which motions accentuate pain. The athlete should describe the onset of the pain, how it relates to the sporting activity, and when pain occurs during sport. The physician should inquire about the training routine, increase in playing time or workout intensity, and the number of repetitions of certain motions (such as tennis strokes or pitches thrown) in a given period of time.

The physician must use his or her knowledge of the complex and compact anatomy of the hand and wrist to develop a differential diagnosis for the patient's complaint. The differential diagnosis may include disorders of bone, tendon, nerve, ligament or joint capsule (Table 1). This differential diagnosis is narrowed down by using the patient's history to determine whether the nature of the injury is chronic or acute. Acute injuries are more commonly fractures or sprains, whereas chronic injuries are more commonly tendinitis or nerve compression.

The physical examination should focus on the location of

pain. Inspection of the wrist is first in any physical examination. The examination of each area should include palpation, which differentiates tenderness of bony structures or tendon sheaths. Palpation should start in the areas that do not cause pain. With the patient's confidence, subsequent guarding will be avoided. We begin with palpation of all bony prominences of the wrist, eg, the scaphoid tuberosity, hook of the hamate, and pisiform (Fig 1).

The physician then examines active and passive range of motion of all joints of the digits and wrist, as well as forearm supination and pronation. These values are compared with the contralateral "normal" side. Sensory examination includes a two point discrimination test as described by Werner and Omer,² and assessment of nerve irritability with Phalen's and Tinel's tests. The physician then assesses the competency of the ligamentous supporting structures by stressing the joint capsules and ligaments. The strength of each muscle is also tested and recorded. We obtain objective data collected to include pinch and grip strength measurements.³ Additional physical tests and special maneuvers are used for specific diagnoses.

If secondary gains are an issue, then we perform a five position grip strength test (Jamar dynamometer, Jackson, MI) from the narrowest to the widest span (Fig 2). When the results are plotted on a graph, one should see a normal bell-shaped curve. The peak may be at positions two or three representing the most efficient distance for the hand to produce force. A flat curve, with the same output, eg, strength, often represents a submaximal or intentionally poor effort. The other modification of the standard grip test is the rapid exchange method.⁴ In this test, the patient is asked to alternate the dynamometer from one hand to the other in rapid succession. When patients intentionally squeeze the instrument weakly, they have trouble producing a constant level of effort while rapidly alternating from hand-to-hand. If the peak grip measurements are much higher than one found during an isolated static testing, the patient is performing a submaximal effort.

An accurate diagnosis may present a challenge. Although most injuries to the hands are easily diagnosed by the patient's history and physical, others may require

From the Albert Einstein College of Medicine, Montefiore Medical Center, Bronx, NY; and the Steadman Hawkins Clinic, Vail, CO.

Address reprint requests to Kevin D. Plancher, MD, Montefiore Medical Center, 111 E 210th St, Bronx, NY 10467-2490.

Copyright © 1996 by W.B. Saunders Company
1060-1872/96/0404-0002\$05.00/0

TABLE 1. Differential Diagnoses for Location of Wrist and Hand Pain

Dorsal Wrist
Scaphoid impaction syndrome.
Distal radioulnar joint instability.
Scapholunate ligament tears.
Lunotriquetral ligament tears.
Occult ganglion.
Carpometacarpal boss.
Kienböck's disease.
Posterior interosseous nerve.
Ulnar Wrist Pain
Triangular fibrocartilage complex tears.
Ulnar impaction syndrome.
FCU tendinitis.
ECU tendinitis.
ECU tendon subluxation.
Radial Wrist Pain
de Quervain's tenosynovitis.
Flexor carpi radialis tendinitis.
Intersection syndrome.
Scaphoid fracture.
Cheiralgia paresthetica.
Volar Wrist Pain
Ganglion.
Carpal instability.
Kienböck's disease.
Preiser's disease (avascular necrosis of the scaphoid).
Flexor carpi radialis tendinitis.
Pisotriquetral arthritis.
Palmar Pain
Ulnar neuritis.
Carpal tunnel syndrome.
Hook of hamate fracture.
Stenosing tenosynovitis.
Guyon's canal compression.
Thumb Carpometacarpal Joint
Carpometacarpal arthritis
Carpometacarpal dislocation.
Ulnar collateral ligament tear.
PIP Joint Pain
Boutonnière
Pseudoboutonnière
DIP joint
Flexor digitorum profundus avulsion.
Mallet finger.

radiographs or other imaging modalities to make a diagnosis. The appropriate use of these imaging modalities is dependent on the physician's knowledge of the differential diagnosis of symptoms for each region of the wrist and hand, as well as the value of imaging studies in obtaining each diagnosis. Once the differential diagnosis has been sufficiently narrowed, specific studies to confirm or eliminate specific diagnoses may be obtained.

ROUTINE RADIOGRAPHIC EVALUATION

Routine radiographic examination of the hand and wrist should include the zero rotation posteroanterior (PA), lateral, and oblique views of the injured side. The zero rotational PA should be performed with the patient's shoulder abducted 90°, the elbow flexed 90°, and the forearm placed in a pronated position with beam perpendicular to the film plate and ulnar styloid seen in full profile. (Fig 3A). This position allows for calculation of ulnar variance.⁵ There should be a small joint space (distal radioulnar joint) seen between the radius and ulna on a successful zero rotation view (Fig 3B). The PA should include the entire third metacarpal to allow calculation of carpal height (Normal $.54 \pm .03$).⁶

The lateral film of the wrist should be taken with the

third metacarpal aligned with the longitudinal axis of the radius, the wrist in neutral and the ulnar head and radius superimposed (Fig 3C). The arm is extended and the ulnar side of the wrist is placed on the x-ray cassette perpendicular to the beam of the x-ray. Diagnosis of an ulna that is volar or dorsally dislocated must be avoided, because forearm rotation can create the illusion of subluxation. A computed tomography (CT) scan is the only reliable test to confirm this diagnosis.⁷ The lateral x-ray of the digits (II-V) is performed with the fingers splayed to allow clear visualization of the joint spaces (Fig 3D). The oblique views of the hand and wrist are directed specifically from the history and physical and will be discussed later under Specific Injuries.

SPECIFIC INJURIES

Scaphoid Fracture

Scaphoid fractures are extremely common in contact sports. They account for two-thirds of all carpal bone fractures and are seen in approximately 1% of college football players.⁸ The athlete falls on an outstretched hand with subsequent radial-sided wrist pain. On physical examination, the patient may have tenderness in the anatomic snuffbox between the first and third dorsal compartments (Figs 4A and 4B). Initial imaging of this patient should include a zero PA x-ray of the wrist. If a fracture is not seen, the patient should have PA x-rays of the wrist in radial and ulnar deviation (scaphoid in longitudinal profile) with the elbow flexed 90°, as well as a clenched-fist view. These



Fig 1. Surface anatomy of the volar wrist. Note the position of the hook of the hamate (intersection of lines), pisiform, and the scaphoid tubercle that is used in Watson's test. (Copyright Dr Kevin D. Plancher.)

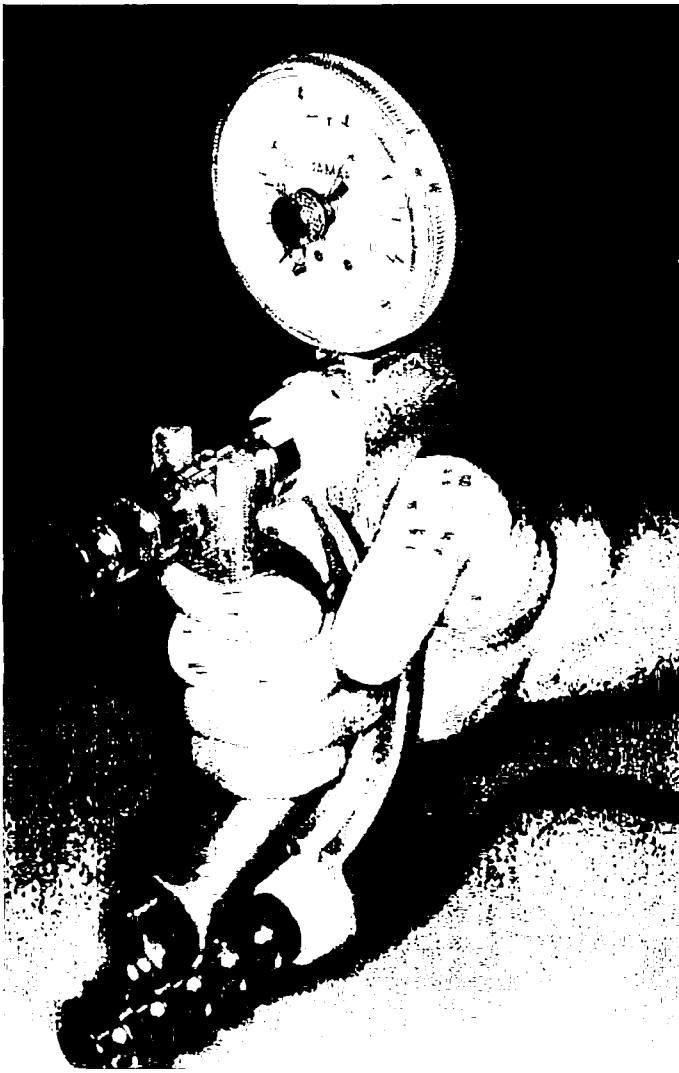


Fig 2. Jamar dynamometer (Jackson, MI) used to test grip strength. (Copyright Dr Kevin D. Plancher.)

views define the anatomy of the scaphoid, allowing better visualization of its margins (Figs 5A and 5B). The clenched-fist, radial, and ulnar deviation views may also diagnose a scapholunate ligament tear as the cause of the patient's pain. If all x-rays are negative, further imaging to diagnose an occult scaphoid fracture not seen on the plain films may be done with a bone scan (Figs 5C and 5D). A negative bone scan 3 to 5 days after injury rules out scaphoid fracture.⁹ Some authors prefer a CT evaluation of the scaphoid believing that the CT gives the best definition of cortical integrity, fracture pattern, and the ability to evaluate a humpback deformity or dorsal intercalated segment instability (DISI) pattern.¹⁰

Rapid diagnosis of a scaphoid fracture is important so that proper treatment may be initiated. The high frequency of nonunion and proximal pole avascular necrosis in scaphoid fractures warrant the use of special imaging to identify an occult fracture that may cause a long-term disability if not diagnosed.

Hamate Fractures

Fractures of the hook of the hamate are commonly associated with sports that use a racquet, bat, or club. This fracture occurs by direct trauma, when the bat or club

impacts on the hypothenar eminence at the hook of the hamate (Fig 1). Fractures of the hook of the hamate have also been described by sudden contracture of the hypothenar intrinsic muscles or during a fall on an outstretched hand.¹¹ Physical examination shows tenderness localized to the hook of the hamate. Diagnosis can be confirmed by visualizing the fracture on a carpal tunnel view, supinated oblique x-ray or by CT scan (Figs 6A-6D). Rupture of the flexor digitorum profundus after a hook of hamate fracture is a common late sequela of a missed hook of the hamate fracture. Rupture results from attrition because the tendon passes around the fractured hook of the hamate. Prompt diagnosis is helpful to treat this fracture which has a high incidence of nonunion with delay in diagnosis.¹¹

Other Carpal Fractures

Triquetrum fractures result from impingement of the wrist in dorsiflexion. These fractures are tender to palpation directly over the triquetrum. PA and lateral x-rays may not show the fracture, but the oblique is often helpful. Pisiform fractures occur commonly in gymnasts. An oblique view of the wrist at 35° of supination shows the pisiform in profile (Figs 7A and 7B). This view helps to diagnose fractures of the pisiform, as well as seeing the hook of the hamate in profile. Trapezoid fractures may occur with a dislocation of the first carpometacarpal joint. Physical examination shows tenderness over the first carpometacarpal joint. Imaging studies should include a PA and lateral x-ray of the wrist and thumb, as well as a hyperpronated (Robert's) view of the carpometacarpal joint (Figs 8A and 8B). The Robert's view is taken with a hyperpronated forearm and the beam perpendicular to the thumb.

Scaphoid Impaction Syndrome

Scaphoid impaction syndrome is a poorly defined condition commonly found in gymnasts and weightlifters who bear heavy weight on the wrist joint in dorsiflexion.¹² Clinically, the patient has dorsal wrist pain over the scapholunate interval and complains of pain with wrist dorsiflexion and axial loading. Palpation over the dorsal wrist produces tenderness in the scapholunate interval. Passive dorsiflexion reproduces the patient's symptoms. Zero PA and lateral radiographs may show osteophyte formation; however, more often radiographs are negative. This condition is often caused by inflammation of the impinged capsule and has no radiographic findings. We believe this condition may represent an occult dorsal carpal ganglion in most cases. This complex of symptoms has been called Dorsal Impingement Syndrome by others.¹³

Kienböck's Disease

Kienböck's disease commonly occurs in an adult's dominant hand between age 30 and 40. The cause of Kienböck's disease is believed to result from devascularization of the lunate owing to either repetitive trauma or a single trauma causing a fracture.¹⁴ There is a significant association between the presence of Kienböck's disease and negative ulnar variance. The disease is seen in sports where the hand is subjected to repetitive impact loading such as the

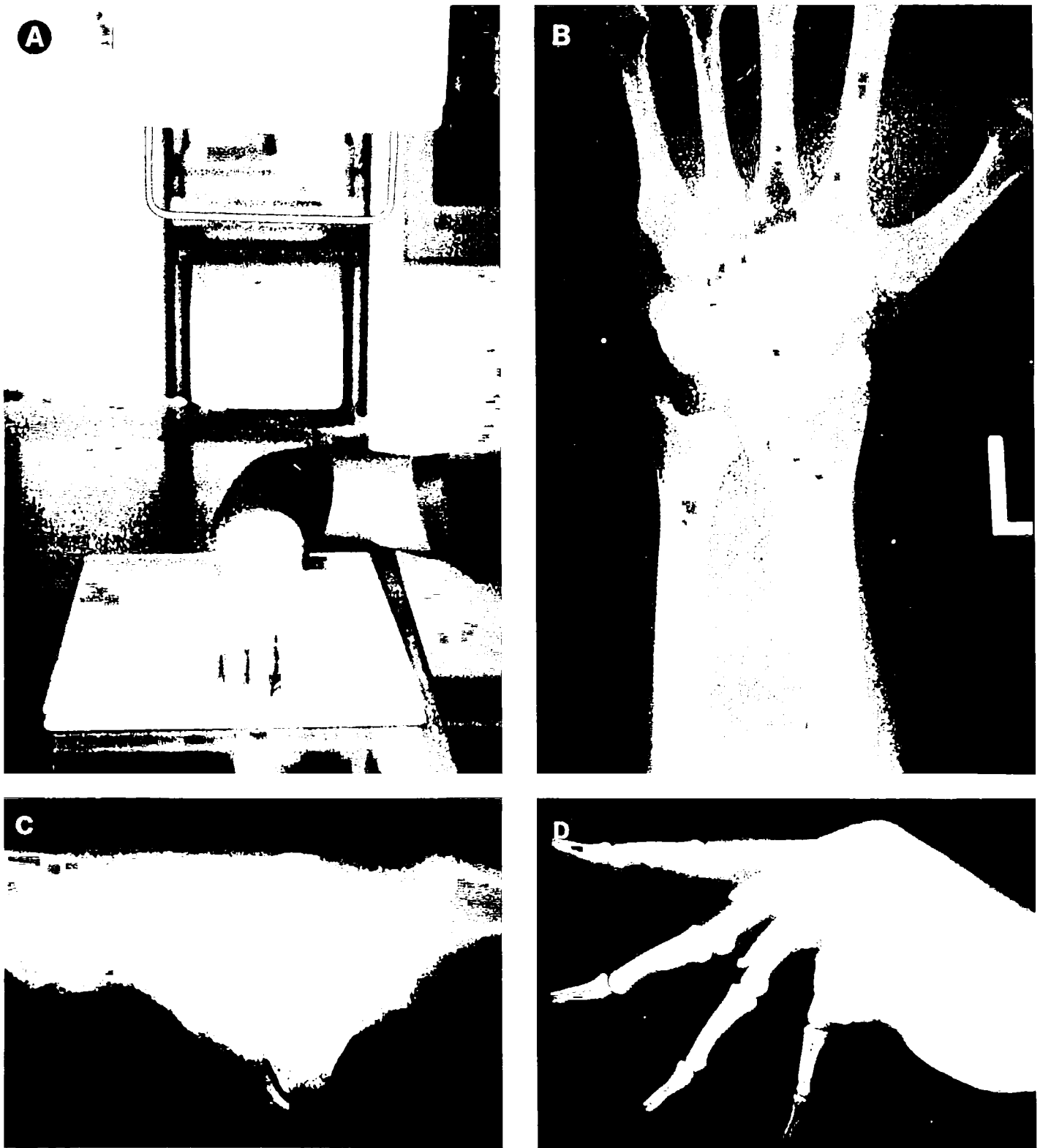


Fig 3. (A) Patient positioned for zero rotation PA wrist radiograph. (B) Zero rotation radiograph of wrist. Note distal radioulnar joint space congruity. This view is used to assess joint arthrosis and ulnar length. Note the scapholunate diastasis in that patient. (C) Lateral radiograph of wrist. Note the colinearity of the radius, lunate, capitate, and third metacarpal. Also note with the thumb abducted, the profile of the hook of the hamate, the pisiform, and pisotriquetral joint are well-visualized. (D) Splayed view of the digits. This view provides true lateral projection of the joints allowing comparison and ability to survey all joints. (Copyright Dr Kevin D. Plancher.)

Marshall Arts or handball.¹⁵ Physical examination shows tenderness to palpation over the radiolunate joint with a decrease in range of motion of the wrist in flexion and extension. Imaging of the lunate on PA and lateral radiographs as described by Lichtman et al,¹⁶ shows no changes in stage I, sclerosis in stage II, collapse in stage III, and total

degeneration of the lunate in stage IV (Fig 9A). Those patients with an equivocal diagnosis and normal radiographs may be diagnosed by bone scan. Magnetic resonance imaging (MRI) is the only current modality that can diagnose avascular necrosis of the lunate in a patient with normal radiographs and a normal bone scan¹⁷ (Fig 9B).

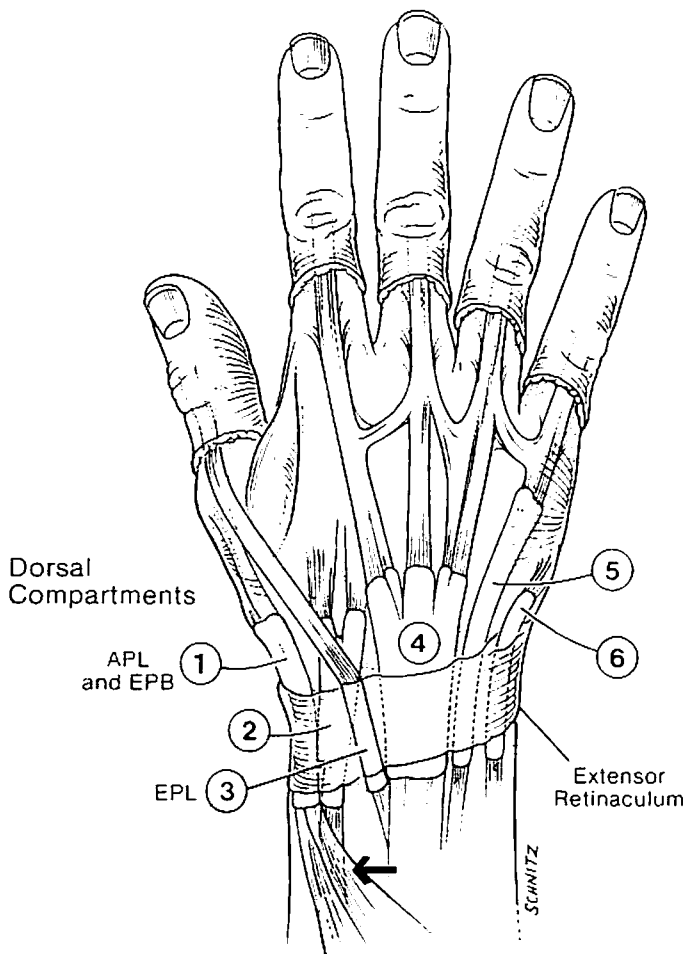


Fig 4. (Top) The six dorsal compartments of the wrist. The first dorsal compartment containing the abductor pollicis longus and extensor pollicis brevis is inflamed in de Quervain's tenosynovitis. Inflammation at the intersection of the first and third dorsal compartments (arrow) seen clinically as intersection syndrome or "squeakers." (Courtesy Gary Schnitz, MD) (Bottom) Clinical radiograph of the wrist. Note the anatomic snuffbox (arrow) where the scaphoid is palpable between the first and third dorsal compartments. (Copyright Dr Kevin D. Plancher.)

Triangular Fibrocartilage Complex Injuries

Triangular fibrocartilage complex (TFCC) injuries are a common cause of ulnar sided wrist pain in the athlete. A differential diagnosis of ulnar sided wrist pain includes

TFCC tears, ulnar impaction syndrome, flexor carpi ulnaris and extensor carpi ulnaris (ECU) tendinitis, and ECU tendon subluxation. The TFCC consists of multiple ligamentous structures including the main stabilizing ligaments of the distal radioulnar joint and the ulnar carpal ligament (Fig 10A). The TFCC is thinner in patients with positive ulnar variance,¹⁸ and these patients may experience more tears. TFCC tears are the most commonly reported ligamentous injury in gymnasts.¹⁹ The history and physical examination of a patient with a TFCC tear may include a history of pain at the ulnar styloid or ulnar wrist occurring with pronation or supination of the wrist, especially with weightbearing. Evaluation of the patient should begin with zero PA and lateral radiographs of the wrist if a positive ulnar variance is visualized. A strong suspicion for a TFCC tear should be present. To confirm a tear of the TFCC, a radiocarpal arthrogram may be performed^{18,19} (Fig 10B). If dye is visualized within the substance of the TFCC, a partial thickness tear is present. If dye passes from the wrist into the distal radioulnar joint, a full thickness tear is present (Fig 10B). The MRI can be a useful noninvasive modality (Fig 10C). Its diagnostic accuracy for TFCC tear is poor with both false-positive and false-negative results.^{20,21} Arthroscopy, in our opinion, is the best diagnostic and therapeutic modality for this lesion if it is unresponsive to conservative therapy.

Distal Radioulnar Joint Instability

Subluxation or dislocation of the distal radioulnar joint may occur with a distal radius fracture or a more proximal radial fracture. However, on rare occasion, distal radioulnar joint subluxation or dislocation may occur without an accompanying radius fracture.²² Dorsal subluxation of the ulna results from a hyperpronation injury of the forearm. During hyperpronation, the dorsal fibers of the TFCC are torn and permit dorsal ulnar subluxation. The patient has an acute injury and locates pain isolated to the distal radioulnar joint. On physical examination, there may be ballottement of the distal ulna that is greater than the contralateral side, as well as pain with forearm rotation. Assessment of this injury includes PA and lateral radiographs of the wrist. CT scanning is used for diagnosis and delineation of congruity of the distal radioulnar joint²³ (Fig 11).

Scapholunate Dissociation

Patients with scapholunate ligament tears may have pain at the wrist in the anatomic snuffbox, and at the dorsal and volar radiocarpal joint. This diagnosis may be difficult to distinguish from scaphoid fractures by looking at the patient's history alone. The patient usually describes a fall on an outstretched hand with the forearm pronated and the wrist dorsiflexed. Physical examination shows decreased motion of the wrist, and tenderness as described. The patient may present either acutely or more commonly later with scapholunate instability. Acutely, the patient will complain of pain, swelling, and lack of motion. Patients with chronic symptoms may complain of similar problems, but often focus on loss of power and motion. Initial radiographic evaluation should include a PA, lateral and



Fig 5. (A) Patient positioned in ulnar deviation for PA radiograph of wrist. (B) This ulnar deviation view shows the scaphoid in profile. A scaphoid nonunion was identified as the cause of wrist pain in this adolescent patient. (C) PA radiograph of wrist. There is no obvious scaphoid fracture seen. (D) Bone scan of the patient in C. Note intense uptake of tracer by the scaphoid 1 week postinjury diagnostic of an occult scaphoid fracture. (Copyright Dr Kevin D. Plancher.)

clenched-fist view radiograph. The PA and lateral views may show a static diastasis between the scaphoid and lunate diagnostic of a scapholunate ligament rupture (Fig 12A). This diastasis may appear on the clenched view when the capitate migrates proximally into the scapholu-

nate interval when the joint is loaded (Figs 12B and 12C). Other signs seen on x-ray are the increase in the scapholunate angle on the lateral projection characteristic of dorsal intercalary segment instability.²⁴ Dobyns et al²⁵ has stated that a scapholunate angle greater than 70° is a clear



Fig 6. (A) This 35° oblique view of the wrist shows the hook of the hamate profile well. However, no fracture is identified. (B) The patient positioned for a carpal tunnel view radiograph. (C) Carpal tunnel view showing the hook of the hamate, but again unable to identify a fracture in this case. (D) Hook of the hamate fracture identified by CT scan axial image. (Copyright Dr Kevin D. Plancher.)

indication of scapholunate dissociation. Other signs present on plain radiographs are loss of carpal height⁶ and the scaphoid ring sign, in which the palmar flexed scaphoid tubercle creates a ring density on the PA projection of the wrist. The Watson test is used on physical examination to assess scaphoid instability.²⁰ This test is performed with the patient's elbow resting in the examiner's lap with the forearm pronated. The hand is brought into ulnar deviation and volar pressure is applied to the distal pole of the scaphoid (See Fig 1). As the hand is radially deviated with

pressure maintained on the distal pole of the scaphoid, normal palmar flexion of the scaphoid is prevented. As the wrist rotates, the proximal pole of the unstable scaphoid subluxates dorsally at the radioscaphoid joint. Release of pressure at the distal pole allows the scaphoid to reduce back into the scaphoid fossa with often a palpable or audible clunk. Please note that this may be a very painful test. For scapholunate instability not seen with these maneuvers or x-ray examination, further imaging may be done with videoradiography.



Fig 7. (A) Patient positioned for 35° supinated oblique radiograph of the wrist. The radial aspect of the hand is elevated off the cassette. (B) This 35° supinated oblique from A identifying pisiform fracture. Note delineation of a normal pisotriquetral joint without arthritis in this patient. (Copyright Dr Kevin D. Plancher.)

Lunotriquetral Ligament Tears

Lunotriquetral ligament tears are part of the differential diagnosis of ulnar sided wrist pain. After a specific traumatic event, the patient has pain of the ulnar wrist. The patient is tender over the lunotriquetral area on the dorsal ulnar wrist. The lunotriquetral ballottement test is a test in which the examiner supports the lunate between the thumb and index finger with one hand, while ballotting the triquetrum with the other. A positive test reproduces

the patient's pain and shows greater excursion than the contralateral side.²⁷ Routine radiographs are often normal and diagnostic only in those cases of an advanced volar intercalated segment instability (VISI) deformity (Fig 13A). Arthrography showing leakage of dye from the midcarpal space into the radiocarpal joint through the lunotriquetral interval, normally occluded by the ligament, confirms a tear. If the test is negative, the patient should also be injected in the radiocarpal space to assess leakage into the distal radioulnar joint diagnostic of a TFCC tear²⁸ (Fig 13B).

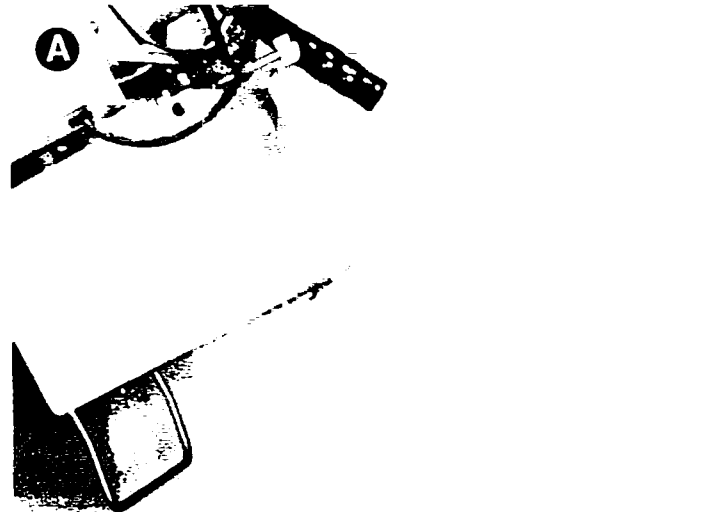


Fig 8. (A) Patient positioned in full forearm pronation for Robert's view of thumb. (B) Robert's view of thumb. Note the ability to see the scaphoid trapezial and trapeziometacarpal joints and true AP of entire first ray. (Copyright Dr Kevin D. Plancher.)



Fig 9. (A) PA radiograph of wrist demonstrating sclerosis and cyst formation in the lunate diagnostic of Lichtman stage II Kienböck's disease. (B) T1 weighted sagittal MRI of the wrist demonstrating AVN of the lunate. This patient had no changes on plain x-ray and was diagnosed with Lichtman stage I Kienböck's disease. (Copyright Dr Kevin D. Plancher.)

Currently, the sensitivity of MRI ranges from 23% to 50% for the diagnosis of lunotriquetral tears and therefore is often not helpful for the diagnosis of this injury.²⁹ Arthroscopy is emerging as a minimally invasive diagnostic modality that may be used for treatment at the same time.

TENDINITIS AND TENOSYNOVITIS OF THE HAND AND WRIST

The wrist and finger tendons pass through retinacular tunnels at the wrist that are lined by synovium. Repetitive motion and trauma experienced in racquet sports, baseball, or golf, may result in synovial inflammation. The synovium is the primary tissue involved in the inflammatory processes with the tendon and retinacular sheath becoming secondarily involved.³⁰

De Quervain's Tenosynovitis

Stenosing tenosynovitis of the abductor pollicis longus and extensor pollicis brevis (de Quervain's disease) is the most common tendinopathy of the wrist.³¹ Although it is often seen in a working population of adults, it can be seen in athletes using forceful grasp coupled with ulnar deviation such as in golf and racquet sports like squash and badmin-

ton.³⁰ Pain is the chief complaint and it occurs on palpation of the first dorsal compartment (Fig 4A). A Finklestein test reproduces the pain with stretching of the tendons of the first dorsal compartment by flexing the thumb into the palm and then passively ulnar deviating the wrist.³² Imaging studies are not necessary to diagnosis this condition. Routine x-rays should be ordered to rule out other causes of pain.

Intersection Syndrome

Intersection syndrome is an inflammatory condition where the tendons of the first dorsal compartment (abductor pollicis longus [APL] and extensor pollicis brevis [EPB]) pass over the tendons of the second dorsal compartment (extensor carpi radialis brevis [ECRB] and extensor carpi radius longus [ECRL])³³ (Fig 4A). The patient complains of pain on the dorsal wrist 4 to 6 cm proximal to the wrist joint. Pain is triggered by extension of the wrist and thumb and can be provoked by active wrist and thumb extension against resistance. This affliction is common in oarsmen in the wrist that feathers the oar, as well as weightlifters.^{31,34} There may be palpable crepitus at the point of intersection, as well as audible crepitus termed "squeakers." Radio-



Fig 10. (A) Anatomic specimen of wrist demonstrating TFCC. The probe shows the articular disk of the TFCC separating the distal radioulnar joint and radiocarpal spaces. Also note the scapholunate and lunotriquetral intervals connected with interosseous ligaments not allowing connection of the midcarpal and radiocarpal spaces in this normal wrist. (Courtesy Brian Sennett, MD.) (B) Arthrogram of the radiocarpal joint with dye flowing into the distal radioulnar joint. This is diagnostic of a complete TFCC tear. (Arrow) (Reprinted with permission from Mosby,⁵⁷ St. Louis, MO from Zemel NP: Fracture and ligament injuries of the wrist, in Jobe FW (ed): *Operative Techniques in Upper Extremity Sports Injuries*, 1996, pp 688-691.) (C) Coronal T2 weighted MRI of wrist showing a tear of the ulnar margin of the TFCC (arrow). Also notice a tear of the scapholunate interosseous ligament (curved arrow). (Courtesy Rusty Fritz, MD.)

graphs are also not useful in this condition except to exclude other causes.

ECU Tendinitis and Subluxation

The sixth dorsal compartment is the second most common site of upper extremity stenosing tenosynovitis.³¹ ECU tendinitis produces pain and swelling along the dorsal ulnar aspect of the wrist in athletes who participate in rowing or racquet sports.³² In diagnosing ECU tenosynovitis, the physician must make certain that the patient does not have ECU subluxation. Traumatic rupture of the ECU

subsheath and subsequent subluxation of the ECU tendon can occur after forced supination, palmar flexion, and ulnar deviation of the wrist.³⁵ The patient may complain of a painful snapping over this dorsal ulnar area of the wrist in supination and ulnar deviation. By palpating the tendon and passing the wrist through active supination, the examiner can feel the subluxation of the tendon.

Flexor Carpi Radialis Tendinitis

The flexor carpi radialis tendon passes through a tunnel formed by the scaphoid tuberosity, the trapezial ridge, and

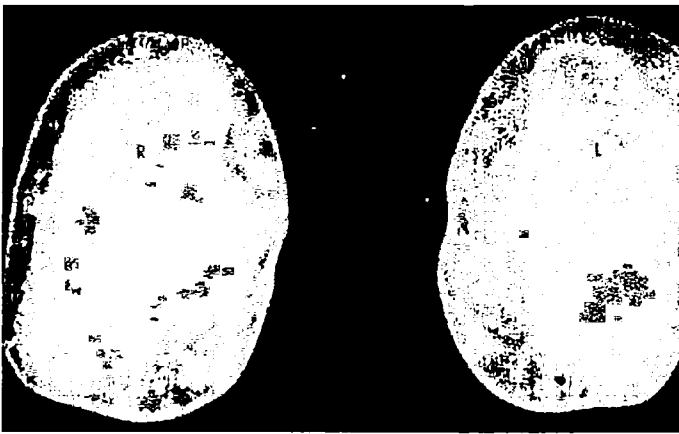


Fig 11. CT scan of both wrists demonstrating subluxation of the left distal radioulnar joint. (Reprinted with permission from Mosby⁵⁷, St. Louis, MO from Zemel NP: Fracture and ligament injuries of the wrist, in Jobe FW (ed): *Operative Techniques in Upper Extremity Sports Injuries*, 1996, pp 688-691.)

the transverse carpal ligament.³⁶ Repetitive motion can cause tenosynovitis in this area. The patient complains of pain proximal to the wrist extending to the insertion of the tendon, which is exacerbated on physical examination by palpation and active wrist flexion against resistance.

Flexor Carpi Ulnaris Tendinitis

Pain at the volar ulnar wrist can be caused by flexor carpi ulnaris (FCU) tendinitis or pisotriquetral arthritis. Both entities are fairly common.^{31,33} These conditions have been reported in golf and racquet sports.³⁷ FCU tendinitis may be diagnosed by pain of the FCU tendons and lack of pain at the pisotriquetral joint. Radiographs are normal in this condition. Pisotriquetral arthritis can be diagnosed by grasping the pisiform and sliding it radially and ulnarly on the triquetrum. The pisotriquetral grind test creates pain on compression and confirms the diagnosis of pisotriquetral arthritis. Loss of the pisotriquetral joint space and arthrosis may be seen on the supinated oblique view of the wrist (Figs 6A and 14).

Flexor Tenosynovitis

Repetitive digital flexion may create a flexor tenosynovitis in athletes in sports that use forceful digital grasping such as gymnastics or racquet sports. Tenosynovitis of the digital flexors may cause median nerve irritability resulting in a carpal tunnel syndrome secondary to the tenosynovitis in the canal.³¹ Provocative testing with Tinel's and Phalen's signs may be positive on physical examination although electrodiagnostic tests are often negative.

Trigger Fingers

Pressure on the metacarpal phalangeal flexion crease from a racquet or other forcefully grasped tools may cause irritation of the A1 pulley and incite an inflammatory response.^{34,38} The athlete complains of pain and tenderness while playing their sport and occasionally complains of triggering or locking.³⁹ On physical examination, the patient has a classic trigger finger with tenderness over the

A1 pulley and often palpable thickening and triggering. Further imaging studies are not necessary.

Neuropathies

Peripheral nerve injuries associated with athletics has been estimated to account for approximately 5% of all peripheral nerve injuries.⁴⁰ The majority of these cases occur in the upper extremities. These neuropathies occur in the same nerves as those found in nonathletes, but certain sports have a predilection for certain neuropathies, ie, ulnar neuropathy also called "handlebar palsy" is much more common in bicyclists than in the general population.⁴¹ The pathology leading to these peripheral nerve injuries is believed to include acute compression by direct or indirect trauma, chronic irritation related to overuse, pressure related to muscular hypertrophy or extreme positions of flexion and extension and repetitive stretching.⁴²

Carpal Tunnel Syndrome

The incidence of carpal tunnel syndrome in athletes is low, but it can be found in cyclists, throwers, and racquet sport players. It may be secondary to overuse tenosynovitis of the digital flexors, or may follow an acute trauma with subsequent swelling. The athlete complains of wrist and hand pain during sport, often with proximal migration to the forearm. The athlete may also note difficulty or clumsiness controlling his hand and a decreased sensation in the radial 3.5 digits. Physical examination may show hypoesthesia or paresthesia of the radial three and one-half fingers, as well as pain over the carpal canal. The patient may have a positive Tinel's sign, which indicates nerve pathology. Phalen's test often reproduces symptoms by placing the wrist in a hyperflexed position. Imaging studies such as plain x-rays with a carpal tunnel view may show a hook of the hamate fracture or Kienböck's disease, as the underlying cause of the disease.

Ulnar Tunnel Syndrome

Athletic ulnar nerve injuries at the wrist are usually caused by compressive forces,⁴³ eg "handlebar palsy" in bicyclists. Other causes may be ulnar artery thrombosis (also called ulnar hammer syndrome), a ganglion from the carpal joint, hook of the hamate fractures, or fibrotic arches in the palm.^{41,43,44} The patient may complain of pure weakness, sensory changes, or mixed findings (lesions in Guyon's canal spare the dorsal sensory branch of the ulnar nerve). Physical examination may show weakness or decreased sensation in an ulnar distribution. Intrinsic weakness and clawing are late findings and are extremely worrisome if seen. Special tests with electromyography should be carried out if there is no response with conservative therapy. Plain x-ray should be obtained.

Radial Sensory Neuropathy

The most frequent site of compression of the superficial radial nerve is in the distal forearm in its subcutaneous area. This is known as *cheiralgia paresthetica*. The causes of radial sensory neuropathy include repetitive pronation and supination of the forearm which may cause impinge-

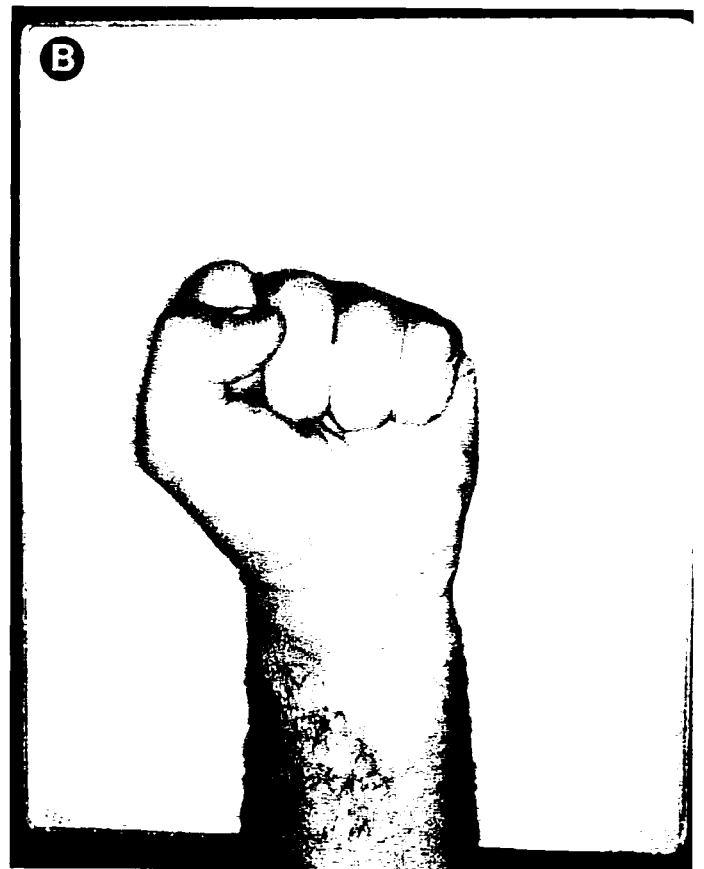


Fig 12. (A) PA radiograph of wrist demonstrating scapholunate diastasis diagnostic of scapholunate ligament rupture. (B) Patient positioned for clenched-fist view of wrist. (C) The capitate migrating proximally into the scapholunate interval. (D) Normal AP clenched-fist radiograph in a patient with volar wrist pain. Carpal height is maintained and the scapholunate interval is not widened with loading ruling out scapholunate dissociation. (Copyright Dr Kevin D. Plancher.)

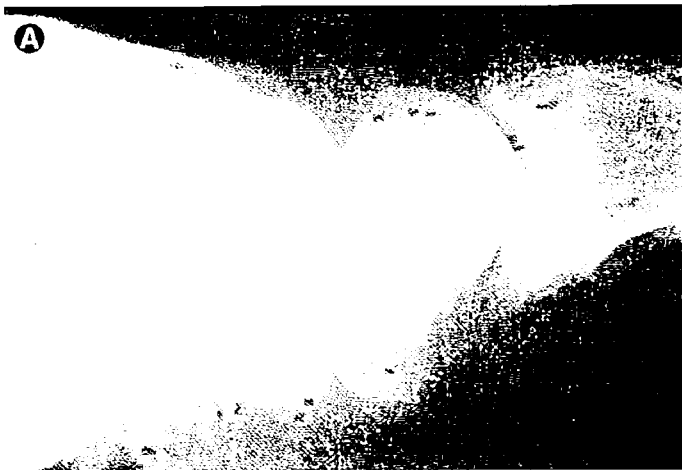


Fig 13. (A) Lateral radiograph of wrist showing a VISI pattern. The scapholunate angle is less than 30° and the lunocapitate angle is greater than 15° .¹² (Reprinted with permission from Mosby⁵⁷). **(B)** Normal midcarpal arthrogram in a patient with ulnar-sided wrist pain. Competent scapholunate and lunotriquetral interosseous ligaments restrict dye flow into the radiocarpal joint. Later injection of the distal radioulnar joint rules out full-thickness TFCC tear as the cause of pain. (Copyright Dr Kevin D. Plancher.) (See Figures 10A and B).

ment of the nerve between the tendons of the ECRL and brachial radialis. Compression from external forces such as watchbands or contusions to the area are very common. This irritation has been seen in runners and other athletes who wear wrist watches or volleyball players who contuse

the nerve during activities. The patient complains of radiating pain of the dorsal radial forearm and decreased sensation over the dorsal radial hand.⁴⁵ On physical examination a positive Tinel's sign may be present with percussion of the nerve. Provocative maneuvers including forceful passive forearm pronation with the wrist in ulnar flexion, as well as a pseudo-Finklestein test can reproduce the patient's pain. Treatment is based on removing the offending object or protecting the nerve from further contusion. Nerve conduction and electromyography studies should not be done initially, but only if the patient's symptoms are unresponsive to conservative therapy.

Ulnar Collateral Ligament Injuries of the Thumb

Hyperextension and abduction of the thumb with the metacarpophalangeal (MP) joint in full extension often tears the ulnar collateral ligament. This injury is most commonly seen in football players and skiers.⁴⁶ The patient may relate a history of an acute event where the thumb was caught either on a fixed ski pole or on another's players jersey and abducted widely. The patient reports sudden acute pain on the ulnar aspect of the MP joint. The patient often gives a history of similar episodes in the past and subsequent reinjuries. The athlete complains of pain, decreased pinch strength, and inability to handle objects with strength. X-ray studies should consist of AP, lateral projection, and a Robert's view. These x-rays may reveal a small avulsion fracture of the metacarpal. Volar subluxation of the joint occurs on x-ray when there is a complete tear. Most observers consider 20° to 30° of increased laxity with thumb flexed compared with the normal thumb to represent a complete tear⁴⁷ (Fig 15A). Chronic laxity may develop because of the presence of a Stener lesion in a complete tear.⁴⁸ This lesion occurs when the abductor aponeurosis becomes interposed between the ligament ends and prevents healing. Stress views are important in making the appropriate diagnosis and to help predict if the lesion will heal or result in chronic laxity of the joint. The MRI has recently been used to diagnose grade III ulnar collateral ligament tears to predict the Stener lesion⁴⁹ (Figs 15B and 15C).



Fig 14. A 35° supinated oblique radiograph of wrist showing arthritis of the pisotriquetral joint. (Copyright Dr Kevin D. Plancher.)



Fig 15. (A) Stress radiograph of MP joint of the thumb with laxity diagnostic of ulnar collateral ligament tear. (B) T1 weighted coronal MRI of thumb showing ulnar collateral ligament avulsion with bony fragment and joint incongruity. (C) T1 weighted axial MRI of the thumb MP joint showing a Stener lesion of the ulnar collateral ligament. Note the ulnar collateral ligament (arrow) positioned dorsal to the adductor aponeurosis. (Copyright Dr Kevin D. Plancher.)

Proximal Interphalangeal Joint

The boutonnière deformity consists of a flexion contracture of the proximal interphalangeal (PIP) joint with hyperextension at the distal interphalangeal joint. This deformity is not seen acutely, but follows an untreated rupture or laceration of the central slip insertion on the middle phalanx. This injury is common in athletes such as when a basketball player's finger is struck by the ball causing PIP flexion while the finger is actively extending. The patient complains of the inability to fully extend the PIP joint, pain at the PIP joint, and loss of power. The patient may say that

he jammed his finger and that he went on to continue playing and had been initially asymptomatic. On physical examination there is swelling of the PIP joint with acute tenderness directly over the dorsal insertion of the central slip. If the patient lacks more than 25° of full extension of the PIP joint, one should assume that a central slip rupture has occurred.⁵⁰

Pseudoboutonnière Deformity

Pseudoboutonnière deformity is a rare entity that was originally described by McCue et al.⁵¹ It is slowly progres-

sive and follows injury to the PIP joint. However, in contrast to the true boutonnière deformity, the injury is from rupture of the volar plate with hyperextension of the PIP rupture of the volar plate. After the injury, the volar plate scars down with the PIP joint assuming a flexed posture. Because the lateral bands have not subluxed volarly, the patient is still able to flex the distal interphalangeal. Physical examination shows lack of full PIP extension and tenderness over the volar plate. The patient is not tender dorsally over the central slip. PA and lateral radiographs may show evidence of calcification at the proximal attachment of the volar plate, which is diagnostic of this condition.⁴⁶

COLLATERAL LIGAMENT INJURIES

Collateral ligament injuries appear to be the most common type of "coaches' finger" or "jammed finger."⁵² In a series of 30 such injuries McCue et al, documented that the index finger was most commonly injured and football was the most common precipitating activity.⁵³ The patient may complain of pain and swelling of the joints. On physical examination there is tenderness over the radial or ulnar aspects of the joints. The patient may have laxity of the joint which can be diagnosed by stressing the joint after lidocaine injection (Figs 16A and 16B). AP and lateral radiographs of the joint should be done to check for any bony avulsion fracture. Subluxation of the joint indicates a concomitant volar plate injury.

DISTAL INTERPHALANGEAL JOINT

Mallet Finger

The mallet finger has also been called the "drop finger" or "baseball finger." It is especially common in softball, baseball, basketball, and football players. The injury occurs when a ball or other object impacts the finger tip of the extended finger flexing the DIP joint and rupturing the extensor mechanism.⁵⁴ McCue and Wooten⁵⁵ have classified these injuries into five types. They are type I—tendon stretching, type II—tendon rupture, type III—rupture with avulsion of a bony fragment, type IV—a large fracture fragment taking off part of the dorsal articular surface of the DIP joint, and type V—epiphyseal fracture. The patient complains of pain and swelling over the dorsal aspect of the DIP joint and the inability to extend the finger. On examination the patient lacks DIP extensor power and is tender dorsally. AP and lateral radiographs should be taken of the finger to differentiate between the five types previously described (Fig 17). Accuracy of diagnosis with x-ray and soft tissue technique is important because therapy is based on the injury type that may necessitate either splinting or surgical intervention.

AVULSION OF THE FLEXOR DIGITORUM PROFUNDUS

Avulsion of the flexor digitorum profundus at its insertion on the distal phalanx is often seen in athletes. The injury occurs most often in the young male that is involved in football, rugby, or flag football and usually results from



Fig 16. (A) Positioning for stress view of the collateral ligaments of the PIP. (B) Stress radiograph of the PIP joint. Note angulation of the joint and joint opening consistent with collateral ligament injury. (Copyright Dr Kevin D. Plancher.)

grasping the jersey of an opposing player. As the player pulls away, the finger is forcibly extended while the profundus is contracting. An avulsion may result.⁵⁶ The lesion has been termed "jersey finger" because of this common injury mechanism.⁵⁴ Leddy and Packer⁵⁶ have classified profundus avulsion into three main categories. They are type I—the FDP tendon retracts into the palm,



Fig 17. Type IV mallet finger with avulsed fragment dorsally. Note the joint is still congruent. This joint was able to be treated with closed reduction and extension splinting until union. (Copyright Dr Kevin D. Plancher.)

type II—the tendon retracts to the PIP level, and type III—a bony fragment is avulsed with the tendon. This classification is important because with retraction of the tendon into the palm both vincula are ruptured in type I and the blood supply to the tendon is lost. In type II the long vinculum remains intact and therefore some blood supply is retained. In Type III the end of the tendon is held at the A4 pulley by the bony fragment and both vincula are intact. On physical examination, the patient has inability to flex the distal interphalangeal joint and has pain at the volar aspect of the distal phalanx at the joint. The tendon end may be palpable in the flexor sheath. The lateral radiograph is most important to attempt to visualize a fleck of bone and thereby help diagnose the type of tendon avulsion present because the classification of these injuries is important in the timing of surgical repair. Some investigators have used MRI or other imaging modalities to diagnose the proximal retraction of the tendon if no bony fleck is visible on x-ray, and the tendon is not palpable within the sheath.⁵⁴

SUMMARY

There are a broad spectrum of injuries of the hands and wrists suffered by athletes. These may involve bony, ligamentous, capsular, tendinous, or nerve structures. Accurate diagnosis is based on the physician's understanding of the demands and specific injuries prevalent for specific sports, a detailed history of the patient, and a precise physical examination. The appropriate use of radiography and other imaging modalities after history and physical examination is useful in confirming the diagnosis. The appropriate use of radiography or other imaging modalities and specific physical examination tests is valuable in accurate diagnosis so that rapid treatment of the correctly diagnosed condition may take place in the athletes' hand and wrist. Timely treatment is necessary so that the athlete can be treated promptly and return to their sport.

REFERENCES

1. Amadio PC: Epidemiology of hand and wrist injuries in sports. *J Hand Clin* 6:379-381, 1990
2. Werner JL, Omer GE: A procedure evaluating cutaneous pressure sensation of the hand. *Am J Occup Ther* 24:347-356, 1970
3. Stokes HM: The seriously injured hand—weakness of grip. *J Occup Med* 25:683-684, 1983
4. Hildreth DH, Breidenbach WC, Lister GD, et al: Detection of submaximal effort by use of the rapid exchange grip. *J Hand Surg* 14A:742-745, 1989

5. Palmer AK, Glisson RR, Werner SW: Ulnar variance determination. *J Hand Surgery* 7:376-379, 1982
6. Youm T, McMurtry RY, Flat AE, et al: Kinematics of the wrist. I. Experimental study of radial—ulnar deviation the flexion—extension. *J Bone Joint Surg* 60:423, 1978
7. Mino DE, Palmer AK, Levisohn EM: The role of radiography in computerized tomography in the diagnosis of subluxation and dislocation of the distal radioulnar joint. *J Hand Surg* 8:23-31, 1983
8. Zemel MP, Stark HH: Fractures and dislocations of the carpal bones. *Clin Sports Med* 5:709-723, 1986
9. Stodahl A, Schjoth A, Woxholt G, et al: Bone scanning of fractures of the scaphoid. *J Hand Surg* 9B:189-190, 1984
10. Sanders WE: Evaluation of the humpback scaphoid by tomography in the longitudinal axial plane of the scaphoid. *J Hand Surg* 13A:182-187, 1988
11. Mirabello SC, Loeb PE, Andrews JR: The wrist: Field evaluation and treatment. *Clin Sports Med* 11:1-25, 1992
12. Linscheid RL, Dobyns JH: Athletic injuries of the wrist. *Clin Orthop* 198:141-151, 1985
13. Teleisnik J: Soft tissue injuries, in Strickland JW, Rettig AC (eds): *Hand Injuries in the Athletes*. Philadelphia, PA, Saunders, 1992, pp 107-128
14. Almquist EE: Kienböck's disease. *Clin Orthop* 202:68-78, 1986
15. Nakamura R, Imaeda T, Suzuki K, et al: Sports related Kienböck's disease. *Am J Sports Med* 19:88-91, 1991
16. Lichtman DM, Mack GR, MacDonald, et al: Kienböck's disease: The role of silicone replacement arthroplasty. *J Bone Joint Surg* 55A:899-908, 1987
17. Firooznia H, Golimbu CN, Rafii M, et al: MRI and CT of the Musculoskeletal System. St. Louis, MO, Mosby, 1992, pp 594-631
18. Palmer AK: Triangular fibrocartilage complex lesions: A classification. *J Hand Surg* 14A:594-609, 1989
19. Dobyns JH, Gabel GT: Gymnast's wrist. *Hand Clin* 6:493-505, 1990
20. Cerfolini E, Luchetti R, Pederzini L, et al: MRI Evaluation of Triangular Fibrocartilage Complex Tears in the Wrist: Comparison of arthrography and arthroscopy. *J Comput Assist Tomogr* 14:963-967, 1990
21. Kang HS, Kindynis P, Brahme SK, et al: Triangular fibrocartilage and intercarpal ligaments of the wrist: MR imaging. Cadaveric study with gross pathologic and histologic correlation. *Radiology* 181:401-404, 1991
22. Snook GA, Chrisman OD, Wilson TC, et al: Subluxation of the distal radioulnar joint by hyperpronation. *J Bone Joint Surg* 51A:1315, 1969
23. Mino DE, Palmer AK, Levinsohn EM: The role of radiography and computerized tomography in the diagnosis of subluxation and dislocation of the distal radioulnar joint. *J Hand Surg* 8A:23, 1983
24. Guilula LA, Weeks PM: Posttraumatic ligamentous instabilities of the wrist. *Radiology* 129:641-651, 1978
25. Dobyns JH, Linscheid RL, Chao YS, et al: Traumatic instability of the wrist. Chicago, IL, American Academy of Orthopaedic Surgeons. Instructional Course Lectures. 24:182, 1975
26. Watson HK, Hempton RS: Limited wrist arthrodesis I. The triscaphoid joint. *J Hand Surg* 5:320-327, 1980
27. Regan DS, Linscheid RL, Dobyns JH: Lunotriquetral sprains. *J Hand Surg* 9A:502, 1984
28. Tirman RM, Weber ER, Snyder LL, et al: Midcarpal wrist arthrography for detection of tears of the scapholunate and lunotriquetral ligaments. *Am J Radiogr* 144:107, 1985
29. Schweitzer ME, Brahme SK, Hodler J, et al: Chronic wrist pain: SPIN echo and short Tau inversion recovery MRI imaging and conventional MRI arthrography. *Radiology* 182:205-211, 1992
30. Kiefhaber TR, Stern PJ: Upper extremity tendinitis and overuse syndromes in the athlete. *Clin Sports Med* 11:39-55, 1992
31. Wood MB, Dobyns JH: Sports related extraarticular wrist syndromes. *Clin Orthop* 202:93-102, 1986
32. Finkelstein H: Stenosing tendovaginitis at the radial styloid process. *J Bone Joint Surg* 12:509-540, 1930
33. Dobyns JH, Sim FH, Linscheid RL: Sports stress related syndromes of the hand and wrist. *Am J Sports Med* 6:236-253, 1978
34. Osterman AL, Moskow L, Low DW: Soft tissues injuries of the hand and wrist in racquet sports. *Clin Sports Med* 7:329-348, 1988
35. Eckhardt WA, Palmer AK: Recurrent dislocation of the extensor carpi ulnaris tendon. *J Hand Surg* 6:629-631, 1981
36. Weeks PM: A cause of wrist pain: Nonspecific tenosynovitis involving the flexor carpi radialis. *Plast Reconstr Surg* 62:263-266, 1978