Basic Athletic Training
Course Pack C

CHAPTER

19

Wrist and Hand Conditions

STUDENT OUTCOMES

1. Identify the major bony and soft-tissue structures of the wrist and hand.
2. Describe the pathways of the median, ulnar, and radial nerves and identify the motor and sensory components of each nerve.
3. Describe the motions of the wrist and hand and identify the muscles that produce them.
4. Describe the forces that produce the loading patterns responsible for common injuries of the wrist and hand.
5. Explain the general principles used to prevent injuries to the wrist and hand.

6. Describe a thorough assessment of the wrist and hand.
7. List the common injuries and conditions sustained to the wrist and hand by physically active individuals (including sprains, dislocations, strains, tendinopathies, and nerve entrapment syndromes).
8. Describe the various types of fractures that can occur in the wrist and hand and explain their management.
9. Explain management strategies for common injuries and conditions of the wrist and hand.
10. Explain general principles and techniques used in developing a rehabilitation exercise program for the wrist and hand.

INTRODUCTION

The wrist and hand are used extensively during activities of daily living and in nearly all sport skills. Injuries to the region often result from the natural tendency to sustain the force of a fall on the hyperextended wrist. Many hand and wrist injuries also are directly related to specific sports. For example, in wrestling, football, hockey, and skiing, forced abduction of the thumb can damage the ulnar collateral ligament of the thumb, leading to an injury called a gamekeeper's thumb. Receivers in football and catchers in baseball and softball are subject to "mallet" deformity of the finger, which is caused when a ball hits the end of the finger and avulses an extensor tendon from its distal attachment. Carpal tunnel syndrome also has been reported among the physically active population in badminton, baseball, cycling, gymnastics, field hockey, racquetball, rowing, skiing, squash, tennis, and rock climbing.[1]

This chapter begins with a review of the anatomy, kinematics, and kinetics of the wrist and hand. Measures to prevent injury and assessment techniques are followed by information regarding common injuries to the wrist and hand and their management. Finally, rehabilitation exercises are found at the end of the chapter.

ANATOMY OF THE WRIST AND HAND

The wrist and hand are composed of numerous small bones and articulations. These function effectively to enable the dexterous movements performed by the hands during both daily living and sport activities.

Wrist Articulations

The wrist consists of a series of radiocarpal and intercarpal articulations (Fig. 19.1). Most wrist motion occurs at the radiocarpal joint. It is a condyloid joint that includes the articulation of the radius with the scaphoid, lunate, and triquetrum. The joint allows sagittal plane motions (i.e., flexion, extension, and hyperextension) and frontal plane motions (i.e., radial deviation and ulnar deviation) as well as circumduction.

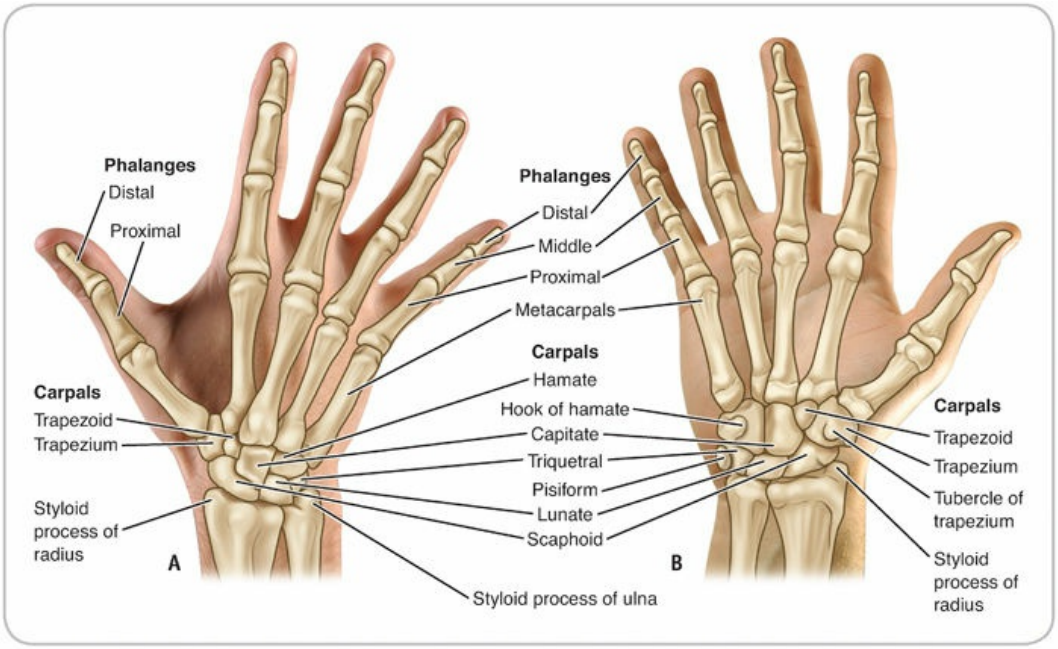


Figure 19.1. Skeletal features of the wrist and hand. A, Anterior view. **B,** Posterior view.

During wrist motions, the scaphoid, lunate, capitate, triquetrum, and pisiform exhibit significant nonplanar motions, with the axis of rotation for each bone shifting with the direction of the wrist movement.[2] The individual motions and interactions among these proximal carpal bones become particularly complex during the combined wrist motions, such as extension and

pronation.[3] Alternately, the bones of the distal carpal row function as a single unit and are separated by gliding joints that contribute little to wrist motion. The distal carpal bones are directly linked to the motion of the third metacarpal.[4]

The distal radioulnar joint is immediately adjacent to the radiocarpal joint. The triangular fibrocartilage (TFC) is a cartilaginous disk overlying the distal ulnar head. This disk binds the end of the ulna and the radius together (i.e., head of the ulna and ulnar notch of the radius) and the distal end of the ulna and the carpal bones (i.e., lunate and triquetral bones). It makes up a portion of the TFC complex (TFCC), which acts as a stabilizer of the distal radioulnar joint. The TFCC also is the ulnar continuation of the radius, providing an articular surface for the carpal condyle. Although the ulna and radius share the articular disk, they have separate joint capsules. The volar radiocarpal, dorsal radiocarpal, radial collateral, and ulnar collateral ligaments reinforce the radiocarpal joint capsule. Its close-packed position is in extension with radial deviation.

Hand Articulations

A large number of joints are required to provide the extensive motion capabilities of the hand. Included are the carpometacarpal (CM), intermetacarpal, metacarpophalangeal (MP), and interphalangeal (IP) joints. The fingers are numbered as digits 1 through 5, with the first digit being the thumb.

Carpometacarpal and Intermetacarpal Joints

The CM joint of the thumb is a classic saddle joint. A capsule surrounding the joint serves to restrict motion. The flexion–extension axis and abduction–adduction axis at the joint are not perpendicular to each other or to the bones, and they do not intersect.[5] The articulating trapezium and metacarpal bones at the joint appear to have greater congruence, or better fit, in males than in females, which may predispose the female joint to osteoarthritis.[6]

The CM joints of the four fingers are essentially gliding joints, although

some anatomists have described them as modified saddle joints. The CM and intermetacarpal joints of the fingers are mutually surrounded by joint capsules that are reinforced by the dorsal, volar, and two interosseous CM ligaments. Among these, the V-shaped interosseous ligaments are the strongest, providing very strong interconnections between the bases of the adjacent metacarpals.

Metacarpophalangeal Joints

The knuckles of the hand are formed by the MP joints. These are condyloid joints formed by the articulation of the rounded, distal heads of the metacarpals with the concave, proximal ends of the phalanges. The ends of the articulating bones at these joints are a poor fit, lending no bony stability.[7] The MP joints are each enclosed in a capsule that is reinforced by strong collateral ligaments. A dorsal ligament also merges with the MP joint of the thumb. Close-packed positions of the MP joints in the fingers and thumb are full flexion and opposition, respectively.

Interphalangeal Joints

The proximal IP (PIP) and distal IP (DIP) joints of the fingers, and the single IP joint of the thumb, are hinge joints. Subtle differences in the geometry of the articulating bone surfaces and soft-tissue restraints govern the motion capabilities at the PIP joints. An articular capsule joined by volar and collateral ligaments surrounds each IP joint. These joints are most stable in the close-packed position of full extension.

Muscles of the Wrist and Hand

Given the numerous, highly controlled, precision movements of which the hand and fingers are capable, it is no surprise that a relatively large number of muscles are responsible. Nine extrinsic muscles cross the wrist, and 10 intrinsic muscles have both of their attachments distal to the wrist. The muscles of the wrist and hand are shown in **Figures 19.2** (anterior) and **19.3** (posterior).

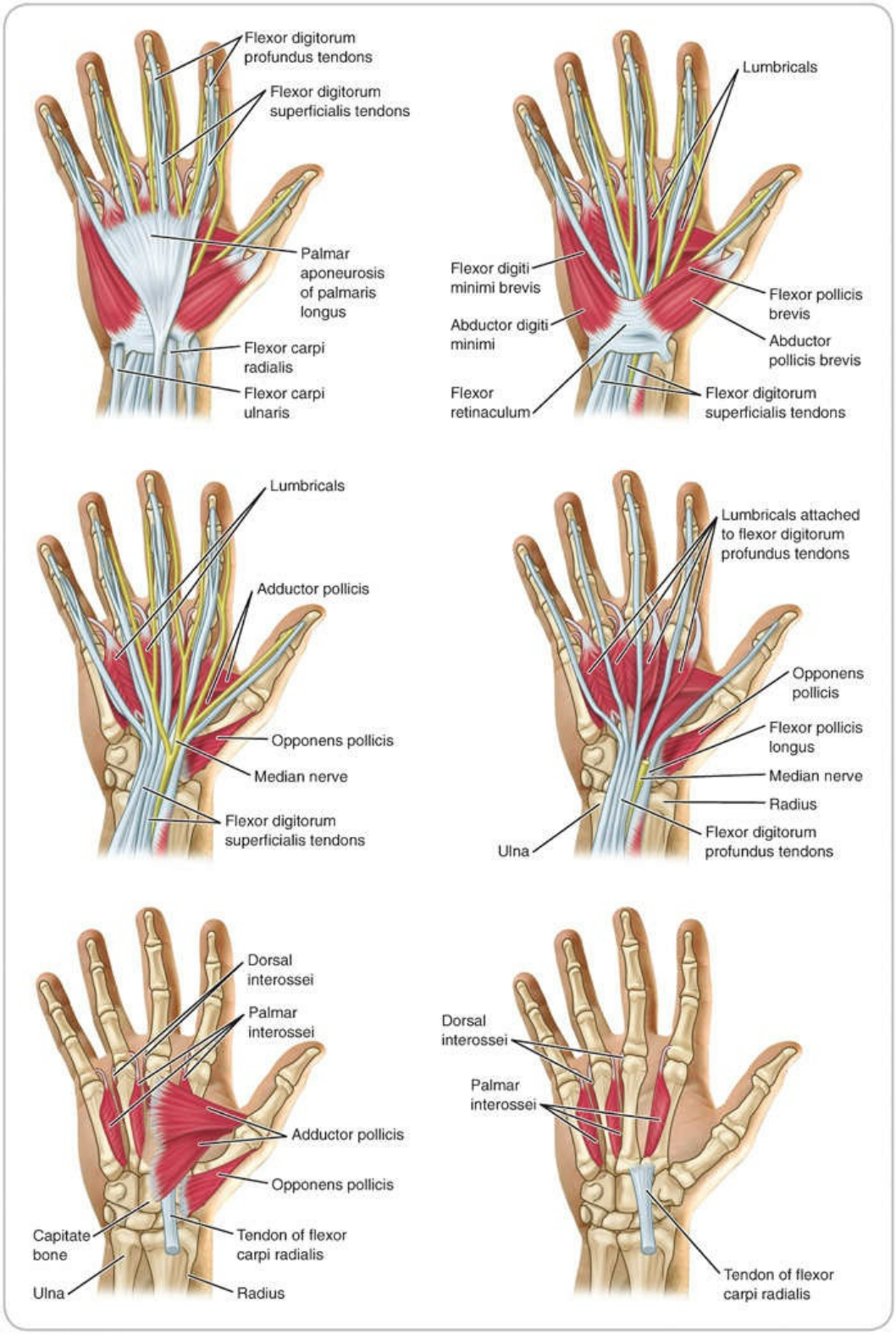


Figure 19.2. **Muscles of the wrist and hand: palmar view.**

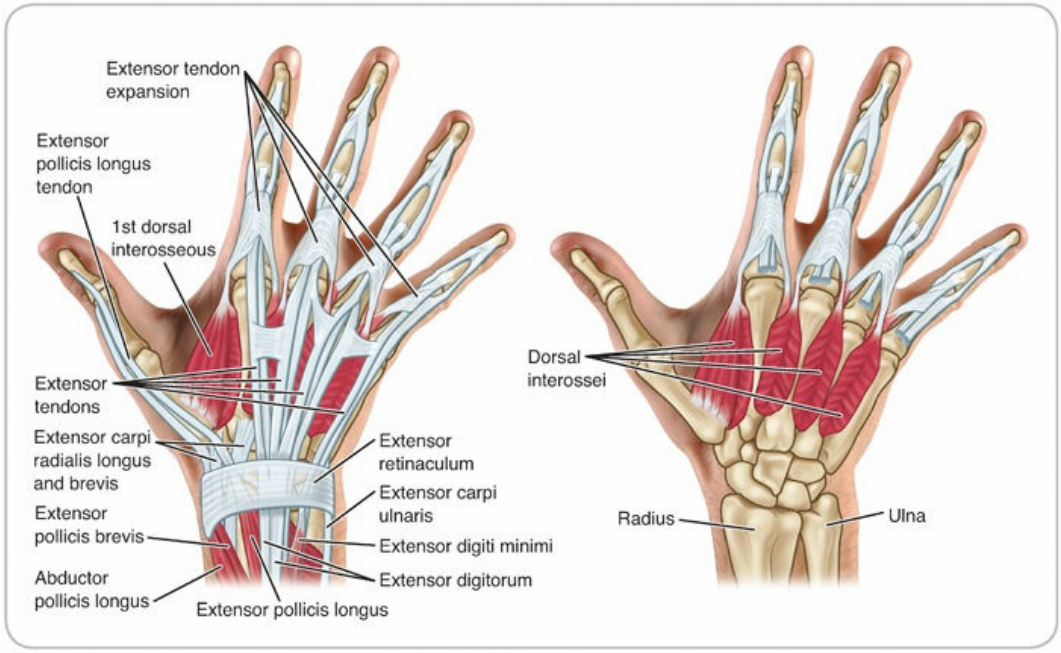


Figure 19.3. Muscles of the wrist and hand: dorsal view.

See **Major Muscles of the Hand and Fingers**, available on the companion Web site at thePoint, for a summary of the muscles, including their attachments, primary actions, and nerve innervation.

Retinacula of the Wrist

The fascial tissue surrounding the wrist is thickened into strong, fibrous bands called retinacula. They form protective passageways through which tendons, nerves, and blood vessels pass. The flexor retinaculum protects the extrinsic flexor tendons and the median nerve as they pass into the hand through the carpal tunnel on the palmar side of the wrist. Within the tunnel, the tendons are enclosed in bursal tissue and tenosynovioma. The extensor retinaculum provides a passageway for the extrinsic extensor tendons on the palmar side of the wrist.

Tendon Sheaths

The level of the metacarpal heads is the point where the flexor tendons enter a flexor tendon sheath, which is a double-walled, hollow tube sealed at both ends (Fig. 19.4). Filled with synovial fluid, the sheath provides low-friction

gliding and nutrition for the flexor tendons. The sheath is supported by a series of retinacular thickenings called annular pulleys or cruciform pulleys, depending on their configuration. The pulleys prevent tendon bowstringing with flexion. The second (A2) and fourth (A4) annular pulleys, which are located at the proximal and middle phalanges, respectively, are the most important for preventing tendon bowstringing during active flexion.

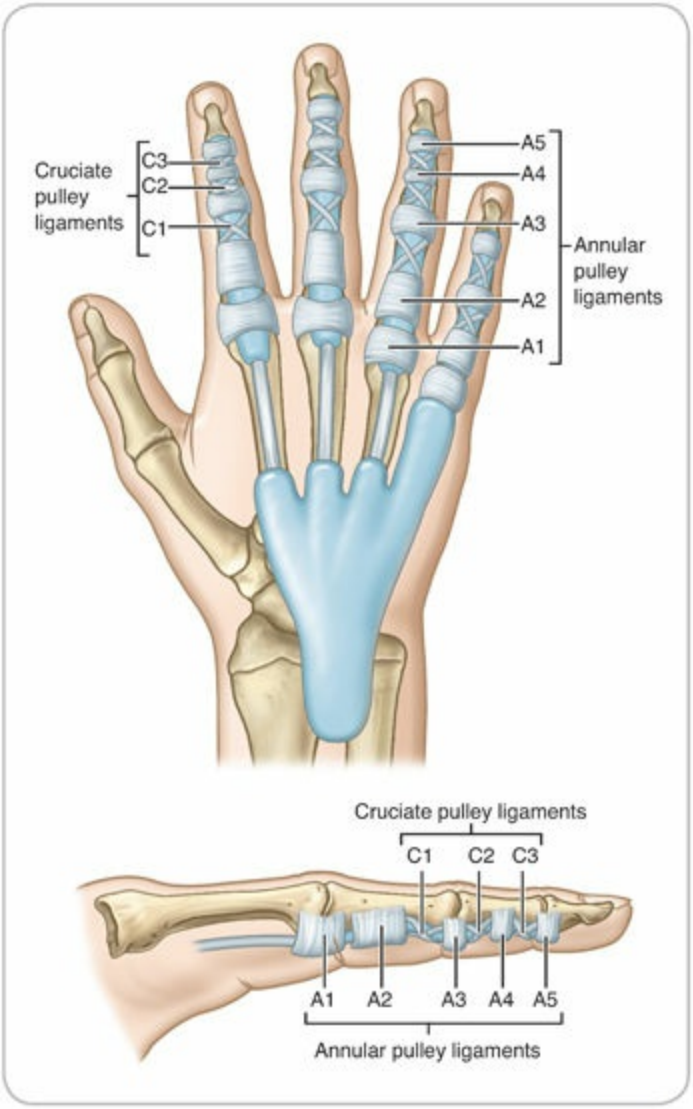


Figure 19.4. Flexor tendons, sheath, and pulley system. The tendons from the finger flexors pass through strong annular pulleys (A1 through A5), which keep the tendons and their encircling sheath closely applied to the phalanges. The thin, pliable cruciate pulleys (C1 through C3) collapse to allow full digital flexion.

Nerves of the Wrist and Hand

The median, ulnar, and radial nerves are major terminal branches of the brachial plexus that provide motor and sensory innervation to the wrist and hand (Fig. 19.5). The median nerve supplies the majority of the flexor muscles of the wrist and hand, as well as the intrinsic flexor muscles on the radial side of the palm, and cutaneous sensation to the skin on the lateral two-thirds of the palm and the dorsum of the second and third fingers. The ulnar nerve innervates the flexor carpi ulnaris, the ulnar portion of the flexor digitorum profundus, and most of the intrinsic muscles of the hand. It also provides cutaneous sensation to the fifth finger and half of the fourth finger on both the dorsal and palmar sides. The radial nerve divides into superficial and deep branches distal to the lateral epicondyle of the elbow. The superficial branch supplies the skin on the dorsum of the hand, and the deep branch innervates most of the extensor muscles of the forearm.

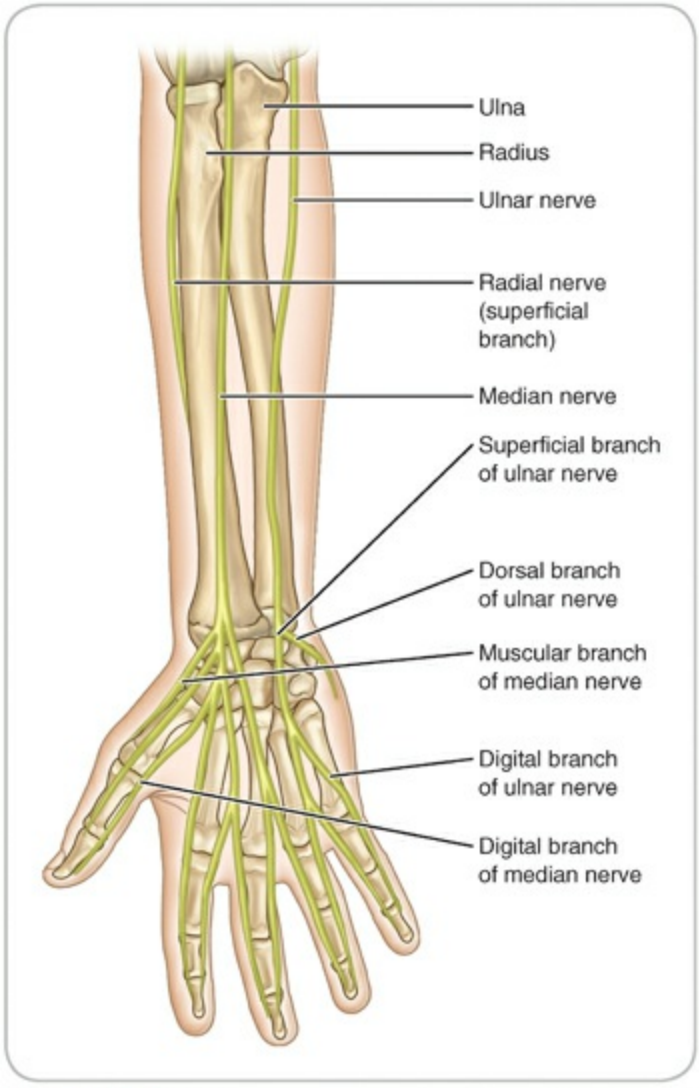


Figure 19.5. Peripheral nerve supply to the wrist and hand.

Blood Vessels of the Wrist and Hand

The major vessels supplying the muscles of the wrist and hand are the radial and ulnar arteries (Fig. 19.6). The radial artery supplies the muscles on the radial side of the forearm as well as the thumb and index finger. The ulnar artery divides into anterior and posterior interosseous arteries to supply the deep flexor muscles and extensor muscles, respectively, of the forearm. In the palm, the radial and ulnar arteries merge to form the superficial and deep palmar arches. Another connecting branch from these arteries forms the carpal arch on the dorsal side of the wrist. Digital arteries branch from the palmar arches to supply the fingers, and branches from the carpal arch run distally

along the metacarpal bones. The radial artery is superficial on the anterior aspect of the wrist. The pulse is readily palpable at this site.

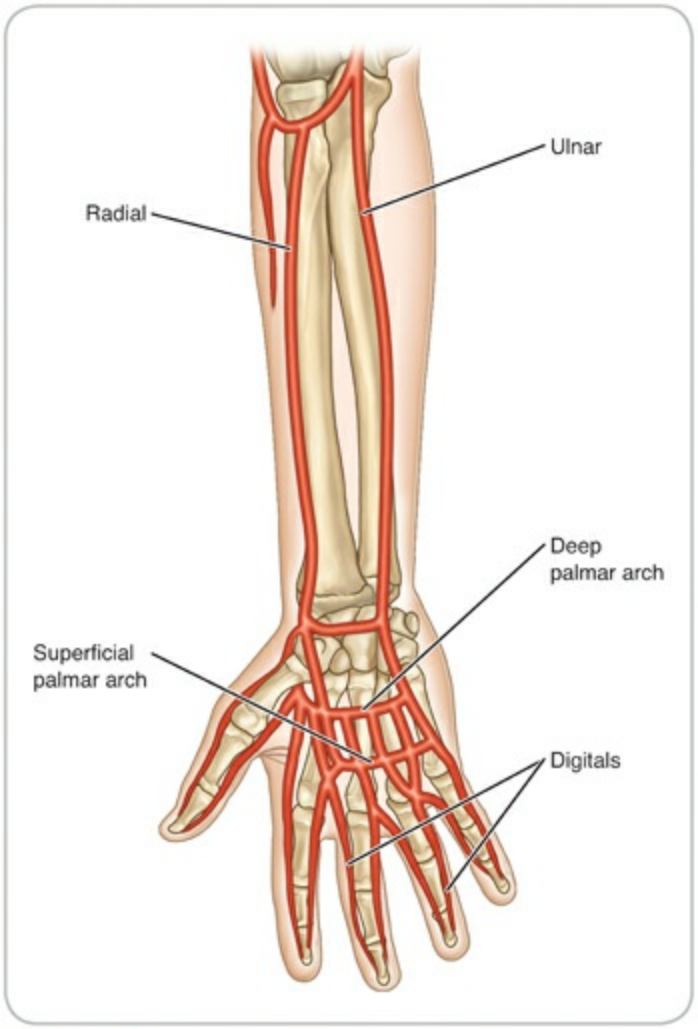


Figure 19.6. Blood supply to the wrist and hand.

KINEMATICS AND MAJOR MUSCLE ACTIONS OF THE WRIST AND HAND

The wrist is capable of both sagittal and frontal plane movements (Fig. 19.7). Flexion occurs when the palmar surface of the hand is moved toward the anterior forearm. Extension involves the return of the hand to anatomical position from a position of flexion, and hyperextension occurs when the dorsal surface of the hand is brought toward the posterior forearm. Movement of the

hand toward the radial side of the arm is known as radial deviation; movement in the opposite direction is known as ulnar deviation. Movement of the hand through all four directions is termed circumduction.

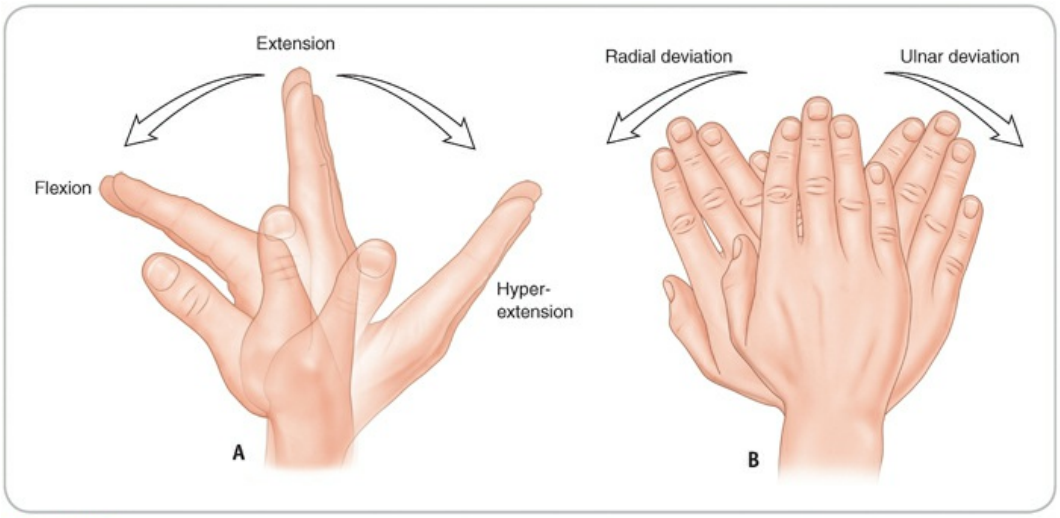


Figure 19.7. Directional movement capabilities at the wrist. A, Sagittal plane movements. **B,** Frontal plane movements.

Flexion

The major flexor muscles of the wrist are the flexor carpi radialis and flexor carpi ulnaris (Fig. 19.2). The palmaris longus, which often is absent in one or both forearms, contributes to flexion. The flexor digitorum superficialis and flexor digitorum profundus assist with flexion at the wrist when the fingers are completely extended, but when the fingers are in flexion, these muscles cannot develop sufficient tension to assist.

Extension and Hyperextension

The extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris produce extension and hyperextension at the wrist. The other posterior wrist muscles also may assist with extension movements, particularly when the fingers are in flexion. Included are the extensor pollicis longus, extensor indicis, extensor digiti minimi, and extensor digitorum (Fig. 19.3). When the wrist moves from full flexion to full extension, the passive tension in the extrinsic muscles causes the DIP joints to go from approximately 12° to 31° of flexion and the PIP joints from approximately 19° to 70° of flexion.[8]

Radial and Ulnar Deviation

The flexor and extensor muscles of the wrist cooperatively develop tension to produce radial and ulnar deviation of the hand at the wrist. The flexor carpi radialis and extensor carpi radialis act to produce radial deviation, and the flexor carpi ulnaris and extensor carpi ulnaris cause ulnar deviation.

Carpometacarpal Joint Motion

The CM joint of the thumb allows a large range of motion (ROM), comparable to that of a ball-and-socket joint. The fifth CM joint permits significantly less ROM, however, and only a very small amount of motion is allowed at the second through fourth CM joints because of the presence of restrictive ligaments.

Metacarpophalangeal Joint Motion

The MP joints of the fingers allow flexion, extension, abduction, adduction, and circumduction (**Fig. 19.8**). Among the fingers, abduction is defined as movement away from the middle finger and adduction as movement toward the middle finger. The MP joint of the thumb, however, functions more as a hinge joint, with the primary movements being flexion and extension.

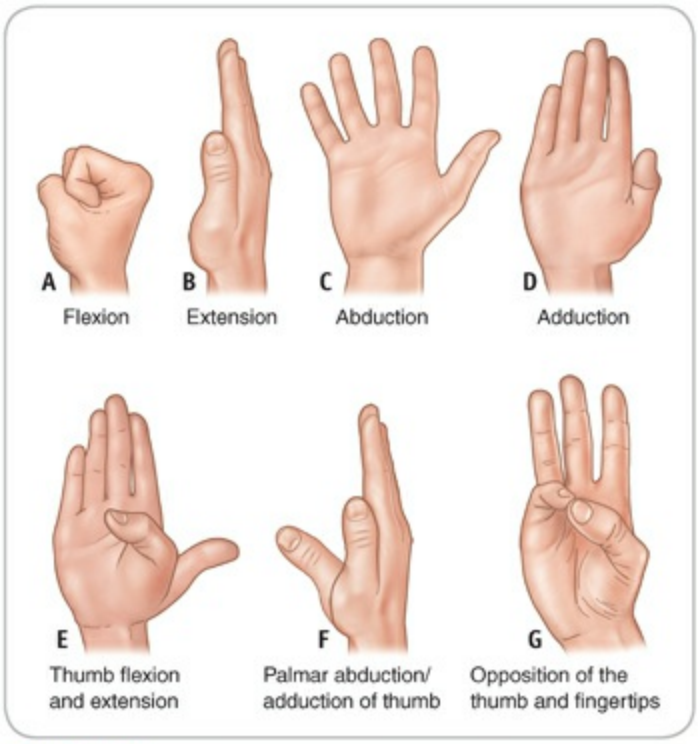


Figure 19.8. Directional movement capabilities at the fingers and thumb. A, Flexion. **B,** Extension. **C,** Abduction. **D,** Adduction. **E,** Thumb flexion and extension. **F,** Palmar abduction/adduction of the thumb. **G,** Opposition of the thumb and fingertips.

Interphalangeal Joint Motion

The IP joints permit flexion and extension and, in some individuals, slight hyperextension. These joints are classic hinge joints.

KINETICS OF THE WRIST AND HAND

The extrinsic flexor muscles of the hand are more than twice as strong as the extrinsic extensor muscles. This should come as little surprise given that the flexor muscles of the hand are used extensively in everyday activities involving gripping, grasping, or pinching movements, whereas the extensor muscles rarely exert much force.

Three types of hand grips are predominantly used in sport activities (Fig. 19.9). The power grip, as typified by the baseball bat grip, is one in which the fingers and thumb are used to clamp the grip of the bat against the palm of the

hand. The wrist is held in a position of ulnar deviation and slight hyperextension to increase the tension in the flexor tendons. In contrast to the power grip, the precision grip, as exemplified by the baseball grip, involves use of the semiflexed fingers and thumb to pinch the ball against the palm, with the wrist in slight hyperextension. A third grip, which is intermediate to the two previously described, is referred to as the fencing grip. Fencing requires both power and precision. The grip on the foil is essentially a power grip; however, because the thumb is aligned along the long axis of the foil handle, it enables precise control over the direction of force application. As might be expected, grip force is less with a precision grip in comparison to the palmar grips.[9]

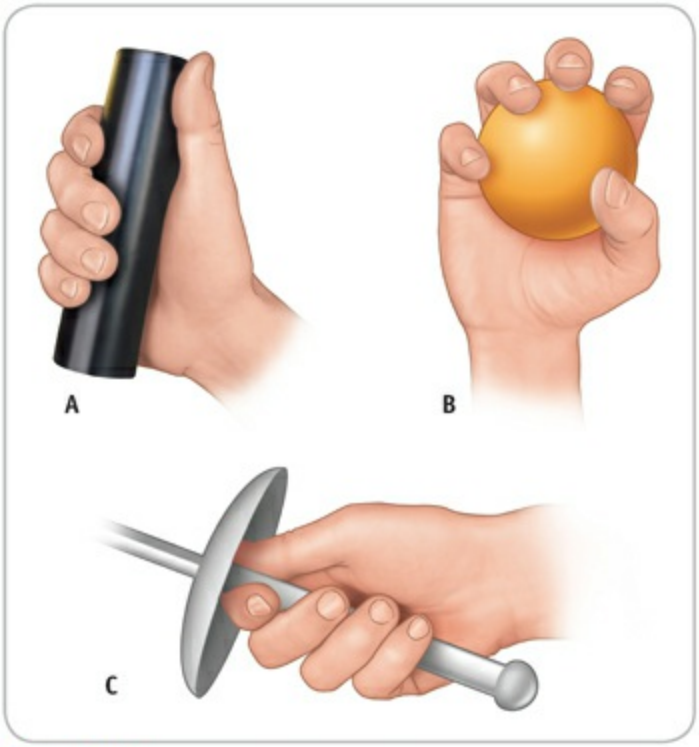


Figure 19.9. Hand grips. Muscles of the hand contract to provide several grips. **A,** Power grip. **B,** Precision grip. **C,** Fencing grip.

PREVENTION OF WRIST AND HAND CONDITIONS

The very nature of many contact and collision sports places the wrist and hand

in an extremely vulnerable position for injury. The hands almost always are the first point of contact to cushion the body during collisions, deflect flying objects, or lessen body impact during a fall. Falling on an outstretched hand is the leading cause of fractures and dislocations at the distal forearm, wrist, and hand. Although several pads and gloves are available, few sports require protective padding for the region.

Protective Equipment

Goalies, baseball and softball catchers, and field players in sports such as ice hockey and lacrosse are required to wear wrist and hand protection. Padded gloves prevent direct compression from a stick, puck, or ball. Several other gloves have extra padding placed at high-impact areas, aid in gripping, and protect the hand from abrasions, particularly when playing on artificial turf or a baseball or softball field. Whenever possible, protective pads and gloves should be worn during sport participation to lessen the risk of injury.

Physical Conditioning

Several muscles that move the wrist and hand cross the elbow. As such, ROM and strengthening exercises for the wrist and hand also must include exercises for the elbow (see **Application Strategy 18.1**). The exercises include elbow flexion and extension, forearm pronation and supination, wrist flexion and extension, and radial and ulnar deviation. Other exercises, such as squeezing a tennis ball or a spring-loaded grip device, can be used to strengthen the finger flexors.

The physical conditioning program should include a preseason and in-season component. Because upper extremity power and speed originates in the trunk and not the upper extremity, it is important to include exercises and training sessions that focus on neuromuscular control, balance, coordination, flexibility, and strengthening of the lower extremities.[10] This is especially true among pediatric athletes and those with a history of past injury.[11] Furthermore, when working with the youth sport athlete, the intensity, load, time, and distance the athlete is required to achieve should only be increased by about

10% each week to avoid overloading and breakdown.[10]

Proper Skill Technique

Unlike the shoulder and elbow, which is subjected to excessive stress during a throwing-type motion, the majority of wrist and hand injuries result from direct trauma. Although analysis of specific movements may detect improper technique, the analysis in many cases is incidental. An important skill technique that can prevent injury of the wrist and hand is proper instruction on the shoulder-roll method of falling. In this technique, the force of impact is dispersed over a wider area, lessening the risk for injury from direct axial loading on the extended wrist.

ASSESSMENT OF WRIST AND HAND CONDITIONS

? A cheerleader is complaining of pain over the right anatomical snuff box. How should the assessment of this injury progress to determine the extent and severity of injury?

The wrist and hand can be difficult to evaluate because of the number of anatomical structures providing motor and sensory function to the region. A thorough examination in this area often takes longer than with other joints of the body because of the multiple structures and joints that are involved. When assessing this region, two major objectives must be kept in mind. First, the injury or condition must be evaluated as accurately as possible to ensure adequate treatment. Second, the clinician must ascertain the remaining function to determine whether the individual has any incapacity in performing sport-specific skills and activities of daily living.

See **Application Strategy: Wrist and Hand Evaluation**, available on the companion Web site at thePoint.

The clinician also must keep in mind that if the mechanism of injury involves axial loading at the wrist, additional assessment may be necessary at the elbow or shoulder. Although uncommon, pain at the wrist and hand may be referred from the cervical spine, shoulder, and elbow. As such, it may be necessary to evaluate these joints before assessing the wrist and hand.

HISTORY

? The injury assessment of the cheerleader should begin with a history. What questions need to be asked to identify the cause and extent of this injury?

Questions about a wrist injury should focus on the primary complaint, past injuries, and other factors that may have contributed to the current problem (e.g., demands of the sport, changes in technique, overuse, occupational requirements, or referred pain). Questions should be asked to determine how the injury occurred, because it is important to determine if the region has been subjected to repetitive trauma, such as constant impact from a ball, racquet, bat, or stick. Current symptoms and their progression must be determined. Questions also must be asked regarding the pain (i.e., localized, general, radiating, or activities that increase or decrease pain), as should questions concerning the presence of sounds and unusual feelings. Recent changes, if any, in the training program should be noted.

Outcome assessment tools can also be incorporated into the history (subjective) portion of the examination process. When appropriate, outcome measures can be used during the initial evaluation but are most often during follow-up evaluations throughout the treatment and rehabilitation process to measure the patient's progress. The most commonly used tool is the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and is seen as the optimal choice to use with patients who may have multiple joints affected. If the patient is dealing with carpal tunnel syndrome, the evidence suggests that the Brigham and Women's score for carpal tunnel syndrome is a

clinically useful assessment measure to use. The Patient-Rated Wrist Evaluation (PRWE) questionnaire was found to be the most responsive tool to measure outcomes in patients with a distal radius fracture.[11]

See **Application Strategy: Developing a History of the Injury**, available on the companion Web site at thePoint, for specific questions regarding the wrist and hand region.

The cheerleader should be asked questions that address the following: when, where, and how the injury occurred; current symptoms and their progression; pain (i.e., localized, general, or radiating); activities that cannot be performed because of the pain; actions or motions that replicate the pain; and previous injury, treatment, and medication.

OBSERVATION AND INSPECTION

The history reveals falling on an outstretched hand approximately 1 month ago. The cheerleader reports that pain is more pronounced during activities that involve wrist extension. Explain the observation component in the ongoing assessment of the cheerleader.

The entire arm should be exposed for observation and inspection. Although the individual may have a wrist injury, the elbow and shoulder region also may need to be evaluated, depending on the mechanism of injury. First, the clinician should observe the position of the wrist, hand, and fingers, noting any noticeable deformity and general presentation. If swelling is present in a specific joint, the individual may be unable to fully extend that joint and may be supporting it in a slightly flexed position. If a fracture or dislocation is not present, the individual's willingness and ability to place the hand in the various positions that are requested should be observed. The functional position of the wrist, sometimes called the position of rest, is with the wrist in 20° to 35° of extension and 10° to 15° of ulnar deviation. This position allows the greatest amount of flexion of the fingers; inability to assume this position

may suggest a tendon or nerve disruption.[12] The palm of the hand should be inspected for palmar creases; swelling in one or more of the hand compartments may obliterate these lines. In a bilateral comparison, the dominant hand tends to be slightly larger than the nondominant hand. The specific site of injury should be inspected for obvious abrasions, deformity, swelling, discoloration, symmetry, hypertrophy, muscle atrophy, or previous surgical incisions. Subtle skin changes may be indicative of a possible nerve injury. For example, the hand normally has moisture on it, and the absence of moisture on the distal phalanx may indicate a digital nerve injury.[12]

See **Application Strategy: Observation and Inspection of the Wrist and Hand**, available on the companion Web site at thePoint, for a summary of the observations of the wrist and hand from the dorsal and palmar views.

During the assessment of the cheerleader's injury, a general observation regarding the presentation of the hand and wrist as well as of the elbow and shoulder should be performed. In addition, the injury site should be inspected for swelling, discoloration, deformity, muscle hypertrophy or atrophy, and other signs of existing or previous trauma.

PALPATION

A bilateral comparison of the cheerleader's wrist and hand reveals no abnormal findings. Explain palpation for this injury.

If the individual is in great pain and is unable or unwilling to move the wrist or hand, the possibility of a fracture or dislocation should be determined before moving the wrist or hand. In the absence of deformity, fracture tests, including compression, percussion, vibration, and traction, should be performed. If a fracture is suspected, it should be treated accordingly. Acute care consists of ice, immobilization, and immediate referral to a physician.

The direction and sequencing for palpation should be determined by

location of pain and site of injury, beginning away from the site and working toward it. Bilateral palpation can determine temperature, swelling, point tenderness, crepitus, deformity, muscle spasm, and cutaneous sensation. Temperature changes may indicate inflammation, infection, or reduction in circulation. Crepitus may indicate tenosynovitis, an irregular articular surface, or possible fracture. Circulation can be assessed by blanching the fingernails; this is performed by squeezing the nail and observing the changes in color. Initially, the nails should turn white, but color should return within 2 seconds of release. Pulses also can be taken at the radial and ulnar arteries in the wrist. The following structures should be palpated (**Figs. 19.1** to **19.4**):

Dorsal Aspect

1. Radial styloid process and tubercle of the radius
2. Styloid process of the ulna
3. Finger and thumb extensors muscles and tendons, and the thumb abductor muscles
4. The carpal bones on the dorsal and palmar aspect (should be palpated at the same time):
   - *Scaphoid*—lies distal to the radial styloid process and forms the floor of the anatomical snuff box
   - *Lunate*—lies just distal to the radial tubercle and is easily palpated during wrist flexion
   - *Triquetrum*—lies one finger's breadth distal to the ulnar styloid process
   - *Pisiform*—palpable on the medial palmar side when the wrist is slightly flexed
   - *Trapezium*—lies distal to the anatomical snuff box
   - *Trapezoid*—lies medial to the trapezium

- *Capitate*—lies distal to the lunate and a slight indentation before the metacarpal
- *Hamate*—lies distal to the triquetrum; the hook of the hamate is more easily palpated on the palmar aspect

5. Metacarpal bones and phalanges
6. Extensor hoods

Palmar Aspect

1. Flexor tendons
2. Carpal transverse arch that forms the carpal tunnel, and the longitudinal arch composed of the carpal bones, metacarpals, and phalanges
3. Palmar fascia and intrinsic muscles within the thenar and hypothenar muscle masses

During the assessment of the cheerleader, the bony and soft-tissue structures of the distal radius/ulna, wrist, and hand should be palpated for point tenderness, swelling, deformity, skin temperature, sensation, and other signs of trauma.

PHYSICAL EXAMINATION TESTS

Palpation reveals pain over the anatomical snuff box, and the physical examination of the injury reveals pain at the end range of passive ROM with wrist extension and ulnar deviation. Pain also is elicited during resistive ROM of those motions. What injury should be suspected, and what is the immediate management for that injury?

The wrist or hand should not be forced through any sudden motions, and caution should be used in proceeding through the physical examination. Only

those tests that are necessary to assess the current injury should be performed. Tests should be performed bilaterally.

Functional Tests

The clinician should determine the available ROM in forearm pronation–supination, wrist flexion–extension, radial/ulnar deviation, finger flexion–extension, finger abduction–adduction, thumb flexion–extension, thumb abduction–adduction, and opposition of the thumb and little finger. As always, bilateral comparison is critical to distinguish normal from abnormal movement. The clinician should ask the individual to do the following:

1. Make a tight fist (flexion).
2. Straighten the fingers (extension).
3. Spread the fingers (abduction).
4. Bring the fingers together (adduction).
5. Make wrist circles (circumduction).
6. Turn hand's palm up and down (supination and pronation).

Active Movements

In determining active movements at the wrist and hand, the movements that are anticipated to be most painful should be performed last. Finger active motion usually is done in a continuous pattern of flexion and extension. It is important to note the fluidness as each digit moves throughout the ROM. If one finger does not move through the full ROM, that finger can be evaluated separately. The motions that should be assessed and the normal ROMs for each are as follows:

- Pronation/supination of the forearm (85° to 90°)
- Wrist flexion (80° to 90°)
- Wrist extension (70° to 90°)
- Radial deviation (15°)

- Ulnar deviation (30° to 45°)
- Finger flexion and extension
- Finger abduction and adduction
- Thumb flexion, extension, abduction, and adduction
- Opposition of the thumb and little finger (tip to tip)

The techniques for taking goniometry measurements of wrist flexion and extension, and of radial and ulnar deviation, are shown in Figure 19.10.

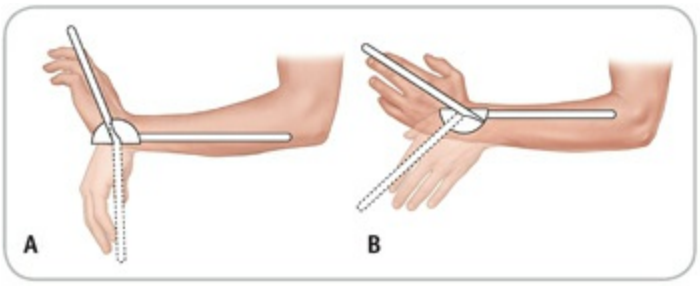


Figure 19.10. Goniometry measurement. A, Wrist flexion and extension. The fulcrum is centered over the lateral aspect of the wrist close to the triquetrum. Align the proximal arm along the lateral aspect of the ulna using the olecranon process as a reference. Then, align the distal arm along the midline of the 5th metacarpal. **B, Radial and ulnar deviation.** Center the fulcrum over the middle of the dorsum of the wrist close to the capitate. Align the proximal arm with the midline of the forearm using the lateral epicondyle as a reference. Then, align the distal arm along the midline of the third metacarpal.

Passive Movements

If the individual is unable to perform active movements in all ranges, the individual's passive movements should be assessed. Slight overpressure at the end of each motion can test the end feel of each joint. The normal end feels are as follows:

- **Tissue stretch**—movements of the wrist and finger joints
- **Bone to bone**—pronation

Resisted Muscle Testing

Active movements are tested using resisted movements throughout the full

ROM. The individual can be standing or seated. The proximal joint is stabilized, and a mild resistance is applied to the distal joint. **Figure 19.11** demonstrates motions that should be tested.

Figure 19.11. Resisted range of motion testing. A, Forearm supination and pronation. **B,** Wrist flexion and extension. **C,** Ulnar and radial deviation. **D,** Finger flexion and extension. **E,** Finger abduction and adduction. **F,** Thumb flexion and extension. **G,** Thumb abduction and adduction. **H,** Opposition.

Manual Muscle Testing

If pain or weakness is found during resisted ROM, the clinician may decide to perform a manual muscle test to determine which muscle is damaged. To correctly apply the manual muscle testing techniques to the wrist and hand, the elbow must be appropriately stabilized.[13] See **Table 19.1** for manual muscle testing procedures for the selected muscles of the wrist and hand.

TABLE 19.1 Manual Muscle Testing of Selected Muscles of the Wrist and Hand

MUSCLE	JOINT POSITIONING	APPLY PRESSURE
Flexor carpi ulnaris	Patient is seated with forearm in full supination and resting on table. Wrist should be flexed and deviated toward the ulna.	To the hypothenar eminence in the direction of extension and radial deviation
Flexor digitorum profundus	Patient is seated with wrist in slight extension. The clinician grasps the proximal and middle phalanges and stabilizes both joints in a neutral position while patient flexes distal phalanx.	To the palmar aspect of the distal phalanx in the direction of extension
Flexor digitorum superficialis	Patient is seated with wrist in slight extension. The clinician stabilizes the MP joint and proximal phalange in a neutral position while patient flexes the PIP joint.	To the palmar aspect of the proximal phalanx in the direction of extension
Extensor digitorum	Patient is seated with forearm pronated and wrist in neutral position. MP joints are extended with IP joints flexed.	To the dorsal aspect of the proximal phalanges in the direction of flexion

For more in depth descriptions and illustrations, see Kendall FP, McCreary EK, Provance PG, et al, eds. *Muscles: Testing and Function with Posture and Pain.* 5th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2005.

Stress and Joint Play Tests

Stress and joint play tests are performed for those individuals with suspected ligament or capsule damage. Only those tests deemed to be relevant should be used, and results should be compared bilaterally.

Ligamentous Instability Test for the Wrist (Varus and Valgus Stress Test)

With the individual's elbow flexed at 90° and the forearm pronated, the clinician grips the distal forearm with one hand and the metacarpals with the other. A varus (i.e., ulnar deviation) or valgus (i.e., radial deviation) stress is applied to the wrist joint, depending on the location of pain. The test is positive when pain or laxity is present. A positive varus test (radial collateral ligament stress test) indicates damage to the radial collateral ligaments. A positive valgus (ulnar collateral ligament stress test) test indicates damage to the ulnar collateral ligament.

Ligamentous Instability Test for the Fingers (Varus and Valgus Stress Test)

The clinician stabilizes the thumb or finger with one hand proximal to the joint being tested. This is followed by applying valgus and varus stresses to the joint to test the integrity of the collateral ligaments (Fig. 19.12) and

anteroposterior glide to stress the joint capsule. This test is used for gamekeeper's thumb and joint sprains of the fingers.

Figure 19.12. Ligament instability test. To stress the ligamentous structures around the joints, the clinician applies varus and valgus forces at the specific joint.

Joint Play Tests

Joint play is accessory movements that occur within a joint to facilitate proper joint motion. However, these accessory motions are not under the patient's control. Joint dysfunction is present if assessment of joint play detects hyper- or hypomobile motion. Hypermobility may be the result of sprain of the supporting ligaments or capsule. Hypomobility may be the result of adhesions, scar tissue or general capsular stiffness from chronic inflammation.[14]

Radiocarpal/Midcarpal Joint Play

Positive radiocarpal/midcarpal joint play suggests damage to the collateral or intercollateral ligaments or possibly to the TFCC of the wrist if hypermobility and/or pain were elicited.[15] The presence of hypomobility may indicate presence of adhesions within the joint. The test is performed with the patient in a seated position, elbow at 90° and forearm resting on the plinth (**Fig. 19.13**). The clinician stabilizes the patient at the distal aspect of the ulnar and radius and with opposite hand grasps the patient's proximal carpals. The clinician then performs a dorsal, palmar, radial, and ulnar glide to assess joint play.

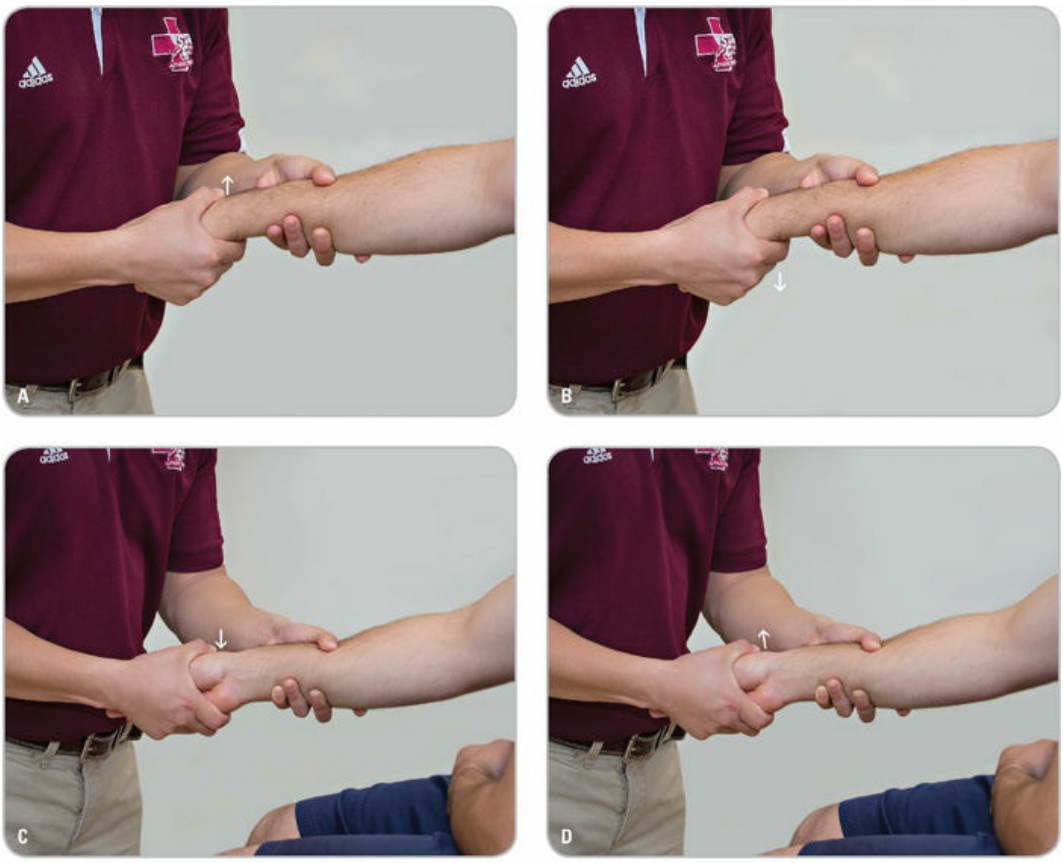


Figure 19.13. Radiocarpal and midcarpal joint play. Joint play is assessed through performing dorsal **(A)**, palmar **(B)**, radial **(C)**, and ulnar **(D)** glides of the radiocarpal joint.

Intercarpal Joint Play

Positive intercarpal joint play[15] tests may indicate sprain of the intercarpal ligaments or presence of scar tissue within the joint. The patient is seated, with elbow at 90° and forearm pronated. The clinician uses one hand (thumb and finger) to apply alternating palmar and dorsa forces to one carpal while using the other hand (thumb and finger) to stabilize the adjacent carpal.

Special Tests

A variety of special tests can be used for detecting injury or related pathology (e.g., muscle/tendon injury, nerve entrapment, or fracture).

Finkelstein Test

While the individual makes a fist with the thumb inside the fingers (Fig. 19.14), the clinician stabilizes the forearm and while the patient actively flexes

the wrist in an ulnar direction. A positive Finkelstein test, indicating de Quervain tenosynovitis, produces pain over the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) tendons at the wrist. Because the test may be uncomfortable even for a healthy individual, false positives frequently occur with this test. All positive test results should be compared bilaterally to the uninvolved wrist and correlated with information gained through the examination process.

Figure 19.14. Finkelstein test. The clinician should instruct the patient to make a fist with the thumb inside the fingers. The athlete then flexes the wrist in an ulnar direction. A positive Finkelstein test produces pain over the APL and EPB tendons.

Phalen (Wrist Flexion) Test

Several variations on how to perform Phalen test can be found in the literature, but all agree that a positive finding implies compression of the median nerve and the presence of carpal tunnel syndrome.[14–17] The clinician instructs the individual to place the dorsum of the hands together to maximally flex the wrists and hold this position for 1 minute by gently pushing the wrists together (**Fig. 19.15A**).[17] It is important to ensure that the individual does not shrug the shoulders during the test, because this causes compression of the median branch of the brachial plexus as it passes through the thoracic outlet. An alternate position is to have the clinician apply overpressure during passive wrist flexion and hold the position for 1 minute (**Fig. 19.15B**).[15] A positive

test, indicating either median or ulnar nerve compression, produces numbness or tingling into the specific nerve distribution pattern: If the median nerve is compressed, sensory changes are evident in the thumb, index finger, third finger, and lateral half of the ring finger; if the ulnar nerve is compressed, sensory changes occur in the fifth finger and medial half of the ring finger.

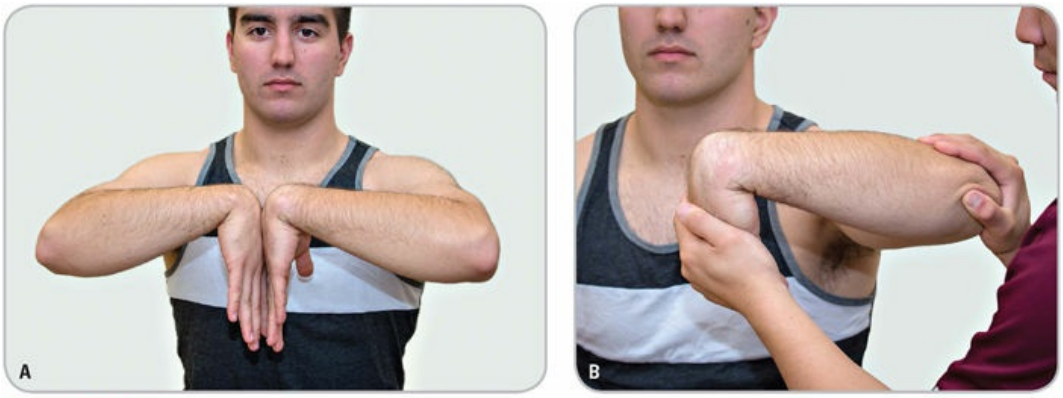


Figure 19.15. Phalen test. A, Original Phalen (wrist flexion) test indicates that the median or ulnar nerve is compressed if numbness or tingling occurs in the specific nerve distribution pattern. **B,** Modified Phalen test.

Wrist Flexion and Median Nerve Compression Test

This test has a reported 86% sensitivity and 95% specificity, making it a very clinically useful test for detecting median nerve neuropathy. To perform the test, the patient is seated with the elbow fully extended. The wrist is flexed, and the forearm is supinated. Using the thumbs, the clinician applies a constant and even pressure over the median nerve where it passes through the carpal tunnel (**Fig. 19.16**). The test is considered positive if there is a reproduction of symptoms within 30 seconds.[16]

Figure 19.16. Wrist flexion and median nerve compression test.

Pinch Grip Test for Entrapment of the Anterior Interosseous Nerve

The clinician instructs the patient to pinch the tip of the index finger and thumb together (Fig. 19.17). If an abnormal pulp-to-pulp pinch is performed, the anterior interosseous nerve, which is an extension of the median nerve, may be entrapped at the elbow as it passes between the two heads of the pronator teres.

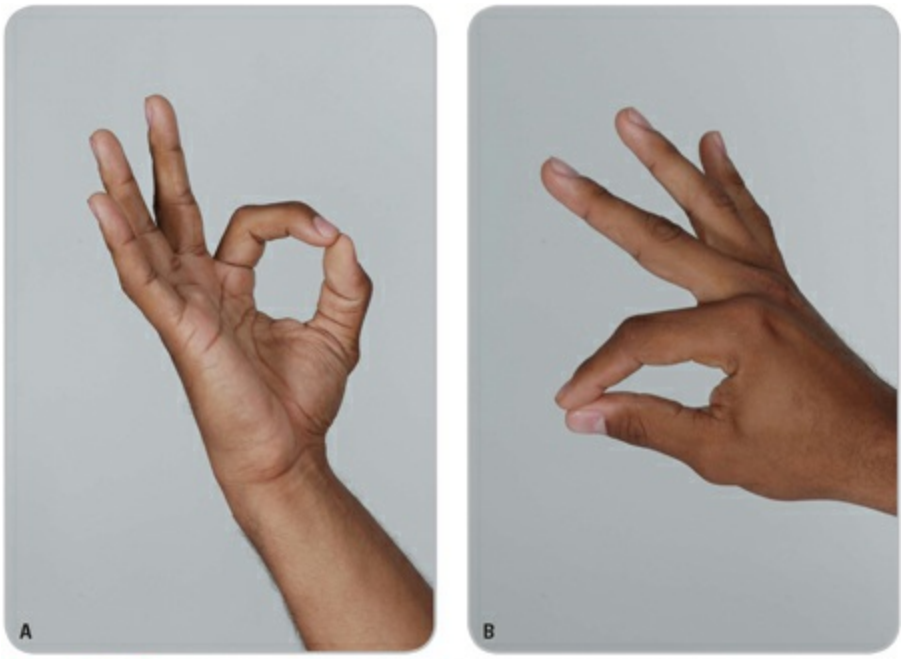


Figure 19.17. Pinch grip test. The clinician instructs the patient to make an "O" with the thumb and forefinger. **A,** Normal tip-to-tip. **B,** Abnormal pulp-to-pulp, which signifies entrapment of the interior interosseous nerve.

Scaphoid Compression Test

The scaphoid compression test is used to assist in screening in/ruling out the presence of possible scaphoid fracture. Holding the thumb of the involved hand, a longitudinal force is applied, compressing the metacarpal bone into the scaphoid (Fig. 19.18). The test is positive if painful. This test has 100% sensitivity and 80% specificity.[16]

Figure 19.18. Scaphoid compression tenderness. Pain in the anatomical snuff box is positive.

Watson Test for Scapholunate Instability

The Watson test is used to assess instability between the scaphoid and lunate. The test has moderately strong sensitivity (69%) but poor specificity (12%).[15] Problems encountered while attempting to perform the test include eliciting significant pain when used with an acute injury and the presence of positive findings without a clinical complaint. The test is performed with the patient seated and forearm slightly pronated. The clinician applies pressure to the scaphoid with the thumb on the volar aspect. With the opposing hand, the clinician grasps the patient's metacarpals and moves the patient's wrist from ulnar deviation and slight extension into radial deviation and slight extension. Pressure is continually applied to the scaphoid.[16] A clunk and pain is considered positive.

Neurological Tests

Neurological integrity can be assessed with the use of myotomes, reflexes, and segmental dermatomes as well as peripheral nerve cutaneous patterns.

Myotomes

Isometric muscle testing to assess the myotomes should be performed in the loose-packed position and include scapular elevation (C4), shoulder abduction (C5), elbow flexion and/or wrist extension (C6), elbow extension and/or wrist

flexion (C7), thumb extension and/or ulnar deviation (C8), and abduction and/or adduction of the hand intrinsics (T1).

Reflexes

Reflexes in the upper extremity include the biceps (C5–C6), brachioradialis (C6), and triceps (C7). These are discussed and demonstrated in Chapters 17 and 18.

Cutaneous Patterns

The segmental nerve dermatome patterns for the wrist and hand region are demonstrated in **Figure 19.19**. The peripheral nerve cutaneous patterns are demonstrated in **Figure 19.20**. Bilateral testing for altered sensation should be performed using sharp and dull touch by running the open hand and fingernails over the shoulder and down both sides of the arms and hands.

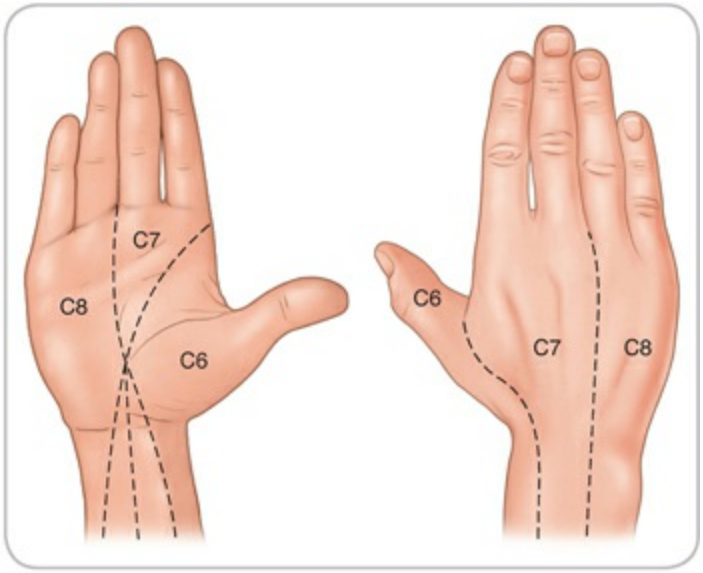


Figure 19.19. Segmental dermatomes for the wrist and hand.

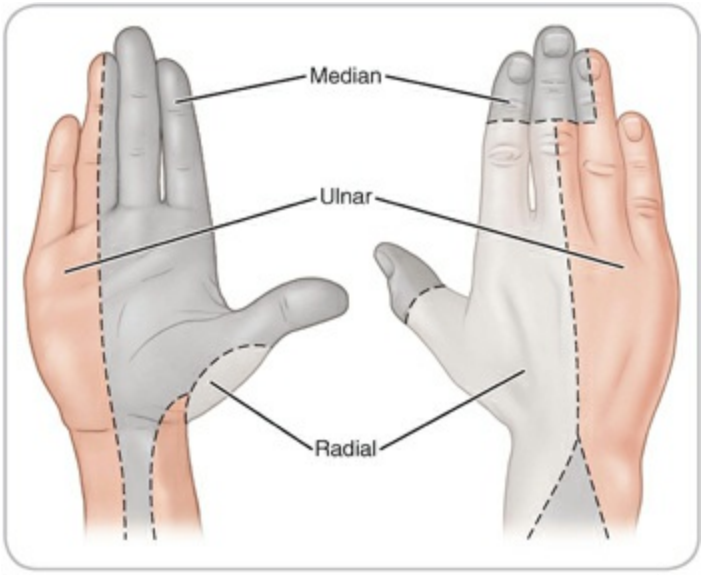


Figure 19.20. Cutaneous nerve distribution patterns for the wrist and hand.

Activity-Specific Functional Tests

Because the wrist, hand, and fingers are vital in performing activities of daily living, individuals should be assessed for manual dexterity and coordination. It is important to assess the abilities to hook, pinch, and grasp an object as well as activities such as combing the hair, holding a fork, brushing the teeth, or picking up a backpack. Before return to activity, the individual should be able to perform these simple functional skills in addition to having bilateral ROM and strength in the wrist and fingers. Conditions that warrant immediate referral to a physician include the following:

- Suspected fracture or dislocation
- Significant pain and/or excessive swelling in soft tissues or around joints
- Joint instability
- Loss or impairment of motion or function
- Presence of any sensory or circulatory changes

The assessment of the cheerleader suggests a fracture of the scaphoid. Immediate management involves ice, compression, immobilization in

an appropriate splint, and immediate referral to a physician.

CONTUSIONS AND SKIN WOUNDS

? In attempting to catch a pass, a football player fell and slid on the artificial turf field. He sustained an abrasion on the palmar side of one hand. What are the immediate and long-term concerns associated with cleaning this superficial wound?

Etiology

Direct impact to the hand by any object may lead to abrasions, lacerations, and puncture wounds. Although many are minor, it is always important to be alert for an underlying fracture.

Signs and Symptoms

Contusions on the back of the hand may appear as a bluish, painful discoloration. Abrasions and lacerations may involve profuse bleeding but are usually minor. Because of the loose skin covering the hand, contusions may produce significantly swelling that is disproportional to the degree of damage sustained. Screen for fractures based on the history, mechanism of injury, and palpations. The presence of deformity and crepitus support a possible fracture. If no deformity or crepitus is present, tapping on the bone or performing a long bone compression test may be used to assess for the presence of a nondisplaced fracture.

Management

Initial treatment of most closed wounds involves ice, compression, elevation, and rest. Symptoms usually disappear in 2 to 3 days. If not, the individual should be referred to a physician for follow-up care. Open wounds must be thoroughly cleansed of any foreign matter. With an abrasion, a 10-minute wash

using surgical soap, a water-soluble iodine solution, and a brush can remove imbedded foreign matter. When the wound has been cleansed, an antiseptic should be applied and the wound covered with a nonocclusive dressing. The dressing should be changed daily and the wound inspected for signs of infection. If the wound appears red, swollen, or purulent or is hot and tender, immediate referral to a physician is warranted.

Completely lacerated digital vessels tend to retract, constrict, and clot, whereas partial transactions may continue to hemorrhage and may result in a traumatic aneurysm.[18] Direct pressure applied to the wound for 10 to 15 minutes with a sterile, semicompressible material should be followed by elevation of the limb above the heart and immediate transportation to the nearest medical facility. A puncture wound should be irrigated with normal saline to flush as much of the foreign material as possible from the wound. After covering the wound with a sterile dressing, the individual should be transported to a physician for further evaluation to ensure that all foreign matter has been eliminated from the wound. Although infection is the most common complication with any open wound, particularly puncture wounds, the use of prophylactic antibiotics remains controversial; however, tetanus prophylaxis is warranted when these injuries are sustained.

The abrasion sustained by the football player should be cleansed thoroughly. Next, an antiseptic and a nonocclusive dressing should be applied. The wound should be inspected daily for signs of infection.

SPRAINS

Following the completion of a floor routine, a gymnast reports pain in the right wrist. What signs and symptoms would suggest that the injury is a wrist sprain?

Ligamentous sprains in the wrist and hand result from either acute trauma or repetitive stress. When caused by a single episode of trauma, the severity of

injury is dependent on the following:

- Characteristics of the injury force (i.e., point of application, magnitude, rate, and direction)
- Position of the hand at impact
- Relative strength of the carpal bones and ligaments

Most injuries to the region result from a compressive load applied while the hand is in some degree of extension, although hyperflexion or rotation may lead to injury. Unfortunately, because of the need to perform simple daily activities, most individuals do not allow ample time for healing. Consequently, many sprains are neglected, leading to chronic instability.

Wrist Sprains

Etiology

Axial loading on the proximal palm during a fall on an outstretched hand is the leading cause of wrist sprains. The most common ligamentous instability at the wrist occurs between the scaphoid and the lunate.[12] Gymnasts have a high incidence of dorsal wrist pain when excessive forces are exerted on the wrist, producing combined hyperextension, ulnar deviation, and intercarpal supination. These excessive forces occur during vaulting, floor exercise, and pommel horse routines. Divers who enter the water with the hands in extension, as well as skaters and wrestlers who fall on an extended hand, are also prone to this injury.

Signs and Symptoms

Assessment reveals point tenderness on the dorsum of the radiocarpal joint. A high degree of palpable pain between the distal radius and the scaphoid and lunate increases with active or passive extension. Varus, valgus, and Watson tests, as well as specific joint play tests, may be positive depending on the structure damaged.

Management

Immediate treatment involves immobilization, application of ice to reduce swelling and inflammation, and immediate referral to a physician to rule out a fracture or carpal dislocation. Subsequent management includes decreasing intensity of training; cryotherapy before and after physical activity; nonsteroidal anti-inflammatory drugs (NSAIDs); and use of an appropriate bandage, taping technique, or splint to prevent excessive hyperextension. As pain decreases, ROM exercises as well as wrist- and hand-strengthening exercises can be initiated (see **Application Strategy 18.1**).

Gamekeeper's Thumb

Etiology

Gamekeeper's thumb, an outdated term, is commonly used for the more appropriate medical term: ulnar collateral ligament sprain of the first MC joint. The thumb is exposed to more force than the fingers by virtue of its position on the hand. Integrity of the ulnar collateral ligament at the MP joint is critical for normal hand function, because it stabilizes the joint as the thumb is pushed against the index and middle finger while performing many pinching, grasping, and gripping motions. This injury is commonly seen in football, baseball/softball, and hockey as well as in skiing when the individual falls on the ski pole (skier's thumb). Tearing of the ulnar collateral ligament at the MP joint occurs when the MP joint is near full extension and the thumb is forcefully abducted away from the hand.

Signs and Symptoms

The palmar aspect of the joint is painful, swollen, and may have visible bruising with increased pain or weakness with opposition or pinching.[19] Instability is detected by replicating the mechanism of injury or by stressing the thumb in flexion and performing a valgus stress test on the joint. In partial tears, only moderate laxity is present, as is a definite end feel. In more severe cases, a soft end point or greater than a 15° difference in angular laxity compared to the uninjured thumb indicates total rupture of the ulnar collateral ligament. Bilateral comparison (as well as assessment of laxity at other major

joints) helps to determine normal joint laxity for the individual.

Management

Initial treatment includes ice, compression, elevation, and referral to a physician. Many physicians will recommend X-ray evaluation prior to physical examination in order to rule out avulsion fractures, which can be displaced and unstable.[18] If no instability is present, early mobilization accompanied by cryotherapy, contrast baths, ultrasound, and NSAIDs is recommended. Strapping or taping the thumb can prevent reinjury. If joint instability is present, a thumb spica cast should be applied for 4 to 6 weeks, followed by further taping for another 3 to 6 weeks during risk activities. Severe cases require surgical repair.

Interphalangeal Collateral Ligament Sprains

Etiology

Excessive varus/valgus stress and hyperextension can damage the collateral ligaments of the fingers. Ligament failure usually occurs at its attachment to the proximal phalanx or, less frequently, in the midportion. Hyperextension of the proximal phalanx can stretch or rupture the volar plate on the palmar side of the joint (Fig. 19.21).

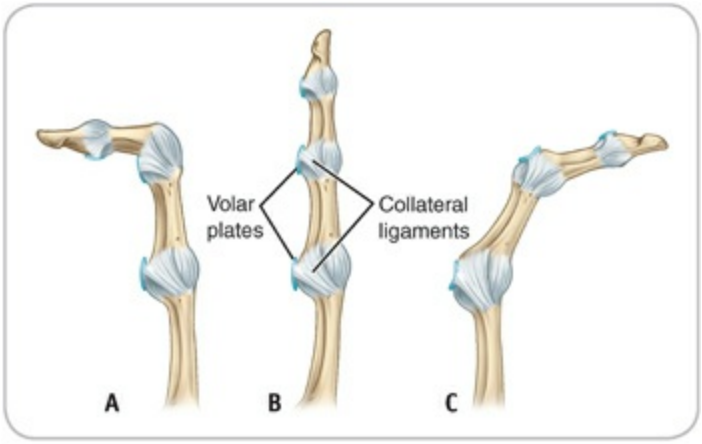


Figure 19.21. Collateral ligaments and volar plate of the fingers can be damaged in hyperextension injuries. A, Flexion. **B,** Extension. **C,** Hyperextension.

Signs and Symptoms

Even with first-degree sprains, the patient will experience stiffness, pain, and limited ROM. The patient may report presence of pain in the entire joint, and tenderness may be elicited over the injured structure when palpated. Depending on which ligament is damaged, the varus or valgus stress test may be positive. An obvious deformity may not be present unless there is a fracture or total rupture of the supporting tissues, causing a dorsal dislocation. Because rapid swelling makes assessment difficult, the clinician may utilize a tap or compression test to help assess for presence of fracture. However, a radiograph is needed to rule out an associated dislocation or fracture.

Management

Following standard acute care, a mild sprain can be treated by taping the injured finger to an adjacent finger (e.g., buddy taping). This provides some support and mobility, but such taping should not be used on an acutely swollen, painful finger because of possible constriction to the vascular flow. If more support is needed, the involved joint can be splinted in extension with a molded polypropylene splint to avoid flexion contractures.

Dislocations

Similar to many other wrist and hand injuries, dislocations often are caused by a fall on the outstretched hand or by traumatic hyperflexion, hyperextension, or rotary movement.

Distal Radioulnar Joint Injury

Etiology

An acute dislocation and subluxation of the distal radioulnar joint (DRUJ) can be an isolated injury or may occur in conjunction with a fracture of the radius. The mechanism of injury almost always involves hyperextension of the wrist. If an ulnar dorsal dislocation of the joint occurs, hyperpronation also is present, whereas an ulnar volar dislocation occurs in conjunction with

hypersupination. Because the TFCC functions as a sling to support the ulnar border of the wrist and connects the distal ulna to the ulnar side of the radius, dislocation of the DRUJ can result in damage to some portion of this complex or its attachments.[19]

Signs and Symptoms

The clinical appearance of a DRUJ dislocation can vary significantly, depending on the presence or absence of an associated fracture. Generally speaking, the joint is deformed, swollen, and very painful. Swelling may be so extensive that it obscures the prominence of the ulnar head. In a dorsal dislocation, the ulnar head is more prominent dorsally. In volar dislocations, the wrist typically appears to be narrow as a result of an overlap of the distal parts of the radius and ulna. If soft-tissue swelling is not excessive, a depression may be noted near the sigmoid notch of the radius, where the ulnar head normally is located. Flexion and extension of the elbow are normal unless there is an associated fracture, but pronation and supination of the forearm are limited.[20]

Management

Immediate action involves immobilization of the limb in a vacuum splint and immediate transportation of the individual to a physician. The prognosis and rehabilitation program depends on the extent of tissue damage and instability. Simple DRUJ dislocations may be stabilized after the internal fixation of associated fractures and immobilized in an above-the-elbow cast. ROM exercises should be started 6 weeks after fixation.

Triangular Fibrocartilage Complex Tear

The DRUJ derives a significant amount of stability from the TFCC and the joint capsule. Therefore, the same mechanism of injury that may result in DRUJ instability may also result in TFCC tear. The TFCC is composed of five structures: (1) the articular disk, which an elongated triangular structure is resting between the ulnar/radius and lunate and triquetrum; (2) the deep and superficial layers of the subcruentum ligament; and (3) the two disk–carpal

ligaments (Fig. 19.22). Patients with a history of falling on an outstretched hand, swinging a bat or racquet, or violently twisting their wrist and complain of wrist pain should be evaluated for the presence of TFCC injury.

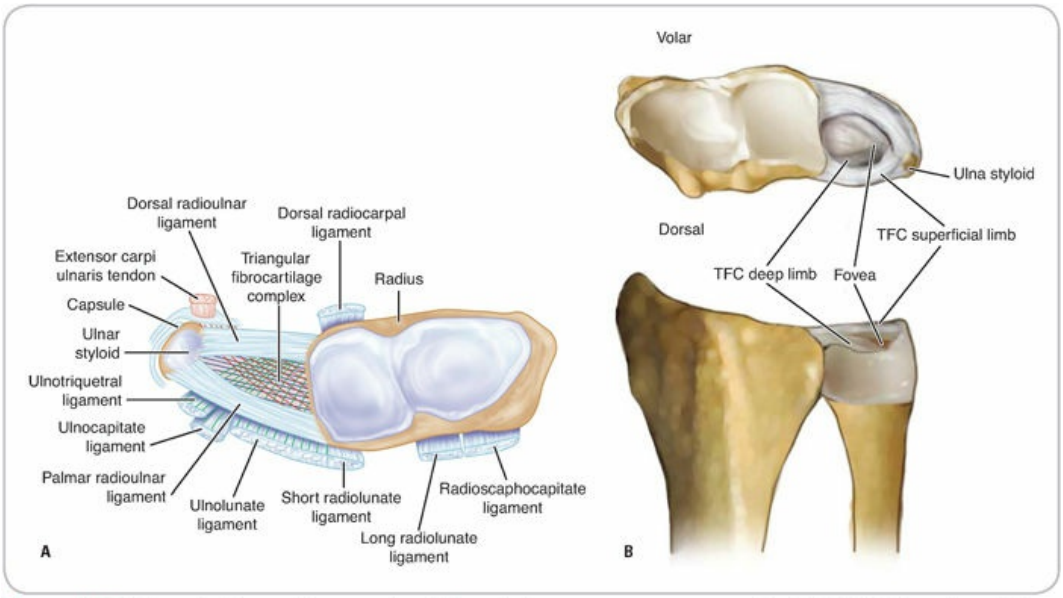


Figure 19.22. Triangular fibrocartilage complex. A, The soft-tissue structures encompassing the TFCC of the wrist stabilize the radioulnocarpal unit. The TFC proper originates from the radius medially and attaches to the base of the ulnar styloid. Fibers originating from the subsheath of the extensor carpi ulnaris dorsally cross path with fibers originating from the ulnocarpal ligaments volarly and blend with the TFC proper. **B, Distal radioulnar joint ligaments.** (The disk component of the TFCC has been removed to show the deep limbs of the radioulnar ligaments.) The volar and dorsal radioulnar ligaments are the major soft-tissue stabilizers of the DRUJ and insert onto the base of the ulnar styloid.

Signs and Symptoms

The patient may present with pain on the ulnar aspect of the wrist over the TFCC. Tenderness is elicited when palpating the area and may increase if palpation is performed in conjunction with passive ulnar deviation.[16] History may also reveal decreased functional use of the hand in activities such as turning doorknobs, pushing open doors, and sports-specific skills involving wrist motion. Mild swelling may be seen or palpated.

Management

TFCC tears may take up to 12 weeks to fully repair. Management ranges from rest and ice and anti-inflammatory medication for pain to immobilization, steroid injections, and surgical repair.[20] Therefore, it is imperative if a TFCC tear is suspected, that the patient be referred to an orthopedic physician for imaging and further evaluation.

Perilunate and Lunate Dislocation

Etiology

Because of the shape of the lunate and its position between the large capitate and lower end of the radius, it is particularly prone to dislocation during axial loading that causes displacement in a volar direction (Fig. 19.23). As force initially impacts the carpals, the distal row is displaced away from the lunate, resulting in the lunate resting dorsally relative to the other carpals (i.e., **perilunate dislocation**). If the force continues to extend the wrist, the dorsal ligaments rupture, relocating the carpals and rotating the lunate. The lunate then rests in a volar position relative to the other carpals (i.e., **lunate dislocation**).

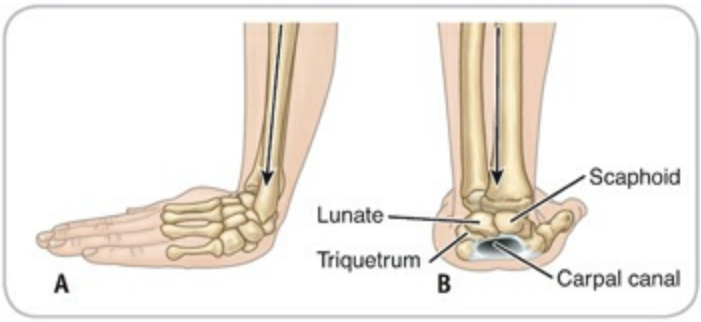


Figure 19.23. Lunate dislocation. A, The lunate can dislocate during a fall on an outstretched hand when the load from the radius compresses the lunate in a volar direction. **B,** If the bone moves into the carpal tunnel, the median nerve can become compressed, leading to sensory changes in the first and second fingers.

Signs and Symptoms

The dorsum of the hand is point tender, and a thickened area on the palm can be palpated just distal to the end of the radius (proximal to the third metacarpal) if not obscured by swelling. Passive and active motion may not be painful. If the bone moves into the carpal tunnel, compression of the median nerve leads to pain, numbness, and tingling in the first and second fingers. In chronic conditions or conditions that go undiagnosed, performing the Watson test for scapholunate instability is indicated.

Management

Immediate action involves immobilization of the wrist in a vacuum splint and immediate transportation of the individual to a physician. Following reduction, the wrist is immobilized in moderate flexion with a silicone cast for 3 to 4 weeks. The wrist is then placed into a neutral position and protected from any wrist extension, particularly during sport participation. This condition often is overlooked until complications, such as flexor tendon contractures and median nerve palsies, arise from chronic dislocations. Repeated trauma to the lunate can lead to vascular compromise, resulting in degeneration or osteochondritis of the lunate (**Kienböck disease**). Kienböck disease should be considered if the patient presents with a painful and swollen wrist, complaining of joint stiffness and decreased ROM, decreased grip strength, and difficulty supinating.

Dislocation of the Metacarpals and Phalanges

Etiology

MP joint dislocations are rare but readily recognizable as a serious injury. Hyperextension or a shearing force causes the anterior capsule to tear, allowing the proximal phalanx to move backward over the metacarpal and stand at a 90° angle to the metacarpal (**Fig. 19.24**).

Figure 19.24. Metacarpophalangeal dislocation. The volar plates protect the anterior joint capsules of the fingers. During hyperextension, the anterior capsule and supporting ligaments can rupture, dislocating the phalanx. The resulting deformity signals a serious dislocation.

The most common dislocation in the body occurs at the PIP joint (Fig. 19.25). Because digital nerves and vessels run along the sides of the fingers and thumb, these dislocations are potentially serious. The usual mechanism of injury is hyperextension and axial compression, such as when a ball hits the end of the finger and forces it into hyperextension.

Figure 19.25. Dislocation variants of the proximal interphalangeal joint. The most common are dorsal **(A)**, followed by pure volar with a central slip rupture **(B)**. The least common is rotatory subluxation **(C)**.

DIP dislocations usually occur dorsally and may be associated with an open wound. These individuals often reduce the injury on their own. As with MP joint dislocations, injuries to the collateral ligaments at the PIP and DIP joints can involve ruptures of the volar plate.

Signs and Symptoms

A swollen, painful finger is the most frequent initial complaint. Pain is present at the joint line and increases when the mechanism of injury is reproduced. With an MP dislocation, the proximal phalanx may stand at a 90° angle to the metacarpal. When the stability of an injured collateral ligament of the PIP joint

exceeds 20° or has no end point on manual stress, it is considered to be a complete rupture.[21] Because of the probability of entrapping the volar plate in an IP joint, which can lead to permanent dysfunction of the finger, no attempt should be made by an untrained individual to reduce a finger dislocation.

Management

Immediate treatment for all dislocations involves immobilization in a wrist or finger splint, application of ice to reduce swelling and inflammation, and immediate referral to a physician for reduction of the dislocation.

If the MP joint is stable, protection with buddy taping for 2 to 3 weeks usually is sufficient. Early active ROM exercises are encouraged. In an uncomplicated dislocation of the PIP joint, the finger may be splinted in approximately 30° of flexion, with active motion being started at 10 to 14 days. Volar-displaced PIP dislocations with suspected central slip injury should have the PIP joint splinted in complete extension for 6 full weeks. During this time, active exercises of the DIP joint are imperative to maintain muscle integrity and strength of the flexor digitorum profundus and extensor mechanism. If inadequately managed, however, dislocations at the PIP joint can result in a painful, stiff finger with a fixed flexion deformity called a **coach's finger**. If the volar plate is trapped in the joint, the deformity may result in the PIP joint being held in flexion and the DIP joint in hyperextension (a pseudo-boutonnière deformity). Immobilization for a DIP joint dislocation involves splinting the DIP joint with a volar splint for approximately 3 weeks. The PIP joint can be left free so that motion can continue at this joint. Protective splinting is continued for at least 3 weeks until the finger is pain-free.

The signs and symptoms that would suggest that the gymnast has sustained a wrist sprain include excessive forces producing a hyperextension mechanism; point tenderness on the dorsum of the radiocarpal joint; point tenderness between the distal radius, scaphoid, and lunate; and pain that increases with active or passive extension.

STRAINS

? While holding an opponent's jersey tightly, a basketball player felt a sharp pain in the distal phalanx of the ring finger. After releasing the jersey, the player was unable to flex the DIP joint of the ring finger. What injury should be suspected?

Muscular strains occur as a result of excessive overload against resistance or stretching the tendon beyond its normal range. In mild or moderate strains, pain and restricted motion may not be a major factor. In many injuries, muscular strains occur simultaneously with a joint sprain. The joint sprain takes precedence in priority of care, especially with an associated dislocation; as a result, tendon damage may go unrecognized and untreated.

Jersey Finger (Profundus Tendon Rupture)

Etiology

This injury typically occurs when an individual grips an opponent's jersey while the opponent simultaneously twists and turns to get away. This jerking motion may force the individual's fingers to rapidly extend, rupturing the flexor digitorum profundus tendon from its attachment on the distal phalanx. The ring finger is most commonly involved, because this finger assumes a position of slight extension relative to the other fingers, which are more flexed during the grip.

Signs and Symptoms

The individual will complain of pain and swelling at the DIP joint and report a popping sensation at the time of injury. Flexor tendon disruption is indicated by one finger lying in complete extension while others are in slight (10°) flexion at the IP joints.[18] If avulsed, the tendon can be palpated at the proximal aspect of the involved finger; it typically has a hematoma formation along the entire flexor tendon sheath and may compromise the palmar digital artery blood supply. If a portion of bone is avulsed, it may become trapped distal to the A4

pulley over the middle phalanx or distal to the A2 pulley, or it may retract all the way into the palm. Because of the avulsion, the individual is unable to flex the DIP joint against resistance.

Management

Following standard acute care, the individual should be referred to a physician. For cases in which the tendon has retracted into the palm, surgical reattachment of the tendon must be performed within 7 to 10 days (before permanent contracture occurs). Typical return to play is 6 to 12 weeks after surgery.[19]

Mallet Finger

Etiology

Mallet finger, or baseball finger, occurs when an object hits the end of the finger while the extensor tendon is taut, such as when catching a ball. The resulting forceful flexion can avulse the lateral bands of the extensor mechanism from their distal attachment, or the tendon may remain attached to an avulsed piece of bone or fracture fragment, leaving a characteristic mallet deformity (**Fig. 19.26**).

Figure 19.26. Mallet finger. This individual was asked to straighten the middle finger but was unable to extend the DIP joint, suggesting that the extensor tendon is avulsed from the attachment on the distal phalanx. The tendon also may avulse a small piece of bone, leading to an avulsion fracture.

Signs and Symptoms

Unlike the jersey finger, in which the flexor tendon retracts into the proximal aspect of the finger, isolated rupture of the extensor tendon usually does not retract. Examination reveals pain, swelling, and a variable lack of active extension at the DIP joint. Dorsal bone avulsion fractures typically signify a grade III rupture of the extensor tendon. If untreated, complete tears lead to permanent DIP extensor lag.

Management

Following standard acute care, the individual should be referred to a physician for further treatment, which may involve splinting the DIP joint in complete extension for 6 to 8 weeks, with an additional 6 to 8 weeks of splinting during sport participation. Motion at the PIP and MP joints, however, is highly

encouraged. Soft-tissue irritation or ulceration on the dorsum of the DIP may occur secondary to splinting; this can be avoided by keeping the splint dry and alternating its position between the dorsal and palmar aspects of the finger. Extreme hyperextension of the distal phalanx also may impair vascular supply to the tip of the finger, leading to further skin damage. If large fracture fragments are present, surgical repair may be necessary.

Boutonnière Deformity

Etiology

A boutonnière deformity is caused by blunt trauma to the dorsal aspect of the PIP joint or by rapid, forceful flexion of the joint against resistance. The central slip of the extensor tendon ruptures at the middle phalanx, leaving no active extensor mechanism intact over the PIP joint. An injury to the volar plate also can lead to a flexion deformity of the PIP joint that resembles a boutonnière deformity; however, the central slip of the extensor tendon is not involved. This condition is called a **pseudo-boutonnière deformity**.

Signs and Symptoms

The deformity is not usually present immediately; rather, it develops over 2 to 3 weeks, as the lateral slips move in a palmar direction and cause hyperextension at the MP joint, flexion at the PIP joint, and hyperextension at the DIP joint (**Fig. 19.27**). Because the head of the proximal phalanx protrudes through the split in the extensor hood, this condition sometimes is referred to as a “buttonhole rupture.” The PIP joint is swollen and lacks full extension.

Figure 19.27. Boutonnière deformity. In a boutonnière deformity, the proximal joint flexes while the distal joint hyperextends.

Management

Any injury that limits PIP extension to 30° or less and produces dorsal tenderness over the base of the middle phalanx should be treated as an acute tendon rupture and immediately referred to a physician. Initial treatment involves splinting the PIP joint in complete extension for 5 to 6 weeks. To avoid the development of adhesions, the DIP joint should not be immobilized.

Tendinopathies

Individuals who are involved in strenuous and repetitive training often inflame tendons and tendon sheaths in the wrist and hand. Injuries can be acute or chronic in nature, but tendons are most at risk for injury when tension is rapidly applied at an oblique angle. Tendons that are already under tension and muscles that are maximally innervated or stretched are risk factors for rupture. Overuse can lead to derangement of both the mechanical and physiological components of the normal tendon. This condition is referred to clinically as tendinitis. In comparison, when the tendon sheath is inflamed as a result of trauma, overuse, or infection, it is called **tenosynovitis** (Fig. 19.28).

Figure 19.28. Tenosynovitis. This 13-year-old boy complained of pain in the finger for 3 days after a paronychia had been drained. Note the swelling and erythema of the distal phalanx.

Trigger Finger

Etiology

Snapping flexor tendons, or trigger finger, may be present in individuals who have multiple, severe traumas to the palmar aspect of the hand or in individuals who perform repeated movement and clenching of the fingers. It most commonly occurs in the middle or ring finger but may occur in the thumb and other fingers. Repeated trauma and inflammation lead to a thickening of the tendon sheath as it passes over the proximal phalanx. A nodule can form and grow within the thickened, synovium-lined tendon sheath that eventually prevents the tendon from sliding within the annular ligaments of the finger. The finger becomes locked in flexion when the nodule becomes too thick, or the sheath too constricted, to allow the finger to be actively reextended (**Fig. 19.29**).

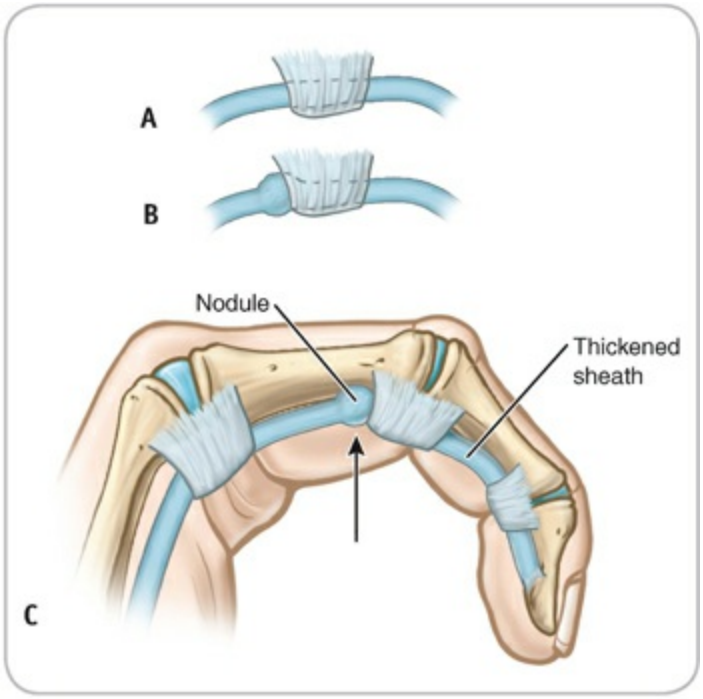


Figure 19.29. Trigger finger. A, Under normal conditions, the flexor tendons slide within the synovial sheaths under the annular ligaments at the proximal and middle phalanx. **B,** Repeated trauma can cause a nodule to form in the tendon sheath, or the sheath may become thickened. **C,** Flexion occurs, and the finger becomes locked in flexion when the nodule becomes too thick or the sheath too constricted. The finger is then unable to reextend.

Signs and Symptoms

Initially, the pain may present as an aching sensation in the joint and gradually, specific areas of point tenderness may be found. As the condition progresses, a locking action usually occurs when the individual first wakes from sleep. A painful popping sensation often is perceived when the flexed PIP joint is passively returned to extension. Additional palpable crepitus may indicate an underlying systemic disease (e.g., systemic sclerosis, rheumatoid arthritis, or granulomatous infection).

Management

Treatment includes NSAIDs, resting the finger, splinting when necessary, and possible cortisone injections into the sheath. For those individuals who do not respond to a steroid injection or who prefer quick, more definitive relief, an

incision proximal to the palpable nodule may be necessary to cut the annular ligament and allow the tendon to slide freely.[22]

de Quervain Tenosynovitis

Etiology

Individuals who must use a forceful grasp, combined with repetitive use of the thumb and ulnar deviation, are particularly at risk for de Quervain tenosynovitis. Sports such as tennis, golf, fly fishing, and javelin and discus throwing place a high demand on the APL and EPB. These two tendons share a single synovial tendon sheath that travels through a bony groove over the radiostyloid process and then turns sharply (as much as 105°) to enter the thumb when the wrist is in radial deviation. Tenosynovitis results from friction among the tendons, stenosing sheath, and bony process (Fig. 19.30). The tendons slide within the sheath not only during movements of the thumb but also during movements of the wrist with the thumb fixed, as in bowling and throwing.

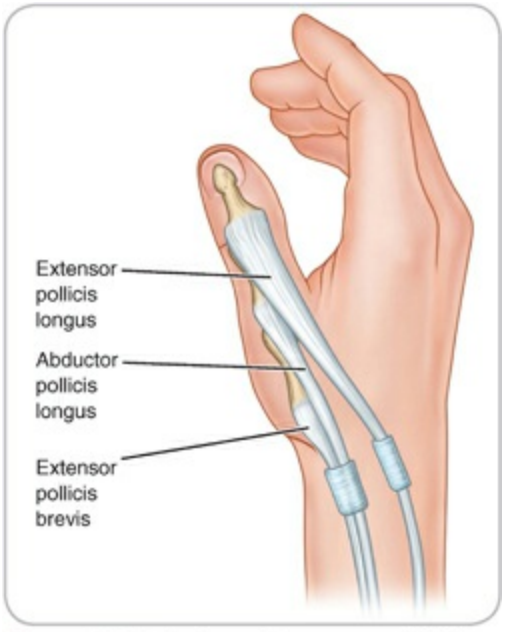


Figure 19.30. de Quervain tenosynovitis. The APL and EPB share the same synovial sheath. Excessive friction among the tendons, sheath, and bony process leads to tenosynovitis of the tendons.

Signs and Symptoms

The individual complains of pain over the radial styloid process that increases with thumb and wrist motion. Palpation reveals point tenderness over the tendons, either at or just proximal to the radial styloid, and occasionally crepitation. Movements of the thumb are painful, and snapping of the tendons may be present with some activities. Pain is reproduced in two ways: (1) by abducting the thumb against resistance and (2) by flexing the thumb and cupping it under the fingers and then flexing the wrist in ulnar deviation to stretch the thumb tendons (**Fig. 19.14**). Swelling may be present in the first dorsal compartment.

Management

Treatment is conservative with ice, rest, and NSAIDs. If symptoms are not relieved, steroid injections, immobilization with a thumb spica for 3 weeks, or both may be indicated. In severe cases, surgical decompression may be necessary.

Intersection Syndrome

Etiology

Intersection syndrome is a tendinitis or friction tendinitis in the first and second dorsal compartments. It has been described in rowers, indoor racquet players, canoeists, and weight lifters who overuse the radial extensors of the wrist by excessive curling.[23] The muscle and tendons of these two compartments traverse each other at a 60° angle at a site approximately two to three fingerbreadths proximal to the wrist joint on the dorsal aspect (i.e., 4 to 6 cm proximal to Lister tubercle). The condition also has been described as a stenosing tenosynovitis of the sheath of the second compartment (i.e., the radial extensors) at the area where it traverses the muscle bellies of the first compartment (i.e., APL and EPB).

Signs and Symptoms

Examination reveals point tenderness on the dorsum of the forearm, two to

three fingerbreadths proximal to the wrist joint. Crepitation or squeaking is noted with passive or active motion. Visible swelling is present along the course of the affected tendons.

Management

Treatment consists of ice massage, rest, NSAIDs, splinting, and avoidance of exacerbating activities. A corticosteroid injection may be necessary to relieve acute symptoms. Rehabilitation should consist of ROM exercises and wrist extensor strengthening. A tenosynovectomy and a fasciotomy of the APL muscle may be necessary if conservative treatment is not effective.

Dupuytren Contracture

Etiology

For unknown reasons, nodules can develop in the palmar aponeurosis. These nodules limit finger extension and, eventually, cause a flexion deformity. The condition, known as Dupuytren contracture, is rare but can impact normal function of the fingers.

Signs and Symptoms

A fixed flexion deformity is visible, occurring more frequently on the ring or little finger. The finger cannot be extended.

Management

Because normal finger function cannot occur with the flexion deformity, the nodule causing the contracture must be surgically removed.

Ganglion Cysts

Etiology

Ganglion cysts are benign tumor masses typically seen on the dorsal aspect of the wrist, although they may occur on the volar aspect.

Signs and Symptoms

Associated with tissue sheath degeneration, the cyst itself contains a jellylike, colorless fluid of mucin and is freely mobile and palpable. Occurring spontaneously, cysts seldom cause any pain or loss of motion. Discomfort from the pressure may occur as the ganglion increases in size.

Management

Treatment is symptomatic: Aspiration, injection, and rupture of the cyst have not proved to be successful, because the condition may recur. Surgical excision remains the treatment of choice.

The mechanism of injury and the symptoms suggest that the basketball player has sustained a rupture of the profundus tendon (i.e., jersey finger). Avulsion of the tendon from the distal phalanx results in an inability to flex the DIP.

FINGERTIP INJURIES

A high school cheerleader has a mild case of paronychia. Are antibiotics required in the management of this condition?

Direct trauma to the nail bed, such as that caused when the finger is impacted by a ball, jammed into an object, or crushed when stepped on, can lead to a subungual hematoma. Infections also can occur in the nail fold, leading to a condition called paronychia.

Subungual Hematomas

Etiology

Direct trauma to the nail bed can result in blood forming under the fingernail, which is called a subungual hematoma.

Signs and Symptoms

Increasing pressure under the nail bed due to hemorrhage can lead to throbbing pain.

Management

After ruling out an underlying fracture, the finger should be soaked in ice water for 10 to 15 minutes to numb the area and reduce the bleeding under the nail bed. If the pain diminishes, it may not be necessary to drain the hematoma. This is preferable, because draining the hematoma opens an avenue for infection. If discomfort interferes with the ability to perform physical activities, however, the hematoma should be drained under the direction of a physician. This is performed by cutting a hole through the nail with a rotary drill or a no. 11 surgical blade or by melting a hole through the nail with the end of a paper clip heated to a bright red color (**Fig. 19.31**). **Application Strategy 19.1** explains the proper care for a subungual hematoma. After the blood has been drained, the area must be checked daily for signs of infection; if signs of infection are present, immediate referral to a physician is warranted.

Figure 19.31. Subungual hematoma. Note the hole that was made to drain the excess blood and relieve pain.

APPLICATION STRATEGY 19.1

Management Algorithm for Subungual Hematoma[a]

To numb the area and reduce hemorrhage, do the following:

1. Soak the finger in ice water for 10–15 minutes.
2. Clean the hands thoroughly with antiseptic soap and water and apply latex gloves.
3. Cleanse the finger thoroughly with either of the following:
   - Antiseptic soap
   - An antibacterial solution
4. Make a hole through the nail. Do either of the following: Cut the hole, using
   - A sterile, no. 11 surgical blade or
   - A rotary drill, cleaned and disinfected with iodine solution, or Melt the hole with the end of a paper clip heated to bright red.
5. Have the patient exert mild pressure on the distal pulp of the finger to drive excess blood through the hole.
6. Watch carefully for signs of shock and treat accordingly by doing the following:
   - Placing the patient in a supine position
   - Elevating the feet above the level of the heart
7. Soak the finger in an iodine solution for 10 minutes.
8. Cover the phalanx with a sterile dressing and apply a protective splint.

Follow up:

1. Do not apply heat for 48 hours.
2. Check the finger daily for signs of infection; if any appear, immediately refer the patient to a physician.

[a]Because of the nature of opening a wound and the potential for subsequent infection, this procedure should be discussed with the supervising physician and documented as a standing order.

Paronychia

Etiology

Paronychia is an infection along the nail fold. It commonly is seen with a hangnail and in individuals whose hands are frequently immersed in water.

Signs and Symptoms

The nail fold becomes red, swollen, and painful, and it can produce purulent drainage (Fig. 19.32).

Figure 19.32. Paronychia of the right middle finger. The infection is clearly localized to the dorsal surface, although the pulp is slightly swollen because of edema.

Management

The condition is treated with warm-water soaks and germicide. In more severe cases, the physician may recommend systemic antibiotics and drainage of localized pus or may perform a partial nail resection.

Treatment of the cheerleader's paronychia should include warm-water soaks and germicide. An antibiotic is necessary only in severe cases.

NERVE ENTRAPMENT SYNDROMES

An ice hockey goalie complains of numbness in the little finger. He is unable to grasp a piece of paper between the thumb and index finger

and has a weakness in grip strength. Inspection reveals atrophy of the hypothenar mass. What condition should be suspected, and how should this condition be managed?

Nerve entrapment syndromes, or compressive neuropathies, can be subtle and often are overlooked. They occur in activities such as bowling, cycling, karate, rowing, baseball/softball, field hockey, lacrosse, rugby, weight lifting, handball, and wheelchair athletics. Mechanisms of injuries most commonly involve repetitive compression, contusion, or traction. A compressive neuropathy also may be caused by anatomical structures such as anomalous muscles or vessels, fibrous bands, osteofibrous tunnels, or muscle hypertrophy. Pathological structures, such as ganglia, lipomas, osteophytes, aneurysms, and localized inflammation, also can compress a nerve. This discussion of compressive neuropathies is limited to those found in the distal forearm, wrist, and hand (Box 19.1).

BOX 19.1 Nerve Entrapment Syndromes

Median Nerve

- Anterior interosseous syndrome
- Carpal tunnel syndrome

Ulnar Nerve

- Ulnar tunnel syndrome
- Cyclist's palsy
- Bowler's thumb

Radial Nerve

- Distal posterior interosseous nerve syndrome
- Superficial radial nerve entrapment

Median Nerve Entrapment

The median nerve lies medial to the brachial artery in the cubital fossa and passes distally between the two heads of the pronator teres. The nerve divides at the distal margin to form the anterior interosseous nerve to supply the flexor pollicis longus, flexor digitorum superficialis to the index and middle digits, and pronator quadratus. The main trunk of the median nerve continues distally beneath the fibrous arch of the flexor digitorum superficialis. The palmar cutaneous branch supplies sensation to the volar wrist, thenar eminence, and palm. The median nerve continues through the carpal tunnel beneath the flexor retinaculum to supply sensation to the palm and the radial three and one-half digits. The deep motor branch supplies the abductor pollicis brevis, opponens pollicis, superficial head of the flexor pollicis brevis, and two lateral lumbricales.

Anterior Interosseous Nerve Syndrome

Etiology

Seen sporadically, anterior interosseous nerve syndrome can occur after a set of strenuous or repetitive elbow motion exercises. Structurally, there may be compression of the nerve by fibrous bands from the deep head of the pronator teres or flexor digitorum superficialis, affecting any or all of the muscles innervated by the nerve. Because the nerve has no sensory cutaneous portion, however, no sensory changes occur.

Signs and Symptoms

The individual presents in one of two ways:

1. **Acute onset:** The individual suddenly loses use of the flexor pollicis longus and index finger profundus tendons.
2. **Slow, insidious onset:** Gradual weakening of these muscles becomes apparent, with weakness during heavy activity.

Examination reveals weakness or loss of flexion of the IP joint of the thumb

and DIP joint of the index finger. The individual characteristically is unable to make a circle with the index finger and thumb (i.e., pinch grip test).

Management

Initial treatment involves splinting the extremity and avoiding heavy activity. If no return of function is noted after 6 months, surgical intervention and decompression of the nerve may be necessary.

Carpal Tunnel Syndrome

Etiology

The floor of the carpal tunnel is formed by the volar wrist capsule, with the roof formed by the transverse retinacular ligament traveling from the hook of the hamate and pisiform on the lateral side to the volar tubercle of the trapezium and tuberosity of the scaphoid on the medial side. This unyielding tunnel accommodates the median nerve, finger flexors in a common sheath, and flexor pollicis longus in an independent sheath (**Fig. 19.33**). Any irritation of the synovial sheath covering these tendons can produce swelling or edema that puts pressure on the median nerve.

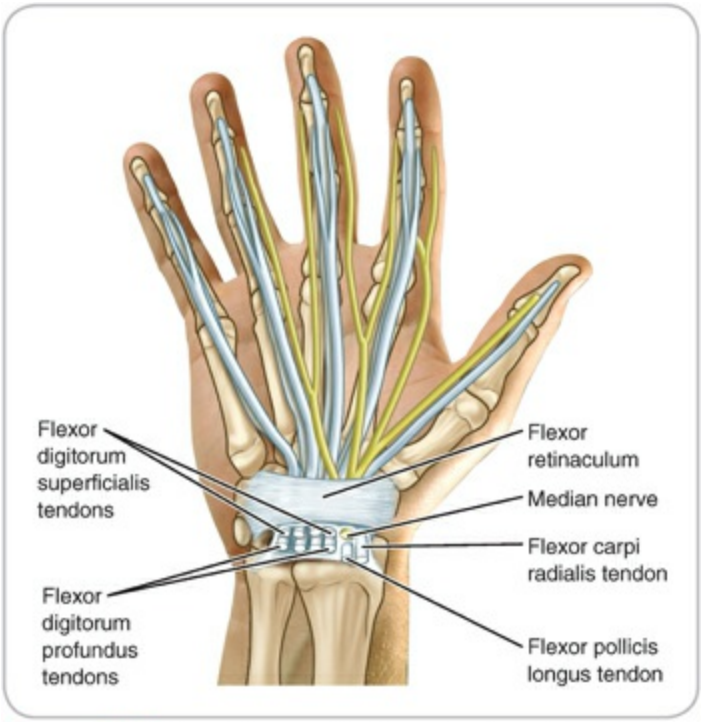


Figure 19.33. Carpal tunnel. The flexor tendons of the fingers pass through the carpal tunnel in a single synovial sheath.

Carpal tunnel syndrome (CTS) is the most common compression syndrome of the wrist and hand, although it is not commonly seen in the physically active population. Movement of tendons and nerves during prolonged, repetitive hand movements may contribute to the development of CTS.[24] In addition, CTS may be caused by direct trauma or anatomical anomalies. It typically is seen in the dominant extremity. Sporting activities that predispose an individual to CTS include those that involve repetitive or continuous flexion and extension of the wrist, such as cycling, throwing sports, racquet sports, archery, and gymnastics. Etiologies for CTS other than traumatic causes include infectious origins (e.g., diphtheria, mumps, influenza, pneumonia, meningitis, malaria, syphilis, typhoid, dysentery, tuberculosis, and gonococcus) and metabolic causes (e.g., hypothyroidism, diabetes, rheumatoid arthritis, gout, vitamin deficiency, heavy metal poisoning, and carbon monoxide poisoning).[25]

Signs and Symptoms

A common sign is pain that awakens the individual in the middle of the night but that often is relieved by "shaking out the hands" (known as a positive

"flick"). Pain, numbness, tingling, or a burning sensation may be felt only in the fingertips on the palmar aspect of the thumb, index, and middle finger. Generally, only one extremity is affected. Grip and pinch strength may be limited. A common complaint is difficulty manipulating coins. Symptoms are reproduced when direct compression is applied over the median nerve in the carpal tunnel for approximately 30 seconds. Although a positive Phalen maneuver is a classic clinical sign of the syndrome, diminished sensitivity to pain and weak thumb abduction are more predictive of abnormal nerve conduction.[26]

Management

Individuals with suspected CTS should be referred to a physician for care. Immobilization in slight wrist extension with a dorsal splint is used to rest the wrist for up to 3 to 5 weeks, particularly at night when symptoms occur. Cold, NSAIDs, or, in some situations, diuretics can initially reduce swelling and pain in the area caused by tenosynovitis. Use of a compression wrap should be avoided, however, because this adds additional compression on the already impinged structures. More than half of the individuals with this condition respond well to conservative treatment, although symptoms may recur, necessitating a corticosteroid injection into the canal. Long-term benefits from corticosteroid injections, however, may not include symptomatic relief as compared to a properly applied splint.[27] In cases that do not respond well to conservative treatment, surgical decompression or carpal tunnel release can be necessary.

Ulnar Nerve Entrapment

The ulnar nerve passes through the ulnar groove posterior to the medial epicondyle to enter the cubital tunnel formed by the aponeurosis and two heads of the flexor carpi ulnaris. The nerve continues distally between the flexor digitorum profundus dorsally and the flexor carpi ulnaris palmarly. The palmar cutaneous nerve arises in the midforearm to supply the proximal hypothenar eminence. The dorsal cutaneous nerve arises 5 to 8 cm proximal to the ulnar

styloid and supplies the dorsum of the ulnar side of the hand. In the wrist, the nerve courses between the hook of the hamate and pisiform and then passes through the Guyon canal to move distally into the fingers (Fig. 19.34). The superficial branch supplies the overlying palmaris brevis and then becomes entirely sensory to supply the hypothenar eminence and the ring and small fingers. The deep branch curves around the hook of the hamate to supply the ulnar intrinsics, ending its terminal branch in the first dorsal interossei.

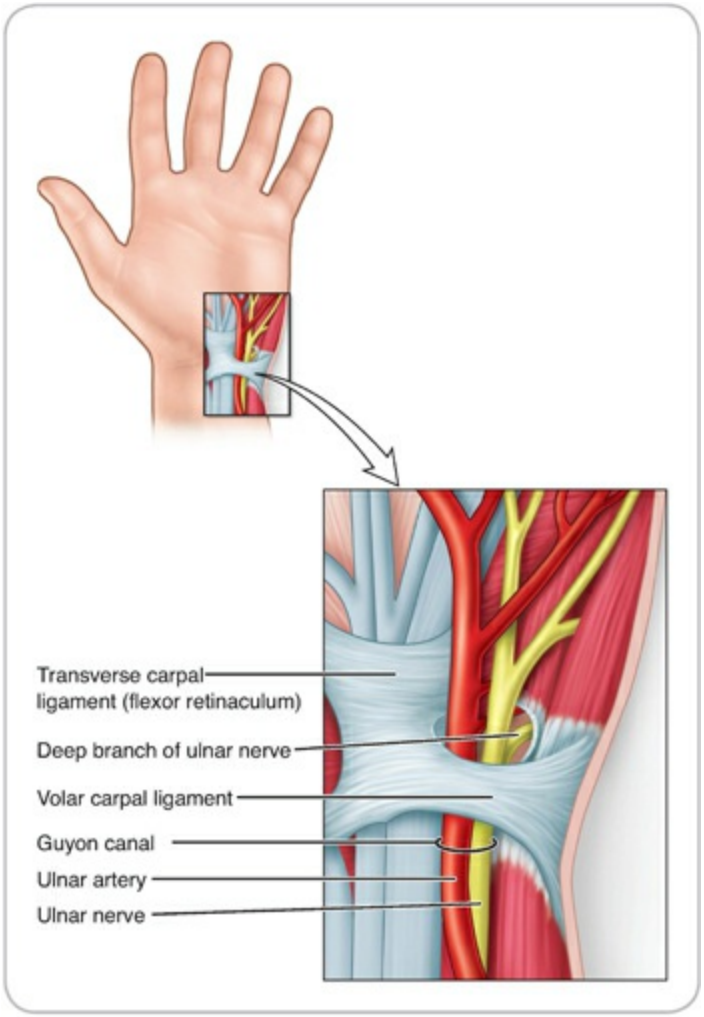


Figure 19.34. Impingement of the ulnar nerve. The ulnar nerve can become impinged in the tunnel of Guyon as it runs under the ligament between the hamate and pisiform.

Ulnar Tunnel Syndrome

Etiology

Compression of the ulnar nerve may occur as the nerve enters the ulnar tunnel or as the deep branch curves around the hook of the hamate and traverses the palm. This condition frequently is seen in cycling and racquet sports and in baseball/softball catchers, hockey goalies, and handball players who experience repetitive compressive trauma to the palmar aspect of the hand. Distal ulnar nerve palsy also may be seen as push-up palsy, following fractures of the hook of the hamate, or as a result of a missed golf shot or baseball swing.

Signs and Symptoms

The lesion may present with motor, sensory, or mixed symptoms. Coincident involvement of the median nerve is common. The individual complains of numbness in the ulnar nerve distribution, particularly in the little finger, and is unable to grasp a piece of paper between the thumb and index finger. Slight weakness in grip strength and atrophy of the hypothenar mass also may be present. Tapping just distal to the pisiform bone produces a tingling sensation that radiates into the little finger and ulnar aspect of the ring finger; although this method is highly sensitive in eliciting a response, it is not very specific.[16]

Management

Treatment involves splinting, NSAIDs, and avoidance of any precipitating activity. If symptoms do not disappear within 6 months of conservative treatment, surgical decompression of the Guyon canal may be necessary.

Cyclist's Palsy

Etiology

Cyclist's palsy, which also is linked to ulnar nerve entrapment, occurs when a biker leans on the handlebars for an extended period of time.

Signs and Symptoms

Swelling in the hypothenar area will be present. Symptoms mimic those of the more serious ulnar nerve entrapment syndrome, but they usually disappear

rapidly after completion of the ride.

Management

Properly padding the handlebars, wearing padded gloves, varying hand position, and properly fitting the bike to the rider can greatly reduce the incidence of this condition.

Bowler's Thumb

Etiology

Bowler's thumb involves compression of the ulnar digital sensory nerve, on the medial aspect of the thumb in the web space, while gripping the ball. Constant pressure on this spot can lead to scarring in the area. The radial digital nerve of the index finger is similarly at risk in racquet sports.

Signs and Symptoms

Numbness, tingling, or pain may develop on the medial aspect of the thumb. The individual may have swelling or thickening over the medial palmar aspect at the base of the thumb. Although no true motor involvement is present, grip strength may be decreased secondary to pain. Athletic trainers develop similar symptoms from excessive use of dull scissors or from added pressure on the thumb as one cuts through thick tape jobs or pads.

Management

Treatment depends on the stage of injury. Because the predominant cause is inflammatory in nature, treatment is directed at reducing inflammation. Cryotherapy, immobilization with a molded plastic thumb guard, NSAIDs, and, if necessary, a corticosteroid injection usually are successful in relieving symptoms.

Radial Nerve Entrapment

The radial nerve bifurcates near the radiocapitellar joint to become the

posterior interosseous and superficial radial nerves. The posterior interosseous nerve travels between the two heads of the supinator, around the proximal radius, and under the forearm extensors to supply the terminal articular branches to the wrist. The superficial radial nerve travels underneath the brachioradialis to become subcutaneous in the distal forearm and supply sensation to the dorsoradial portion of the hand, including the first web space and the proximal phalanges of the first three digits. The most common compressive neuropathy of the radial nerve, which occurs at the radial tunnel, is discussed in Chapter 18.

Distal Posterior Interosseous Nerve Syndrome

Etiology

Compression of the distal posterior interosseous nerve occurs as it passes dorsally over the distal radius and enters the wrist capsule. Gymnasts are particularly prone to this injury because of repetitive and forceful wrist dorsiflexion.

Signs and Symptoms

The individual usually complains of a deep, dull ache in the wrist that is reproduced with forceful wrist extension or deep palpation of the forearm with the wrist in flexion. Because the condition often can be confused with carpal instability, ganglions, and wrist sprains, the clinician should perform several tests for carpal stability.

Management

If the condition does not improve following standard acute care and activity modification, referral to a physician for further treatment is warranted.

Superficial Radial Nerve Entrapment

Etiology

The superficial branch of the radial nerve can be compressed at the wrist as it

pierces the deep fascia to become subcutaneous between the tendons of the extensor carpi radialis longus and brachioradialis. This constriction is made worse by sports that require repeated pronation and supination, such as batting, throwing, and rowing; by gloves that are strapped too tight; or by the use of tight wristbands.

Signs and Symptoms

The individual complains of burning pain, sensory changes, and night pain over the dorsoradial aspect of the wrist, hand, dorsal thumb, and index finger. The absence of pain with wrist motions can rule out a tendinitis-, arthritis-, or impingement-type syndrome.

Management

If the condition does not improve following standard acute care and activity modification, referral to a physician is warranted.

The ice hockey goalie may have ulnar tunnel syndrome. Treatment involves splinting, NSAIDs, and avoidance of any precipitating activity. If symptoms do not disappear within 6 months of conservative treatment, surgical decompression of the Guyon canal may be necessary.

FRACTURES OF THE WRIST AND HAND

A volleyball player appears to have sustained a boxer's fracture. What is the immediate management of this injury?

Fractures of the distal ulna and radius and of the carpal bones usually are caused by axial loading when an individual falls on an outstretched hand. The majority are simple and nondisplaced. Subsequent to the advent of external orthoses, many fractures can be immobilized adequately to allow individuals to continue with regular sport participation. Specific rules governing special

protective equipment, however, require that braces, casts, or any unyielding substances on the elbow, forearm, wrist, or hand be padded on all sides so as not to endanger other players. When the fracture has reached a stage at which external support is no longer necessary during daily activities, it may be advantageous to wear a splint during sport participation.

Distal Radial and Ulnar Fractures

Etiology

Fractures to the distal radius and ulna present a special problem. In adolescents, epiphyseal and metaphyseal fractures are common. These fractures usually heal without residual disability. In older individuals, one or both bones may be fractured, or one bone may be fractured with the other bone dislocated at the elbow or wrist joint. A **Colles fracture** occurs within 1.5 in of the wrist joint and results in a "dinner-fork" deformity when the distal segment displaces in a dorsal and radial direction (Fig. 19.35). A reverse of this fracture is the **Smith fracture**, which tends to move toward the palmar aspect (volar). A **Monteggia fracture** is characterized by a fracture of the proximal third of the ulna accompanied by a dislocation of the radial head. In a **Galeazzi fracture**, the distal radioulnar dislocation is secondary to the marked shortening of the radius caused by the severe ulnar displacement and dorsal angulation of the distal radial fragment. Figure 19.36 demonstrates the four common fractures of the forearm.

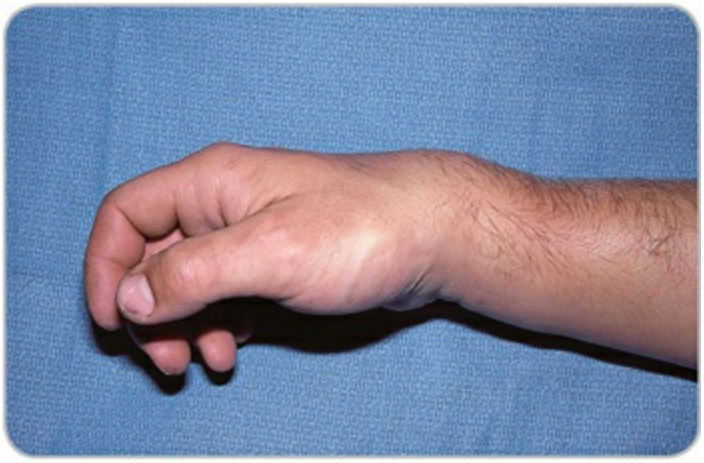


Figure 19.35. Clinical view of a Colles fracture.

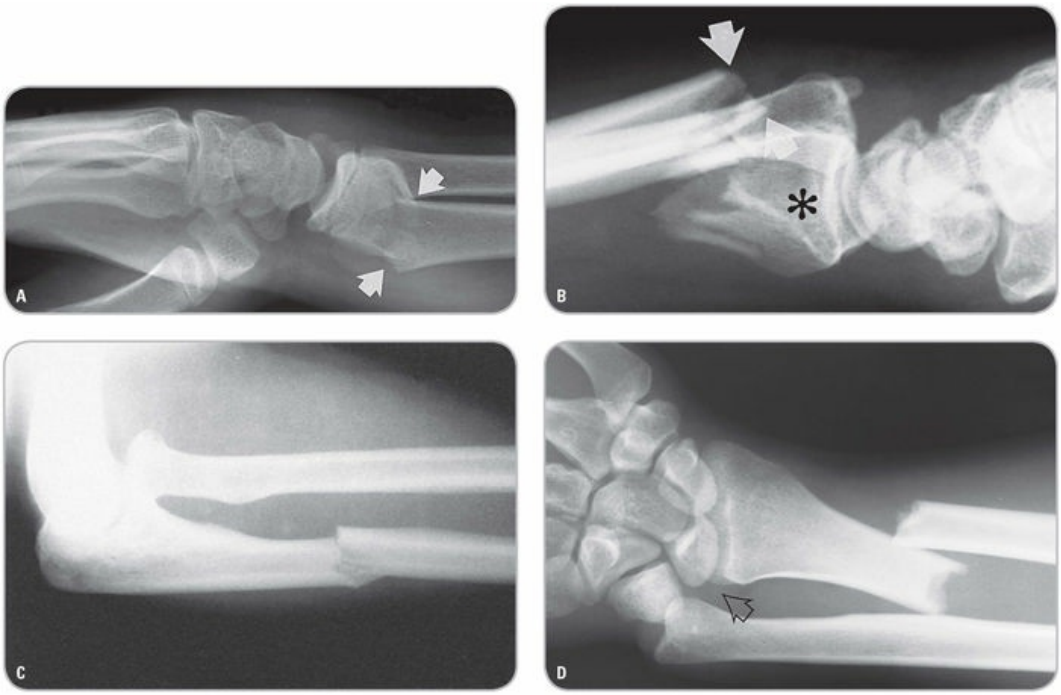


Figure 19.36. Forearm fractures. A, Colles fracture. The extra-articular distal radial fracture is associated with a fracture of the base of the ulnar styloid. **B, Smith fracture.** This type of fracture is characterized by a transverse fracture of the distal radius, with volar and proximal displacement of the distal radial fragment. **C, Monteggia fracture.** This type of fracture is characterized by a fracture of the proximal third of the ulna, accompanied by a dislocation of the radial head. **D, Galeazzi fracture.** The distal radioulnar dislocation is secondary to the marked shortening of the radius caused by the severe ulnar displacement and dorsal angulation of the distal radial fragment.

Signs and Symptoms

In adolescents, fractures of the growth plate may present with the distal fragment being dorsally displaced. Other signs and symptoms associated with traumatic fractures include intense pain, swelling, deformity, and a false joint. Swelling and hemorrhage may lead to circulatory impairment, or the median nerve may be damaged as it passes through the forearm.

Management

Immediate immobilization in a vacuum splint and a careful neurovascular evaluation of the hand should be followed by immediate referral to a physician. In many instances, open reduction and internal fixation with rigid plates and screws are necessary to restore function.

Stress Fracture of the Distal Radial Epiphyseal Plate (Gymnast's Wrist)

Etiology

The distal radial epiphyseal plate is the classic location for the stress injury commonly called "gymnast's wrist." In contrast to other growth-plate overuse syndromes in adolescents, this fracture is caused by compression. Repetitive performances on the pommel horse and uneven bars cause excessive wrist loading, leading to pain over the dorsum of the wrists. Pain increases as the wrist is carried into maximum dorsiflexion, such as occurs in vaulting, tumbling, and beam work.

Signs and Symptoms

Diffuse tenderness typically is present over the dorsum of the midcarpal area. Pain increases with the extremes of wrist motion. Edema, discoloration, and clinical instability generally are not present. The distal ulnar epiphysis also may be involved.

Management

Treatment involves splinting, NSAIDs, and avoidance of the offending exercises until the individual is asymptomatic. Complete resolution of symptoms may require 3 to 6 months or longer. A dorsal block splint may be beneficial for practice and competition to avoid extremes of wrist extension.

Carpal Fractures

The small bones of the wrist greatly enhance the mobility of the hand. Of the eight bones, only the scaphoid and lunate articulate with the radius; therefore, these two bones transmit the entire force of a fall on an outstretched hand to the forearm.

Scaphoid Fractures

Etiology

Scaphoid fractures account for more than 70% of all carpal bone injuries in the general population and are the most common wrist bone fracture in physically active individuals.[28] Peak incidence is between 12 and 15 years of age.[29] In

many cases, the individual falls on the wrist, has normal radiographs, and is discharged with the diagnosis of a wrist sprain and without further care. Several months later, however, the individual continues to experience persistent wrist pain. Radiographs at this time may reveal an established nonunion fracture of the scaphoid (Fig. 19.37A). Because of a poor blood supply to the area, aseptic necrosis (death of the tissue) is a common complication with this fracture.

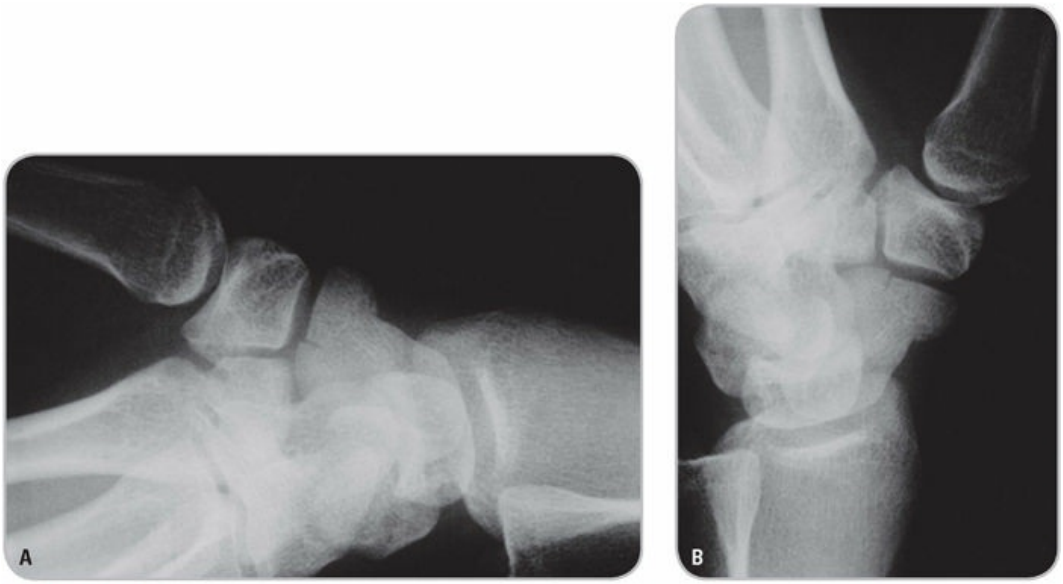


Figure 19.37. Scaphoid fracture. A, Radiograph of a scaphoid fracture. Nonunion fractures occur when the area has a poor blood supply. **B,** The scaphoid forms the floor of the anatomical snuff box. It is bounded by the EPB medially and by the extensor pollicis longus laterally. Increased pain during palpation in this region indicates a possible fracture to the scaphoid bone.

Signs and Symptoms

Assessment reveals a history of falling on an outstretched hand. Pain is present during palpation of the anatomical snuff box (Fig. 19.37B), which lies directly over the scaphoid, or with inward pressure along the long axis of the first metacarpal bone. Pain increases during wrist extension and radial deviation.

Management

Treatment involves ice, compression, immobilization in an appropriate splint, and immediate referral to a physician. Nondisplaced scaphoid fractures can be immobilized in a thumb spica cast, with the wrist in slight radial deviation. The cast is changed at 2-week intervals to ensure proper molding around the

forearm until union occurs.[29] Follow-up radiographs are obtained at 3- to 4-week intervals to monitor healing and detect signs of delayed union, nonunion, malunion, or avascular necrosis. Some fractures may take several weeks or months to heal; during this time, the individual may participate with a padded, short-arm thumb cast or silicone cast. Displaced scaphoid fractures are secured with internal fixation.

Lunate Fracture/Kienböck Disease

Etiology

Of the carpal bones, the lunate has the largest area, proportionately, of cartilage surface; however, a true lunate fracture is rare in sports. These fractures are difficult to identify and diagnose; therefore, some may be overlooked. Because a large portion of the lunate is cartilage and cancellous bone, the amount of pain associated with a fracture to this area is minimal. Avascular necrosis of the lunate, however, which also is known as **Kienböck disease**, is common if the vascular pathway is disrupted. Its cause has yet to be determined, but it is thought to arise from repetitive trauma or an unrecognized lunate fracture. Kienböck disease should be considered if the patient presents with a painful and swollen wrist, complaining of joint stiffness and decreased ROM, decreased grip strength, and difficulty supinating.

Signs and Symptoms

A history of trauma may or may not be present. The individual usually complains of dorsal wrist pain, swelling, and weakness of the wrist associated with use. If left untreated, Kienböck disease can result in chronic tenderness, pain, and swelling over the lunate as well as in decreased grip strength and weakness during wrist extension. Pain during passive extension of the third finger is a common characteristic with this condition.

Management

Treatment involves ice, compression, immobilization in an appropriate splint, and immediate referral to a physician. Early radiographs are needed to

ascertain the correct diagnosis. The preferred treatment is early surgical intervention.

Hamate Fracture

Etiology

Direct impact to the hamate may lead to a nonunion fracture. This typically occurs when an individual strikes a stationary object with a racquet or club in full swing. Once fractured, the ligamentous insertions of the transverse carpal ligament, pisohamate ligament, short flexor, and opponens digiti minimi act to displace the fragment and prevent union.

Signs and Symptoms

Physical examination reveals tenderness over the hypothenar muscle mass. Painful abduction of the small finger against resistance is present, as is decreased grip strength.

Management

Treatment involves ice, compression, immobilization in an appropriate splint, and immediate referral to a physician. Radiographs and tomograms using a carpal tunnel view with the wrist in extension confirm the diagnosis. Care usually is symptomatic, with a protective orthosis worn for 4 to 6 weeks (until tenderness subsides). It may be 2 to 3 months before a racquet or bat will feel comfortable in the hand again.

Triquetrum Fractures

Etiology

Fractures of the triquetrum are fairly common. An avulsion fracture is believed to be caused by sudden wrist flexion or sudden, forceful impingement of the ulnar styloid into the dorsum of the triquetrum. The ulna tends to shear a portion of bone away from the triquetrum. This type of fracture occurs when pressure is put on the wrist during a fall and the wrist is hyperextended and deviated to the ulnar side.

Signs and Symptoms

The individual usually reports a history of acute wrist dorsiflexion injury or direct trauma to the wrist area. Pain in the dorsal wrist is present over the triquetrum.

Management

Treatment involves ice, compression, immobilization in an appropriate splint, and immediate referral to a physician. Immobilization in a short-arm cast with mild extension of the wrist for 4 to 6 weeks is the treatment of choice. Some fractures may become nonunion and require surgical excision.

Metacarpal Fractures

Uncomplicated fractures of the metacarpals result in severe pain, swelling, and deformity. Unique fractures at the base of the first metacarpal may involve a simple intra-articular fracture (i.e., Bennett fracture) or a comminuted fracture (i.e., **Rolando fracture**). A unique fracture involving the neck of the 4th or 5th metacarpal is called a boxer's fracture, and it occurs when an individual punches an object with a closed fist, leading to rotation of the head of the metacarpal over the neck.

Uncomplicated Fractures

Etiology

Axial compression on the hand can lead to a fracture dislocation of the proximal end of the metacarpal. This often goes undetected, however, because edema obscures the extent of injury. Fractures of the shaft of the metacarpal are more easily recognized.

Signs and Symptoms

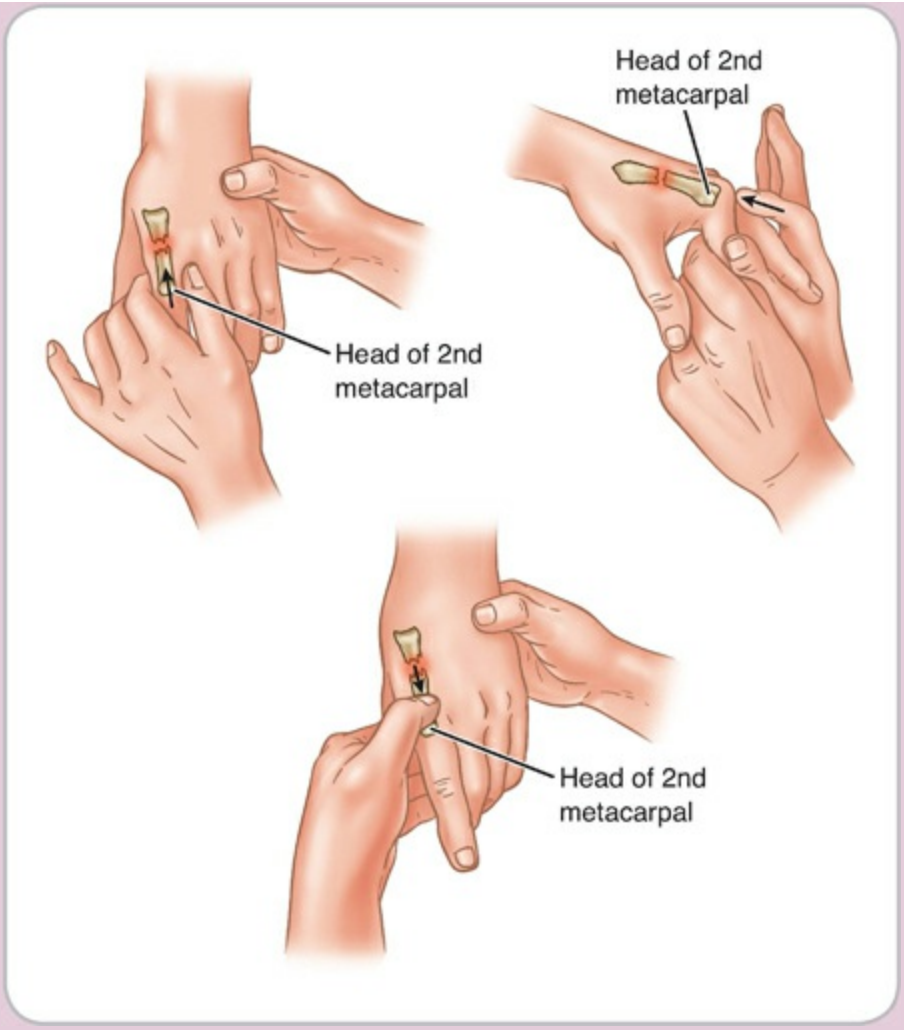
Increased pain and a palpable deformity are present in the palm of the hand directly over the involved metacarpal. Gentle percussion and compression along the long axis of the bone increase pain at the fracture site (Application

Strategy 19.2). These same techniques can be used to detect possible fractures in the carpals and phalanges.

APPLICATION STRATEGY 19.2

Determining a Possible Fracture to a Metacarpal

1. Palpate for pain along the shaft of the bone.
2. Apply compression along the long axis of the bone. A positive sign occurs if pain is felt at the injury site.
3. Apply percussion or vibration at the end of the bone. A positive sign occurs if pain is felt at the injury site.
4. Apply distraction at the end of the bone. A positive sign occurs if pain is decreased; increased pain may indicate a ligamentous injury.



Management

Fractures should be immobilized in the position of function, with the palm face down and the fingers slightly flexed. Ice should be applied to reduce hemorrhage and swelling; an elastic compression bandage should not be applied to a swollen hand, because it may lead to increased distal swelling in the fingers. The fingernails must remain uncovered so that circulation can be periodically assessed. The individual should be referred immediately to a physician for further assessment.

Bennett Fracture

Etiology

A Bennett fracture is an articular fracture of the proximal end of the first metacarpal and usually is associated with a dislocation. It typically is caused by axial compression, as occurs when a punch is thrown with a closed fist or the individual falls on a closed fist. The pull of the APL tendon at the base of the metacarpal displaces the shaft proximally. A small medial fragment, however, is held in place by the deep volar ligament, leading to a fracture dislocation (Fig. 19.38).

Figure 19.38. Bennett fracture. A Bennett fracture usually is associated with a dislocation of the MP joint of the thumb. An avulsion fracture, however, occurs when a segment of the metacarpal is held in place by the deep volar ligament.

Signs and Symptoms

Pain and swelling are localized over the proximal end of the first metacarpal, but deformity may or may not be present. Inward pressure exerted along the long axis of the first metacarpal elicits increased pain at the fracture site.

Management

Acute care consists of ice, compression, immobilization in a wrist splint, and immediate referral to a physician. The preferred treatment for this fracture is closed reduction and percutaneous pinning for less than 3 mm of fracture displacement and open reduction and fixation for greater displacements.

Rolando Fracture

Etiology

Similar to a Bennett fracture, a Rolando fracture involves only an intra-

articular fracture of the first metacarpal, with no dislocation. The potential for serious complications is significantly increased, however, because it tends to be more comminuted.

Signs and Symptoms

Pain and swelling are localized over the proximal end of the first metacarpal. Deformity is more apparent than with a Bennett fracture. Inward pressure exerted along the long axis of the first metacarpal elicits increased pain at the fracture site.

Management

Acute care consists of ice, compression, immobilization in a wrist splint, and immediate referral to a physician. Open reduction and internal fixation with multiple Kirschner wires may be necessary for excellent results. When the fracture is accurately reduced and fixated, complete healing leads to excellent joint ROM; however, because the joint surface was involved in the fracture, arthritic symptoms may eventually develop.

Boxer's Fracture

Etiology

Fractures involving the distal metaphysis or neck of the 4th or 5th metacarpals are commonly seen in young males involved in punching activities, hence, the name boxer's fracture (although the fracture rarely occurs in boxers) (**Fig. 19.39**). The fracture typically has an apex dorsal angulation and is inherently unstable secondary to the deforming muscle forces and the frequent volar comminution.

Figure 19.39. Boxer's fracture. These fractures usually involve the 4th and 5th metacarpals.

Signs and Symptoms

Sudden pain, inability to grip objects, rapid swelling, and possible deformity are present. Palpation reveals tenderness and pain over the fracture site as well as possible crepitus and bony deviation. Delayed ecchymosis is common. Pain increases with axial compression of the involved metacarpal and percussion.

Management

Acute care consists of ice, compression, immobilization in a wrist splint, and immediate referral to a physician. Closed reduction is followed by immobilization in a splint for 4 to 6 weeks, followed by early ROM exercises.

Phalangeal Fractures

Etiology

Fractures of the phalanges are very common in sport participation, and these fractures can be difficult to manage. They may be caused by having the fingers stepped on or impinged between two hard objects, such as a football helmet and the ground, or by hyperextension that may lead to a fracture dislocation (Fig. 19.40).

Figure 19.40. Phalangeal fracture. This fracture demonstrates a shearing pattern in the diaphysis.

Signs and Symptoms

Increased pain is present with circulative compression around the involved phalanx. Gentle percussion and compression along the long axis of the bone increase pain at the fracture site. Particular attention should be given to a possible fracture of the middle and proximal phalanges. These fractures tend to have marked deformity because of the strong pull of the flexor and extensor tendons. The four fingers move as a unit. Failure to maintain the longitudinal and rotational alignments of the fingers can lead to long-term disability in grasping or manipulating small objects in the palm of the hand. This deformity often results in one finger overlapping another when a fist is made.

Management

Acute care involves ice to reduce pain and swelling. While the hand is immobilized in a full-wrist splint, gauze pads or a gauze roll are placed under the fingers to produce approximately 30° of finger flexion and reduce the pull of the flexor tendons. The individual should be referred immediately to a physician. Immobilization depends on the type of fracture and its location and may vary from 2 to 4 weeks.

Immediate management for the suspected boxer's fracture includes ice, compression, immobilization in a wrist splint, and immediate referral to a physician.

REHABILITATION

? A scaphoid fracture can take several weeks or months to heal. What exercises could be included during this period to help the cheerleader maintain her fitness?

Injuries to the wrist and hand often require immobilization; however, early ROM and strengthening exercises should be conducted at the elbow and shoulder. Many of the exercises for the wrist and hand are discussed and demonstrated in Chapter 18, because they often are combined with rehabilitation of the elbow.

Restoration of Motion

Immobilization typically results in joint contractures and stiffness in the fingers. Therefore, active ROM exercises should begin as soon as possible. In the acute phase, exercises can be performed using cryokinetic techniques. Ice immersion is alternated with active ROM exercises. The individual can use the opposite hand to apply a low-load, prolonged stretch in the various motions to minimize joint trauma and increase flexibility. As inflammation decreases, a warm whirlpool or paraffin bath may be used to facilitate motion.

Restoration of Proprioception and Balance

Closed chain exercises may involve shifting body weight from one hand to the other on a wall, tabletop, or unstable surface, such as a foam mat or biomechanical ankle platform system (BAPS) board. Push-ups and step-ups on a box, stool, or StairMaster also can be used. Precision techniques to restore dexterity can be performed by picking up and manipulating the following objects:

1. Coins of different thicknesses
2. Playing cards
3. Small objects of different shapes

4. Large, light objects
5. Large, heavy objects

In addition, the individual can tear tape, use scissors to cut paper, or juggle balls of different sizes.

Muscular Strength, Endurance, and Power

Once the ROM approximates what is normal for the individual, open chain kinetic exercises are performed in the various motions using lightweight dumbbells. Many of these exercises are listed and explained in **Application Strategy 18.1**. The individual should complete 30 to 50 repetitions with a 1-lb weight and should not progress in resistance until 50 repetitions have been achieved. Using a table to support the forearm, wrist curls, reverse wrist curls, pronation, and supination can be performed. Wrist curl-ups using a light weight suspended from a broomstick on a 3- to 4-ft rope can be used to increase strength in the wrist flexors and extensors. A weighted bar or hammer can be used for radial and ulnar deviation and for pronation and supination. Proprioceptive neuromuscular facilitation (PNF)-resisted exercises, surgical tubing, or strong rubber bands can be used in all motions for concentric and eccentric loading. Gripping exercises using a tennis ball or putty can be combined with pinching small and large objects. Plyometric exercises may involve catching a weighted ball in a single hand and throwing it straight up and down or using a minitramp to do bounding push-ups.

Cardiovascular Fitness

Cardiovascular conditioning should be maintained throughout the rehabilitation program. Several examples of such programs are provided at thePoint.

The cheerleader should engage in general body conditioning and strengthening exercises. Only those exercises that aggravate the condition are contraindicated.

SUMMARY

1. Most wrist motion occurs at the radiocarpal joint. The TFC is the cartilaginous disk that acts as a stabilizer of the DRUJ and serves as the ulnar continuation of the radius.
2. The CM joint of the thumb is a classic saddle joint that allows it to have more motion than the CM joints of the other four digits.
3. Retinacular tissue is found throughout the hand and forms protective passageways through which tendons, nerves, and blood vessels pass.
4. Most injuries to the wrist are a result of axial loading on the proximal palm during a fall on an outstretched hand.
5. Excessive varus/valgus stress and hyperextension can damage the collateral ligaments of the fingers. Failure of a ligament usually occurs at its attachment to the proximal phalanx or, less frequently, in the midportion.
6. The most common dislocation in the body occurs at the PIP joint. Because digital nerves and vessels run along the sides of the fingers and thumb, dislocation can be serious if it is reduced by an untrained individual.
7. Muscular strains occur as a result of excessive overload against resistance or stretching the tendon beyond its normal range. Ruptures of a muscle tendon may cause the tendon to retract, necessitating surgical reattachment of the tendon in its proper position.
8. Chronic overuse of a tendon can lead to tendinitis or friction tendinitis in one or more of the dorsal tunnels. Treatment usually consists of ice, rest, NSAIDs, splinting, and avoidance of exacerbating activities.
9. CTS is the most common compression syndrome of the wrist and hand. It is characterized by pain and numbness that wakes the individual in the middle of the night and that often is relieved by shaking the hands.
10. Compression of the ulnar nerve leads to weakness in grip strength, atrophy

of the hypothenar mass, and loss of sensation over the little finger.

11. If pain is present during palpation of the anatomical snuff box or with inward pressure along the long axis of the first metacarpal bone, a fracture of the scaphoid should be suspected.
12. Any injury that impairs the function of the hand or fingers should be referred to a physician. The area should be immobilized to prevent further damage, ice applied to control hemorrhage and swelling, and the individual transported in an appropriate manner.

APPLICATION QUESTIONS

1. A softball catcher was hit in the throwing hand by the bat of the hitter. Observation reveals immediate swelling over the 5th metacarpal of the affected hand. What areas should be addressed in the palpation component of an assessment of this injury? What special tests should be performed in assessing this injury?
2. A cheerleader reports to the athletic training room complaining of wrist pain. She fell the previous day on an outstretched hand while performing a back flip. Observation reveals minor swelling but no discoloration or deformity. Palpation reveals sharp pain in the anatomical snuff box. What injury should be suspected? How might the condition be managed?
3. A long-distance cyclist complains of bilateral numbness in the little finger and medial half of the ring finger and an inability to adduct the little finger. The individual cannot recall an incident that could have caused this condition but states that the training distance has significantly increased this past week. What possible factors are involved in this condition? What suggestions can be made to alleviate the symptoms yet permit this cyclist to continue training?
4. You are providing athletic training coverage for a Senior Olympics event. During a softball game, a 58-year-old male pitcher sustains a blow to the

end of his finger off a line drive hit. Initially, the pitcher reports pain to the area, which is visibly swollen. The pitcher is confident that it's "just a jammed finger." How would you respond to this scenario?

5. A shot putter pinched a finger under the shot, causing blood to accumulate under the fingernail. The fingertip is extremely painful from the increasing pressure. What factor(s) should be considered in deciding whether or not to relieve the pressure?
6. A football player had his hand stepped on by another player. Immediate pain and a cracking sensation were felt in the palm of the hand. Observation reveals noticeable swelling on the dorsum of the hand. Palpation of the 3rd metacarpal and percussion on the distal end of the third finger cause increased pain. What injury should be suspected? How should the hand be immobilized?
7. While attempting a jump maneuver, a skateboarder loses his balance. The 16-year-old male falls on an outstretched hand. How would you differentiate whether this injury is a perilunate dislocation or a lunate dislocation?
8. A hockey player complains of thumb pain and instability. You suspect an ulnar collateral ligament tear. What tests should be performed to confirm your suspicion?
9. In preparation for tennis season, which begins in 8 weeks, a 45-year-old recreational tennis player would like to strengthen the muscles in her wrist and hand. What exercises would you recommend? Why?

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