Chapter 11

EXTREMITY TRAUMA

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Degloving injury. (Photo contributor: Selim Suner, MD, MS.)

Clinical Summary

Injury to the acromioclavicular (AC) joint usually results from an impact on the superior aspect of the acromion. The classification system for AC joint includes six types. A type I injury is equivalent to a stretching of the AC ligament. A type II injury consists of tearing of the AC ligaments and stretching of the coracoclavicular ligaments. Complete disruption of the AC and coracoclavicular ligaments is seen in types III to VI.

Patients complain of pain at the AC joint and will actively splint the injured shoulder. Ecchymosis may be present; however, an obvious deformity is not always seen. There is significant tenderness upon palpation of the AC joint.

Standard radiographs should include anteroposterior (AP) and axillary lateral views of the shoulder. Type I injuries will appear normal. Type II injuries may show 0% to 50% displacement at the AC joint but no increase in the coracoclavicular interval. Types III to VI will demonstrate displacement at the AC joint and the clavicle will appear to be displaced superiorly (the acromion actually is rotated inferiorly) 50% to greater than 100% its width when compared with the normal side.

Management and Disposition

Type I and type II injuries are treated with rest, ice, analgesics, and a simple sling until acute pain with movement is relieved. Treatment of type III injuries may be nonoperative or operative. However, these patients can be discharged from the emergency department in a sling without an emergent orthopedic consult. Types IV, V, and VI are treated operatively. Referral to a musculoskeletal specialist is essential for all AC joint injuries since many patients who initially appear to have minor injuries will have more obvious deformity after the swelling and pain have subsided.

Pearls

1. The early AC joint stress radiograph can be negative due to splinting of the shoulder girdle muscles and does not add anything to the acute patient management.
2. Differentiating between types I and II versus types IV to VI is the goal of the ED physician, since the latter will require an emergency orthopedic consult.

FIGURE 11.1 ■ **AC Joint Separation.** Subtle prominence of the left distal clavicle. The upward clavicle displacement is due to suspending ligament stretching or disruption. (Photo contributor: Frank Birinyi, MD.)

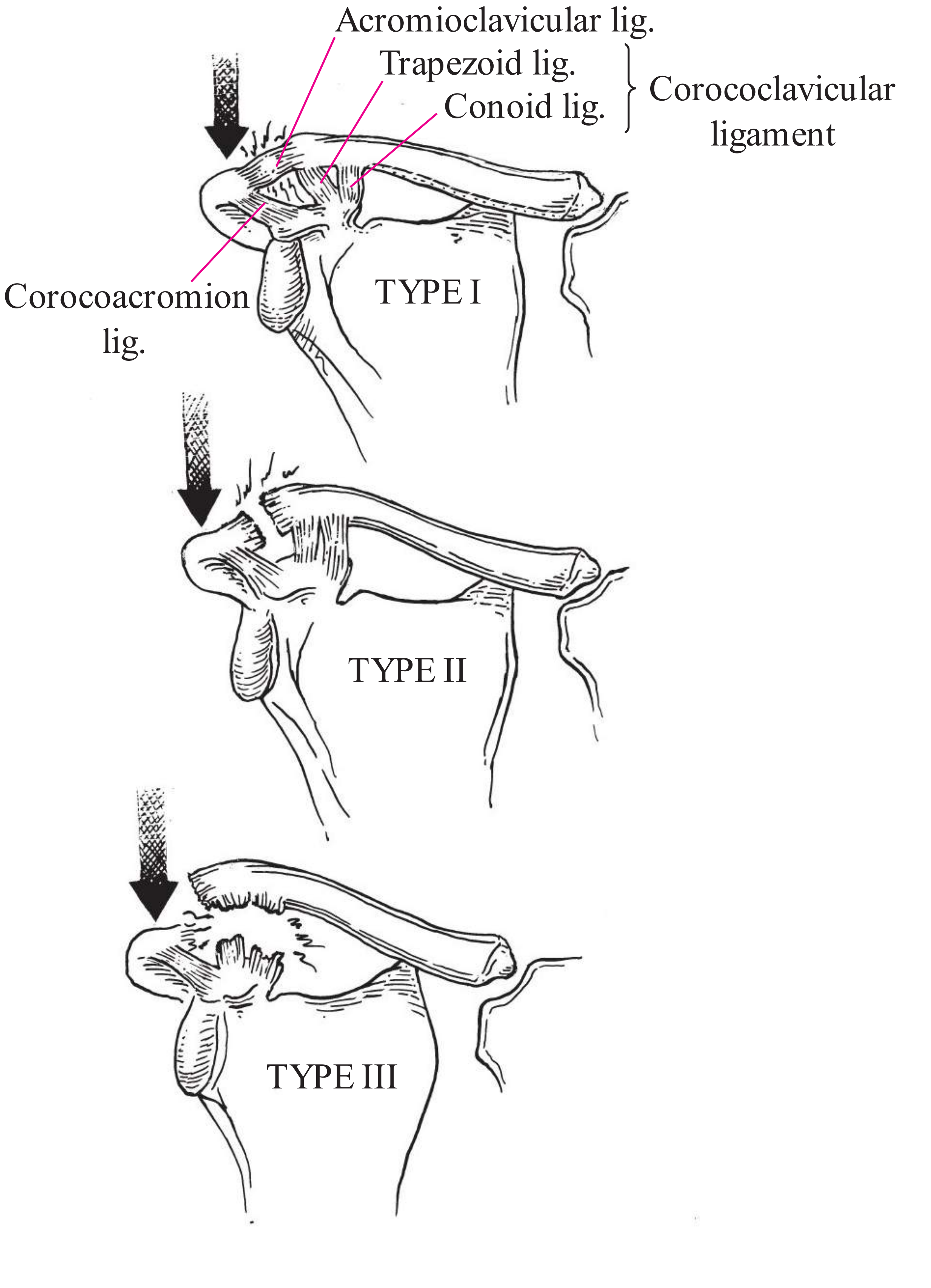

FIGURE 11.2 ■ **Types of AC Joint Injuries.** Classification schemes may subdivide type III injuries into III through VI depending on the position of the clavicle.

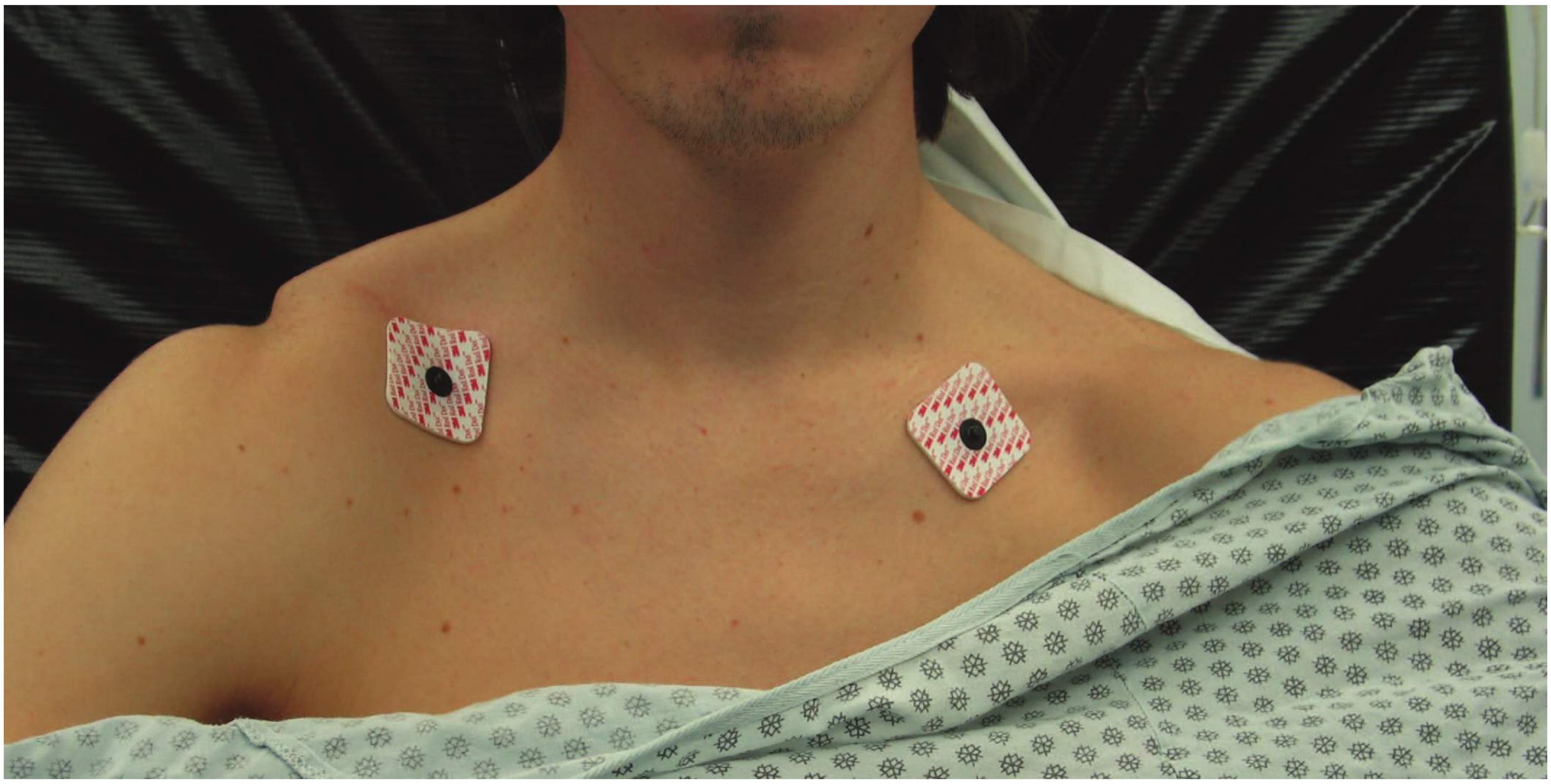

FIGURE 11.3 ■ **AC Joint Separation.** Large deformity at the right distal clavicle suggesting complete ligament disruption. (Photo contributor: R. Jason Thurman, MD.)

FIGURE 11.4 ■ **AC Joint Separation, Third Degree.** A wide AC joint and the clavicle displaced from the acromion. (Reproduced with permission from Simon RR, Sherman SC, Koenigsknecht SJ. Emergency Orthopedics: The Extremities. New York: McGraw-Hill; 2007: p 297, Fig. 11-54.)

SHOULDER DISLOCATION

Clinical Summary

Anterior shoulder dislocations are the most common and frequently caused by falling with the arm externally rotated and abducted. Patients present with the affected extremity held in adduction and internal rotation. Often, they complain of shoulder pain, refuse to move the affected arm, and may support the dislocated shoulder with the other arm. The acromion becomes prominent with loss of the rounded contour of the deltoid. A neurovascular examination of the upper extremity should be performed to rule out associated injury, most commonly of the axillary nerve (sensation over the deltoid) and of the musculocutaneous nerve (sensation on the anterolateral forearm). Vascular injuries have rarely been reported to occur. Standard radiographic examination to evaluate for associated fracture should include AP and either axillary lateral or scapular Y views.

Posterior shoulder dislocations are commonly missed because of subtle radiographic findings. The arm is held internally rotated and slightly abducted. Patients are unable to externally rotate their shoulder. On examination, a posterior prominence exists. Posterior dislocations can occur with a posterior-directed force as seen during grand mal seizures or electric shock.

The Hill-Sachs lesion (an impaction of the humeral head) can occur in up to 50% of patients.

Management and Disposition

Closed reduction is the treatment for all types of shoulder dislocations and should be completed as soon as possible to avoid avascular necrosis to the humeral head. Due to shoulder girdle spasm, conscious sedation is often required. There are many methods to reduce anterior shoulder dislocations, including Stimson, Rockwood traction and countertraction, and Milch. The basic premise is to apply axial traction, externally rotate, and abduct. Scapular manipulation and the Stimson method are successful techniques, especially in the thin patient. Neurovascular and radiographic examination should occur before and after reduction. The patient should be placed in a sling after reduction and follow-up with a musculoskeletal specialist should be recommended.

Pearls

1. Occult, nondisplaced greater tuberosity fracture can be identified on postreduction radiographs. These usually occur during the traumatic event but not seen on initial radiographs. They are not the result of the reduction and usually only identified when there is no bony overlap on the x-rays.

FIGURE 11.5 ■ **Anterior Shoulder Dislocation.** This right anterior shoulder dislocation occurred when the patient fell while playing basketball. There is an obvious contour deformity as well as prominence of the acromion. (Photo contributor: Kevin J. Knoop, MD, MS.)

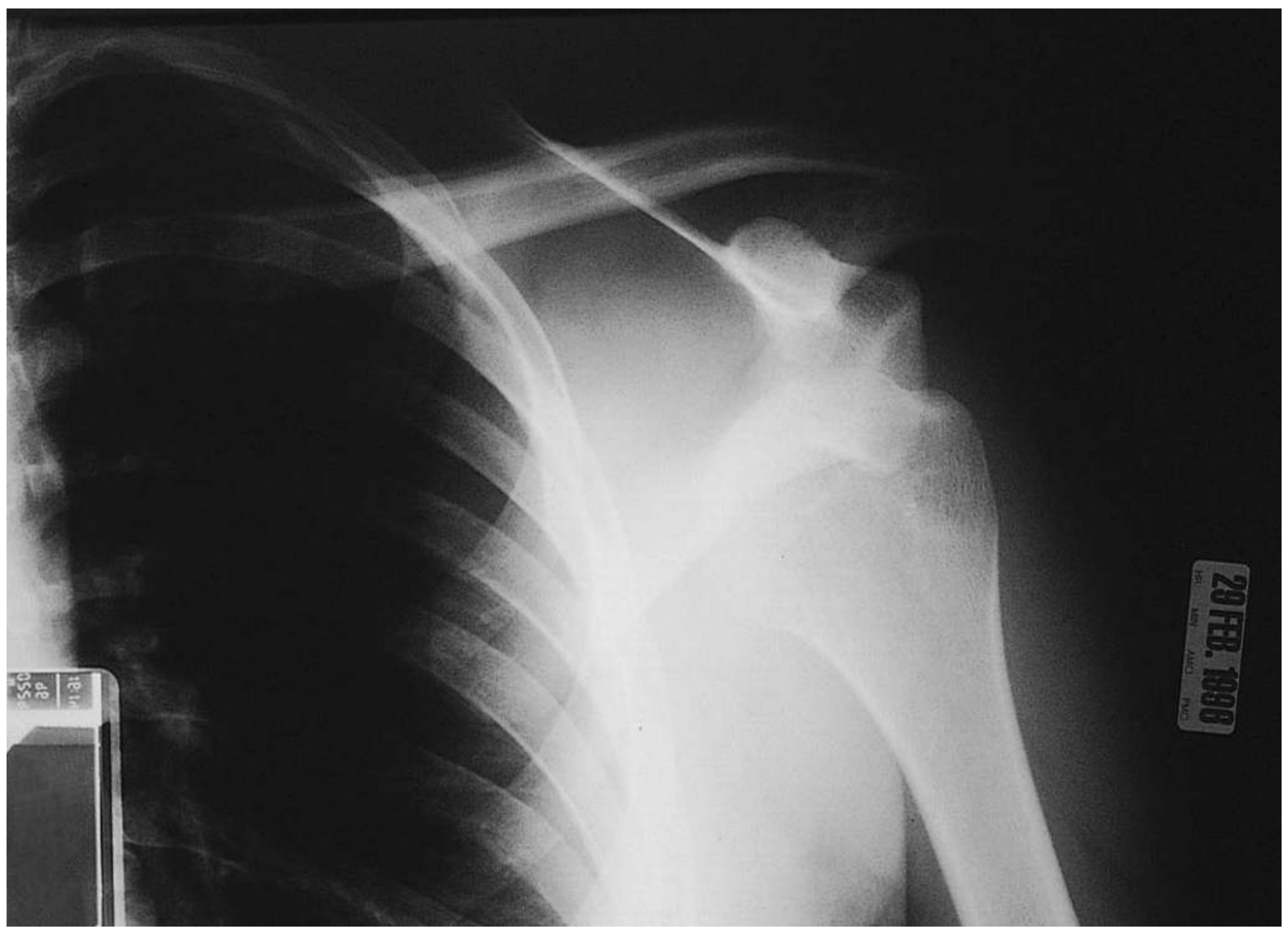

FIGURE 11.6 ■ **Anterior Shoulder Dislocation.** Radiographic evaluation demonstrates that the humeral head is not in the glenoid fossa but is located anterior and inferior to it. (Photo contributor: Kevin J. Knoop, MD, MS.)

2. Luxatio erecta is inferior glenohumeral dislocation that is rarely encountered. The humeral head is forced below the inferior aspect of the glenoid fossa due to a hyperabduction of the arm. These patients present with the arm locked fully abducted and externally rotated. Axillary nerve injury is reported to occur in 60%. Vascular injury occurs most frequently with this type of dislocation. Reduction is accomplished with overhead traction.

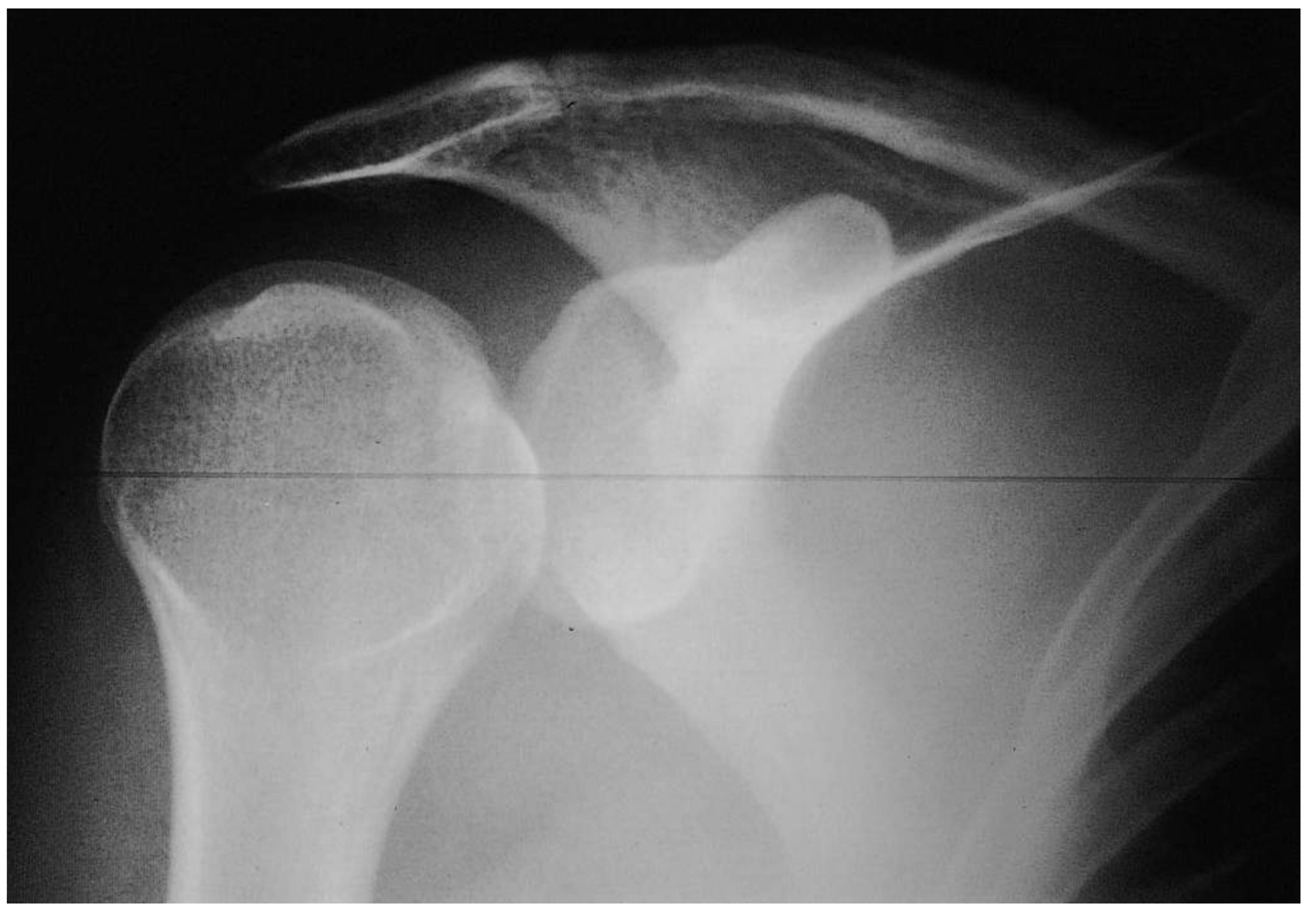

FIGURE 11.7 ■ **Posterior Shoulder Dislocation.** AP radiograph of this rare type of shoulder dislocation. Because of internal rotation of the greater tuberosity, the humeral head appears like a dip of ice cream on a cone, thus called the "ice cream cone sign." (Photo contributor: Alan B. Storrow, MD.)

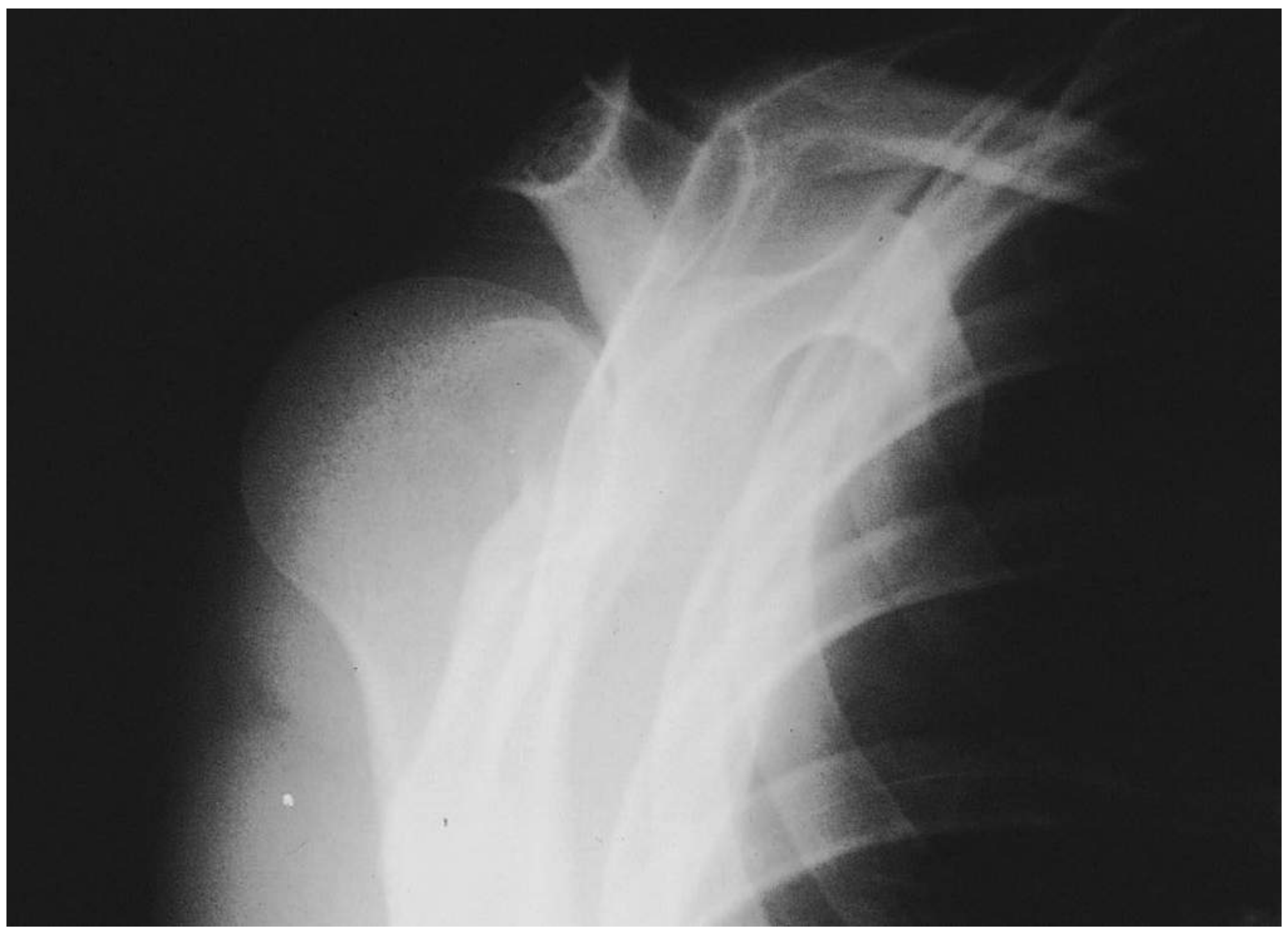

FIGURE 11.8 ■ **Posterior Shoulder Dislocation.** A scapular Y view of the same patient in Fig. 11.7 confirms the diagnosis. (Photo contributor: Alan B. Storrow, MD.)

3. Posterior shoulder dislocations can be bilateral and are often missed due to preserved symmetry on standard chest x-rays.

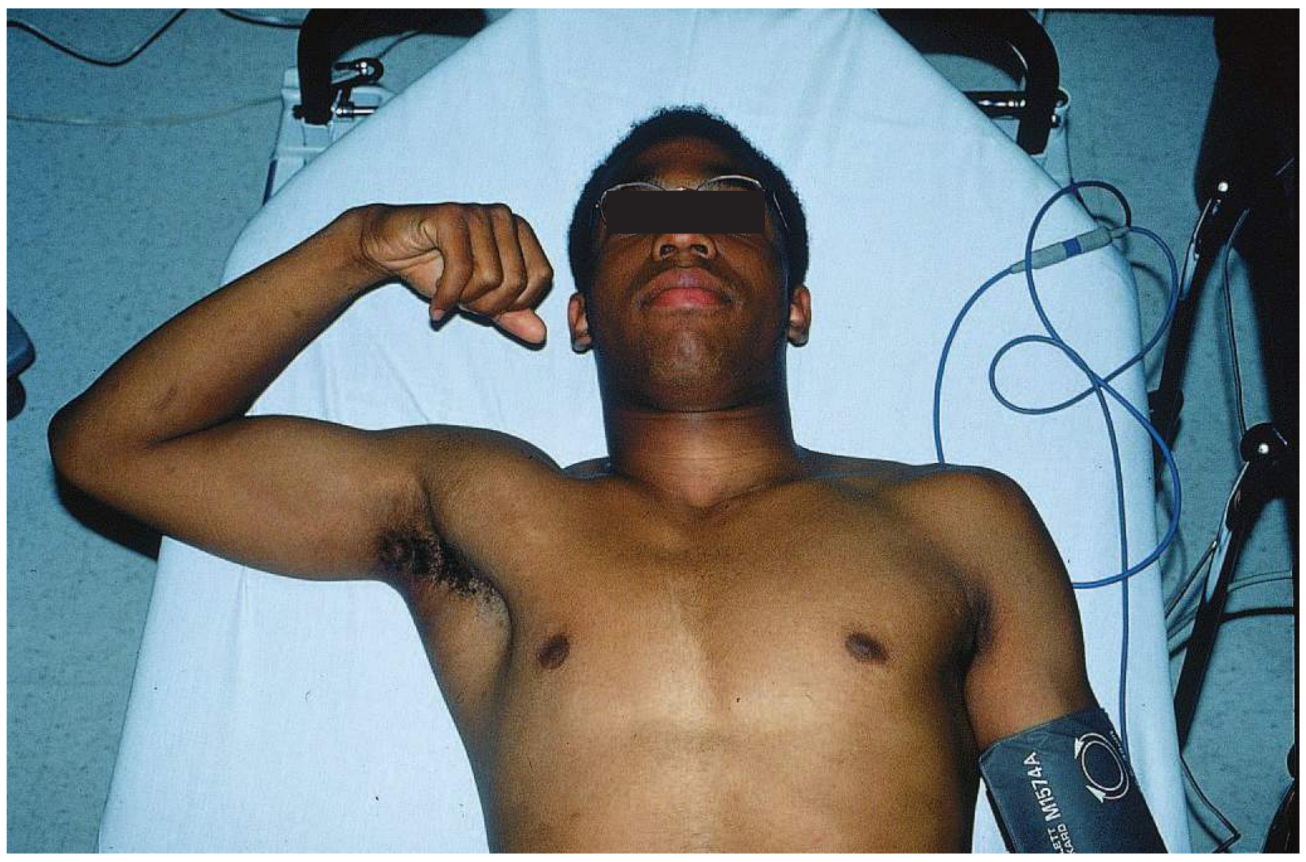

FIGURE 11.9 ■ **Luxatio Erecta.** Hyperabduction may cause the relatively rare inferior dislocation known as luxatio erecta. The arm is held in elevation and the humeral head may be palpated along the lateral chest wall. (Photo contributor: Kevin J. Knoop, MD, MS.)

FIGURE 11.10 ■ **Luxatio Erecta.** An inferior dislocation of the humeral head with the arm above consistent with luxatio erecta. (Photo contributor: Benjamin Milligan, MD.)

Clinical Summary

Direct trauma or fall on an outstretched hand may result in elbow fractures. The patient may be unable to extend the elbow and have pain on supination/pronation. AP, lateral, and oblique radiographic views visualize most. The radial head should be aligned with the capitellum on all views. The anterior fat pad may be seen on normal radiographs but displacement anteriorly and superiorly (sail sign) suggests effusion or hemarthrosis. The posterior fat pad is not normally visualized and, if seen, is indicative of effusion or hemarthrosis; it is often associated with a radial head fracture in adults.

Supracondylar fractures often occur in pediatric patients. Neurovascular insult occurs in 7%, with the anterior interosseous nerve most commonly injured. This can be checked by having the patient make an "ok" sign. This neuropraxia usually resolves in 6 months. Arterial injury to the brachial artery occurs in approximately 5% to 20%, with less than 1% of these complicated by compartment syndrome. Arteriography is indicated if the radial pulse is decreased after reduction; however, it should not delay operative evaluation.

Capitellum fractures represent less than 1% of adult elbow fractures, occur with high-energy trauma, and are difficult to diagnose radiographically; a CT scan may be required. This fracture is commonly associated with fractures of the radial head.

Management and Disposition

Treatment of supracondylar fractures is influenced by stability of the fracture pattern as well as associated neurovascular injuries. If neurovascular compromise exists, the emergency physician may need to apply forearm traction to reestablish distal pulses. If the pulse is not restored with traction, emergent operative intervention for brachial artery exploration or fasciotomy is indicated. In children, nondisplaced fractures can be splinted in 90 degrees of flexion. Angulated or displaced fractures often require operative intervention.

Capitellum fractures are treated with immobilization in a posterior long-arm splint with the elbow in 90 degrees flexion and the forearm in supination. Complications of displaced capitellum fractures include arthritis, avascular necrosis, and decreased range of motion.

Radial head fractures can be treated with a sling for comfort and patients should be told to discontinue the sling as early as possible. Fractures that are greater than 2 mm displaced, those that have greater than 20% of articular depression, or

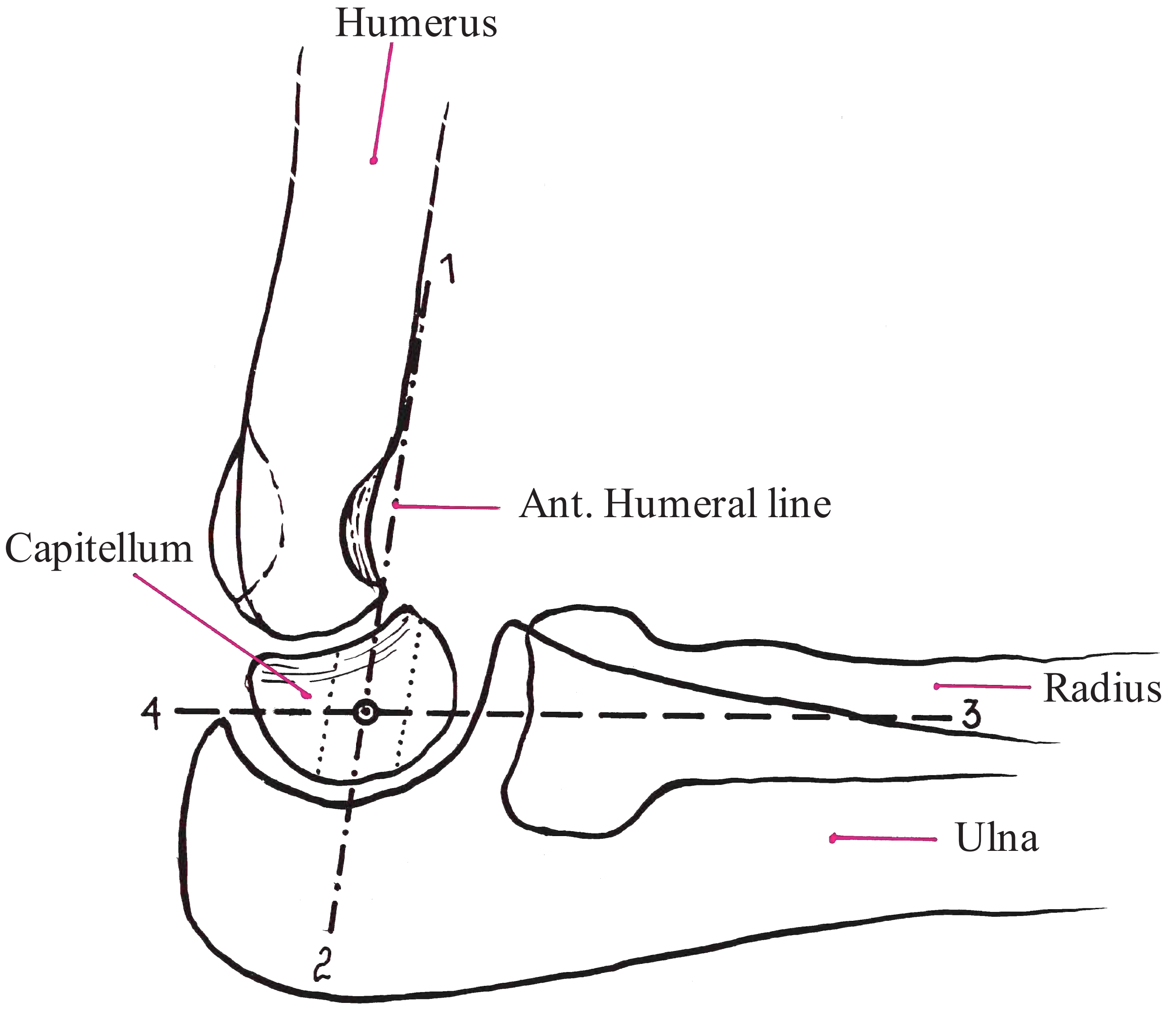

FIGURE 11.11 ■ **Radiographic Elbow Relationships.** In lateral views, the anterior humeral line (1-2) should bisect the middle third of the capitellum. The radiocapitellar line (drawn through the center of the radius, 3-4) should also pass through the center of the capitellum. Disruption of these relationships may indicate fracture.

FIGURE 11.12 ■ **Supracondylar Fracture.** This radiograph shows both a pronounced anterior fat pad (sail sign) and posterior fat pad indicative of a supracondylar fracture. (Photo contributor: Alan B. Storrow, MD.)

open fractures may need operative treatment and should follow up within a week with an orthopedic surgeon.

Pearls

1. An intimal arterial injury may not be initially apparent and frequent radial artery checks are warranted in the pediatric population. Some practitioners opt to admit supracondylar fractures so these neurovascular checks can be done.
2. Capitellum and radial head fractures often occur together.
3. The presence of a joint effusion or a posterior fat pad with a history of trauma is presumptive evidence of a fracture.

FIGURE 11.13 ■ **Supracondylar Fracture.** (**A**) Clinical picture with marked soft tissue swelling in a child with a history of falling on an outstretched arm. (**B** and **C**) AP and lateral views of the elbow, demonstrating a distal humerus fracture with posterior displacement of the medial and lateral condyles. (Reproduced with permission from Shah BR, Lucchesi M. Atlas of Pediatric Emergency Medicine. New York: McGraw-Hill; 2006.)

Clinical Summary

Elbow dislocations are the second most common major joint dislocation and usually occur posteriorly, although they can be anterior, medial, or lateral. All require immediate reduction to relieve pain and prevent neurovascular compromise. Brachial artery function and ulnar, median, and radial nerve integrity must be evaluated when examining any patient. Elbow dislocations are often associated with a radial head fracture. Patients with posterior dislocation present with their elbow held in flexion and examination reveals a swollen, tender, and deformed elbow with a prominent olecranon. Anterior dislocations, though rare, present with the elbow extended with the forearm supinated and elongated.

Radiographic evaluation should include an AP and a lateral view. The presence of fractures should be noted, as this may complicate reduction.

Management and Disposition

Most patients require conscious sedation prior to reduction. Posterior dislocations are accomplished by applying posterior pressure to the humerus while an assistant applies longitudinal forearm traction. Alternatively, the patient is placed in the prone position so the humerus hangs perpendicular to the stretcher. A 5- to 10-lb weight is applied to the wrist or axial traction is applied to the wrist while the elbow at the humerus is stabilized. After a few minutes, the olecranon slips back into place. It is possible to entrap the nerve while attempting reduction, so neurovascular integrity must be checked before and after reduction. If this occurs, an orthopaedic surgeon should be consulted immediately. After successful reduction, the elbow should be immobilized in 90 degrees of flexion in a posterior splint and sling. Elbow dislocations with associated fractures may make closed reduction difficult and also leave the joint unstable. In these cases, consultation with an orthopedic surgeon is recommended prior to reduction attempts.

Pearls

1. The ulnar nerve is the most common nerve injured.
2. The olecranon should form a straight line with the two epicondyles when the elbow is extended. At 90 degrees of flexion, the olecranon and the two epicondyles should form a triangle. This relationship is disrupted in the dislocated elbow.

FIGURE 11.14 ■ **Posterior Elbow Dislocation.** This patient dislocated his elbow while playing basketball. Note the flexed position and the prominence of the olecranon. (Photo contributor: Frank Birinyi, MD.)

FIGURE 11.15 ■ **Posterior Elbow Dislocation.** Lateral radiograph demonstrating posterior elbow dislocation. (Photo contributor: Selim Suner, MD, MS.)

Clinical Summary

The biceps has two origins, crosses the shoulder and elbow joints, and inserts on the proximal radius. The long head of the biceps is much more susceptible to injury and rupture may occur anywhere along its route. Clinically, patients with proximal rupture present with pain along the anteromedial aspect of the shoulder. On inspection, ecchymosis is often acutely noted. Muscle retraction within the arm may create a “Popeye” deformity. Due to the two proximal attachments, the short head of the biceps can allow for maintenance of forearm supination strength. Rupture may also occur at the tendon insertion into the radial tuberosity at the elbow. This diagnosis is made on the basis of a history of a painful, tearing sensation in the antecubital region. A snap or pop may also occur. The ability to palpate the tendon in the antecubital fossa may indicate partial tearing.

Management and Disposition

Proximal and distal biceps tendon ruptures can be discharged with a sling, pain control, physical therapy, and referral for operative repair consideration. Distal biceps tendon ruptures often require surgical management due to the significant loss of forearm supination strength. Partial proximal biceps tendon ruptures should also be referred to a specialist.

Pearls

1. Functional deficits from a long head rupture are usually temporary and are influenced by coexistent tears.
2. Biceps rupture occurs most commonly in the dominant extremity of men between 40 and 60 years of age when an unexpected extension force is applied to the flexed arm.

FIGURE 11.16 ■ **Biceps Tendon Rupture.** The tendon is noted to contract within the arm after rupture. (Photo contributor: Daniel L. Savitt, MD.)

Clinical Summary

Fractures of the wrist and elbow usually involve a fall onto the outstretched arm, while isolated fractures of the ulnar shaft are more commonly from a direct blow. AP and lateral views of the wrist, forearm, and elbow are required when a forearm fracture is suspected. Functional deficits in the hand are important clues to identification of occult injury to forearm neurovascular structures, and could require immediate surgical intervention. The Monteggia fracture-dislocation is a fracture of the ulna (usually proximal third) with an associated proximal radial head dislocation; it is occasionally associated with radial nerve injury.

Galeazzi fracture-dislocation is a fracture of the distal one-third of the radius with dislocation of the distal radioulnar joint. It occurs three times more often than a Monteggia fracture and can be associated with ulnar nerve injury.

Isolated fractures of the ulna's middle third may result from direct trauma, while the forearm is used to block the blow (nightstick fractures). Fractures of the forearm may result in compartment syndrome.

Management and Disposition

Both Monteggia and Galeazzi fracture-dislocations require emergent orthopedic consultation and are treated with immobilization in a long-arm splint (with elbow flexed at 90 degrees). The forearm is placed in a neutral position for a Monteggia fracture and supinated for a Galeazzi fracture. Treatment is usually surgical for both injuries, although children may be treated by reduction and casting.

Pearls

1. Any ulnar fracture with greater than 10 degrees of angulation or with a bony fragment displaced more than 50% usually requires surgical correction.
2. Do not be satisfied with the diagnosis of an isolated proximal third ulnar shaft fracture. A line drawn through the radial shaft and head must align with the capitellum in all views to exclude dislocation.
3. An ulnar styloid base fracture, if found, can be a clue to a Galeazzi fracture.
4. Since the radius and the ulna create a ring, injury to one of the bones of the forearm is often associated with fracture or dislocation of the other. Consequently, upon recognition, one must continue to seek out the other half of the injury by examining both the elbow and wrist joints.

FIGURE 11.17 ■ **Nightstick Fracture.** Isolated fracture of the middle third of the ulna. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 11.18 ■ **Monteggia Fracture.** Patients present with swelling and pain in the forearm, and often a palpable radial head in the antecubital fossa. (Photo contributor: Alan B. Storrow, MD.)

FIGURE 11.19 ■ **Monteggia Fracture Radiograph.** A Monteggia fracture is defined by a fracture of the proximal one-third of the ulna combined with dislocation of the radial head. (Photo contributor: Alan B. Storrow, MD.)

FIGURE 11.20 ■ **Galeazzi Fracture.** Note the fracture of the distal one-third of the radius and dislocation of the distal radioulnar joint. (Photo contributor: Lawrence B. Stack, MD.)

Clinical Summary

Falls on an outstretched arm are common and, often, the radius is first to fracture. If there is a supinating component to the fall, the distal ulna may also fracture. In the elderly, distal radius fractures are usually extra-articular metaphyseal fractures, whereas in younger patients they are usually intra-articular with displacement of the joint surface. There are four types of radial fractures, associated with commonly known eponyms: Colles, Smith, Barton, and Hutchinson (chauffeur).

Colles fracture is the most common. There is dorsal displacement of the distal fragment and apex palmer angulation of the distal fracture fragments; on examination, a "dinner fork" deformity is often described.

The Smith fracture is of the distal metaphysis with volar displacement and apex dorsal angulation. This usually results from a blow to the dorsum of the wrist or a hyperflexion injury. Examination reveals a reverse dinner fork deformity. Barton fracture is a fracture of the dorsal or palmer rim of the distal radius. It may be associated with dislocation of the radiocarpal joint. A Hutchinson fracture is due to a direct impact to, or an avulsion of, the radial styloid.

Management and Disposition

Evaluation requires AP, lateral, and oblique views. Orthopedic consultation is required for comminuted, displaced, unstable, or open fractures, as well as those with >20 degrees of angulation or more than 1 cm of shortening. The patient can be immobilized in a sugar-tong splint. Detailed discharge instructions should be given regarding symptoms of median nerve impingement, including paresthesias and hand weakness, which should prompt return evaluation.

Pearls

1. All fractures of the distal radius must be evaluated for median nerve function before and after reduction.
2. Colles fractures warrant a high index of suspicion for intra-articular injury, especially when a radial styloid fracture is noted.
3. With a Hutchinson fracture, associated ligamentous injuries should be sought, especially scapholunate dissociation, and perilunate or lunate dislocation.

FIGURE 11.21 ■ **Colles Fracture.** The classic dinner-fork deformity is demonstrated. The distal forearm is displaced dorsally. (Photo contributor: Kristin L. Stevens, MD.)

FIGURE 11.22 ■ **Colles Fracture.** Dorsal displacement of the distal fragment. (Photo contributor: Kristin L. Stevens, MD.)

FIGURE 11.23 ■ **Smith Fracture.** A Smith fracture is sometimes described as a reverse Colles. (Photo contributor: Frank Birinyi, MD.)

FIGURE 11.24 ■ **Smith Fracture.** The radiograph reveals volar displacement of the distal radial fragment together with the bones of the wrist and hand. (Photo contributor: Frank Birinyi, MD.)

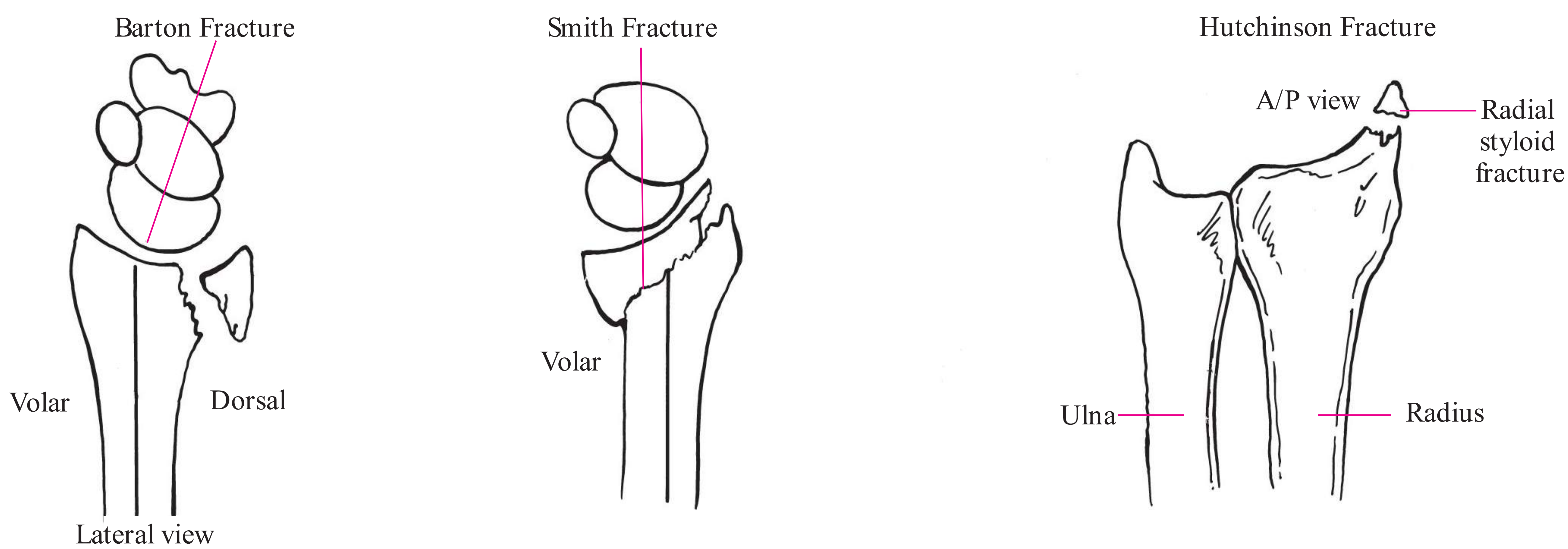

FIGURE 11.25 ■ **Distal Forearm Fractures.** Three different types of distal forearm fractures: Smith, Barton, and Hutchinson. (Adapted with permission from Simon R. Emergency Orthopedics: The Extremities. Norwalk, CT: Appleton & Lange; 1987: pp 118-119.)

Clinical Summary

Carpal and carpometacarpal dislocations are serious wrist injuries usually occurring from hyperextension. Patients complain of decreased range of motion, pain, swelling, and ecchymosis.

Lunate dislocation can occur in a palmer or dorsal position with the lunate displaced relative to the other carpals ("spilled tea cup sign"). The normal lunoradial relationship is disrupted. The median nerve is commonly involved.

FIGURE 11.26 ■ **Lunate Dislocation.** This photograph demonstrates swelling associated with a volar lunate dislocation. (Photo contributor: Cathleen M. Vossler, MD.)

If the lunoradial articulation is intact and the other carpal bones are dislocated relative to the lunate, it is termed a perilunate dislocation.

Another potentially serious injury is scapholunate dissociation, often mistakenly diagnosed as a sprained wrist. Although examination may be unremarkable except for wrist pain, an AP radiograph reveals a widening of the scapholunate joint space. A space of ≥4 mm should prompt suspicion of disruption of the scapholunate ligament. The lateral radiograph may reveal an increase of the scapholunate angle to greater than 60 to 65 degrees (normal 45-50 degrees). All these injuries may present with concomitant fractures of the carpal bones or distal forearm.

Carpometacarpal dislocations of the index and long metacarpals are fortunately rare since functional loss is often marked. Thumb, ring, and small finger carpometacarpal dislocations are more common and are frequently missed injuries.

Management and Disposition

Initial management includes adequate radiographic evaluation followed by ice, elevation, and splinting. Referral to a hand specialist is essential for adequate reduction and long-term care.

Pearls

1. A true lateral wrist radiograph best demonstrates a lunate dislocation by exhibiting the usual cup-shaped lunate bone as lying on its side and displaced either dorsally or palmerly.
2. On lateral wrist radiographs, the metacarpal, capitate, lunate, and radius should all align within a line drawn through their long axes. If this is not found, some element of dislocation, subluxation, or ligamentous instability likely exists.
3. Carpometacarpal dislocations are frequently difficult to reduce and require open reduction and fixation in approximately 50%.

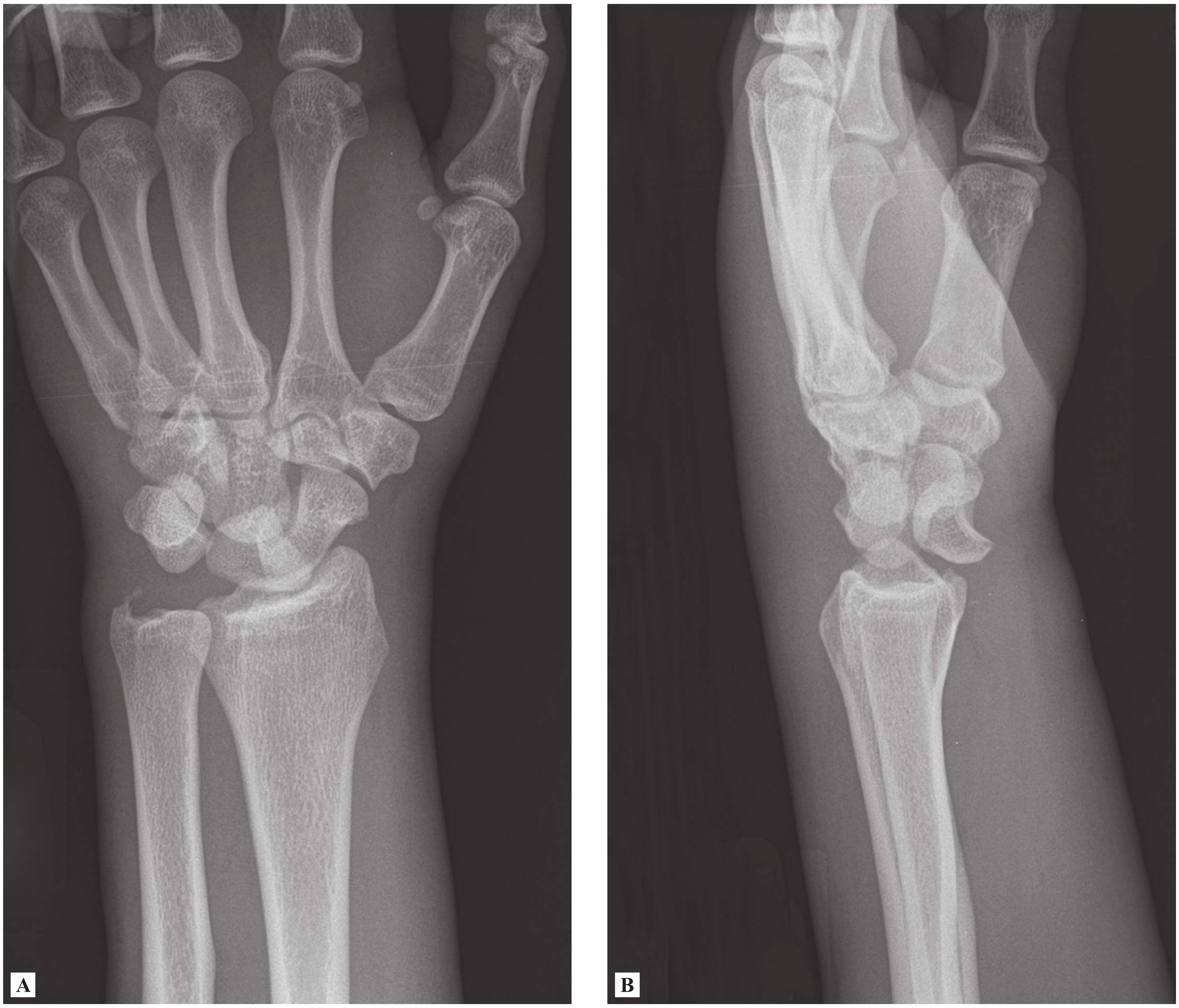

FIGURE 11.27 ■ **Lunate Dislocation.** (**A**) PA wrist view shows disruption of the carpal arcs. (**B**) Lateral reveals volar displacement of the lunate. The radius, capitate, and third metacarpal align. (Reproduced with permission of Block J, Jordanov MI, Stack LB, Thurman RJ. The Atlas of Emergency Radiology. McGraw-Hill; 2013.)

FIGURE 11.28 ■ **Carpometacarpal Dislocation.** Note the prominent deformity of the proximal metacarpals, II to IV, on the dorsal hand and the normal prominence of the ulnar styloid. (Photo contributor: Alan B. Storrow, MD.)

FIGURE 11.29 ■ **Perilunate Dislocation.** The force from a fall on an outstretched hand disrupted the lunate-capitate articulation; the capitate and other carpal bones were driven posteriorly with respect to the lunate. (Photo contributor: Alan B. Storrow, MD.)

FIGURE 11.30 ■ **Scapholunate Dissociation.** Note the widened scapholunate joint space. This injury is often misdiagnosed as simple wrist sprain. (Photo contributor: Alan B. Storrow, MD.)

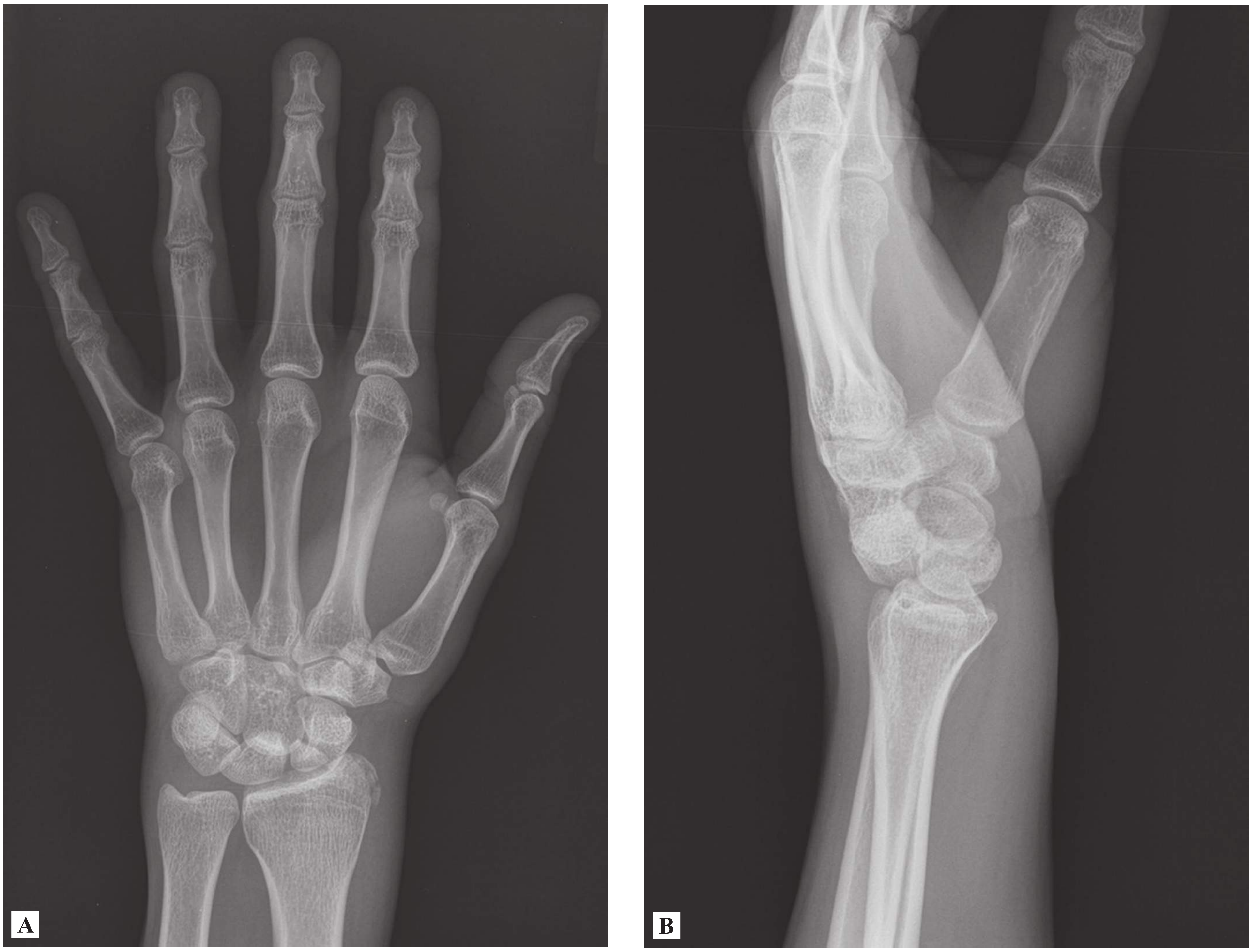

FIGURE 11.31 ■ **Perilunate Dislocation.** (**A**) PA wrist view shows disruption of the carpal arcs. (**B**) Lateral reveals the lunate aligns with the distal radius, while the capitate and metacarpals are dislocated dorsal to the lunate. (Reproduced with permission of Block J, Jordanov MI, Stack LB, Thurman RJ. The Atlas of Emergency Radiology. McGraw-Hill; 2013.)

Clinical Summary

The scaphoid is the most common carpal bone fractured. Injuries result from either a fall on an outstretched dorsiflexed hand or an axial load along the thumb's metacarpal. Misdiagnosis of a scaphoid fracture can result in delayed healing or avascular necrosis due to lack of a direct blood supply to the proximal portion of the bone. Tenderness on palpation of the anatomic snuffbox is a common finding. Examination of the wrist in ulnar deviation exposes more of the scaphoid to palpation within the anatomic snuffbox. Eliciting pain in this area when the patient resists supination or pronation of the hand, or pain with axial pressure directed along the thumb's metacarpal, is also suggestive of injury.

Negative radiographs do not rule out an occult scaphoid fracture.

Management and Disposition

Initial management includes adequate radiographic evaluation followed by ice, elevation, and a thumb spica splint. Referral to a hand specialist is essential.

Pearls

1. Patients in whom there is a clinical suspicion of an occult scaphoid fracture should receive a thumb spica splint and a repeat examination in 7 to 10 days.
2. Avascular necrosis can lead to disabling arthritis.
3. MRI is the gold standard for diagnosis.

FIGURE 11.32 ■ **Scaphoid Fracture.** Fracture of the waist, or middle third, of the scaphoid. These injuries can be associated with delayed healing and avascular necrosis. (Photo contributor: Alan B. Storrow, MD.)

Clinical Summary

The clenched fist injury classically occurs when the metacarpophalangeal (MCP) joint contacts human teeth, resulting in a laceration. Many patients will not divulge the true circumstances surrounding the injury; therefore, all wounds at the MCP joint must be considered a clenched fist injury until proven otherwise. These wounds occur most often in the dominant hand. Serious complications can result, including infection, loss of function, and amputation. Most wounds are polymicrobial. Patients who present early may have little evidence of intra-articular injury on examination, whereas those who present more than 18 hours after injury are more likely to have evidence of infection, including pain, swelling, erythema, and purulent drainage.

Management and Disposition

All wounds should be irrigated, debrided, explored, and immobilized. Patients should receive antibiotics directed at both oral and skin flora. Tetanus prophylaxis is given if needed. Radiographs should be obtained to evaluate for fractures and foreign bodies. These wounds should never be closed and should be allowed to heal by secondary intention. Reliable patients who present early, without evidence of infection or significant comorbidity, and no involvement of bone, joint, or tendon, may be treated on an outpatient basis with 24-hour follow-up. Any patient who does not meet these requirements must be hospitalized for intravenous antibiotics and wound care.

Pearls

1. Complications include cellulitis, lymphangitis, septic arthritis, abscess formation, osteomyelitis, and flexor tenosynovitis.
2. All wounds need to be examined in full flexion and extension to evaluate for tendon injuries.

FIGURE 11.33 ■ **Clenched Fist Injury.** The lacerations in this photograph were sustained from teeth during a fight. Note the subtle black ink stamp across the proximal metacarpals possibly revealing a clue about the wound's etiology. (Photo contributor: Lawrence B. Stack, MD.)

Clinical Summary

A boxer's fracture is a metacarpal neck fracture of the fifth digit, which commonly occurs after a direct blow to the MCP joints of the clenched fist. The apex of the fractured metacarpal bone is dorsal. On physical examination, the "knuckle" is flattened and can be palpated on the volar surface.

Examination should address neurovascular integrity and rotational deformity. Rotational deformity is evaluated by having the patient flex the digits at the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints; the four digits should point towards the scaphoid. If the involved digit overlaps another digit or does not point toward the scaphoid, a rotational deformity is present and needs to be corrected.

Management and Disposition

Radiographic evaluation is needed to determine the degree of angulation. Angular deformity of up to 40 degrees is acceptable for the fourth and fifth metacarpals, while 10 to 20 degrees is acceptable for the second and third metacarpals. Closed reduction for angulation that exceeds the limits should be attempted in the ED under appropriate nerve block.

Treatment includes ice, elevation, and immobilization in a short-arm gutter splint in the intrinsic plus position. For reduction, the MCP joint is held in 90 degrees of flexion and pressure exerted on the metacarpal head, directed dorsally. Simultaneously, the apex of the fracture is directed palmerly. Postreduction radiographs are needed to ensure adequate reduction. Early follow-up (within 7 days) with a hand specialist is essential, as the reduction can be lost with simple splinting. Higher degrees of angulation and fractures with any rotational deformity require follow-up for possible open reduction and fixation.

Pearls

1. Subtle malrotation can be recognized by looking at the alignment of the nail beds with the digits flexed.
2. Complications include collateral ligamentous damage, extensor injury damage, and malposition or clawing of the fingers secondary to incomplete reduction.

FIGURE 11.35 ■ **Boxer's Fracture.** Radiograph reveals a fracture through the neck of the metacarpal and volar displacement of the fractured segment. (Photo contributor: Cathleen M. Vossler, MD.)

FIGURE 11.34 ■ **Boxer's Fracture.** This fracture occurred when the patient punched a wall. There is loss of the "knuckle" when the dorsum of the hand is examined, especially noticeable when the patient makes a fist. (Photo contributor: Cathleen M. Vossler, MD.)

FIGURE 11.36 ■ **Boxer's Fracture: Rotational Deformity.** Malpositioning of the right fifth digit. Normally, all digits point toward a single spot on the scaphoid. (Photo contributor: Alexander T. Trott, MD.)

Clinical Summary

Chronic ulnar nerve injury results in the classic claw-hand (intrinsic minus) deformity due to atrophy and contracture of the lumbrical and interosseus hand muscles. The deformity is formed by hyperextension of the MCP joint and flexion at the PIP and DIP joints of the fourth and fifth digits. There is wasting of the interosseous and hypothenar muscles, as well as the hypothenar eminence. The acutely injured patient is unable to abduct or adduct the digits.

Chronic median nerve damage also results in the claw-hand deformity, but to the second and third digits. Thenar eminence atrophy also occurs. Acute and chronic damage to the proximal portion of the median nerve results in weakness of wrist flexion, forearm pronation, thumb apposition, and flexion of the first three digits.

Wrist drop is the most common symptom seen with radial nerve damage, occurring in situations of acute compression. It is frequently referred to as “Saturday night palsy” (as when a person falls asleep on an arm, or with the arm over a chair, resulting in temporary radial nerve neuropraxia).

Sensory and two-point discrimination sense is lost in the distribution of any acutely or chronically injured nerve.

FIGURE 11.37 ■ **Claw Hand.** Claw-hand appearance resulting from median and ulnar nerve injury. Note metacarpophalangeal joint hyperextension. (Photo contributor: Daniel L. Savitt, MD.)

Management and Disposition

Treatment is aimed at recognizing the underlying cause, including laceration of the nerve, compression from swelling, or hematoma formation. Treatment is splinting and appropriate referral.

FIGURE 11.38 ■ **Claw Hand.** Atrophy of the thenar and hypothenar eminences also occurs as a result of damage to the median and ulnar nerves, respectively. Note the concavity to the hypothenar eminence. (Photo contributor: Cathleen M. Vossler, MD.)

Pearl

1. Long-term nerve injury results in muscle wasting. Prior to any nerve damage, the thenar and hypothenar eminences have a full appearance. Initially, there is flattening of each eminence, followed by a concave or hollow appearance.

Clinical Summary

These patients complain of pain, swelling, and decreased range of motion at the thumb carpometacarpal joint. Bennett fracture is an intra-articular fracture at the ulnar aspect of the base of the first metacarpal with radial displacement of the thumb metacarpal and subluxation or dislocation of the carpometacarpal joint. A Rolando fracture is an intra-articular comminuted fracture at the base of the first metacarpal, with radial and ulnar fragments resulting in a Y- or T-shaped intra-articular fragment.

FIGURE 11.39 ■ **Bennett Fracture.** Bennett fracture involves the base of the first metacarpal. The digit is swollen and ecchymotic over the affected area. (Photo contributor: Daniel L. Savitt, MD.)

Management and Disposition

Treatment consists of ice, elevation, immobilization in a thumb spica splint, and early referral to a hand specialist. These fractures generally require operative reduction and fixation.

Pearls

1. Osteoarthritis is a common long-term complication, even after optimal management.
2. Swelling can mask significant angulation.
3. Neurovascular and tendon injuries are not commonly associated with Bennett and Rolando fractures.

FIGURE 11.40 ■ **Bennett Fracture.** Radiographic examination of a Bennett fracture illustrates an intra-articular fracture at the base of the first metacarpal with the metacarpal displaced radially and proximally. (Photo contributor: Cathleen M. Vossler, MD.)

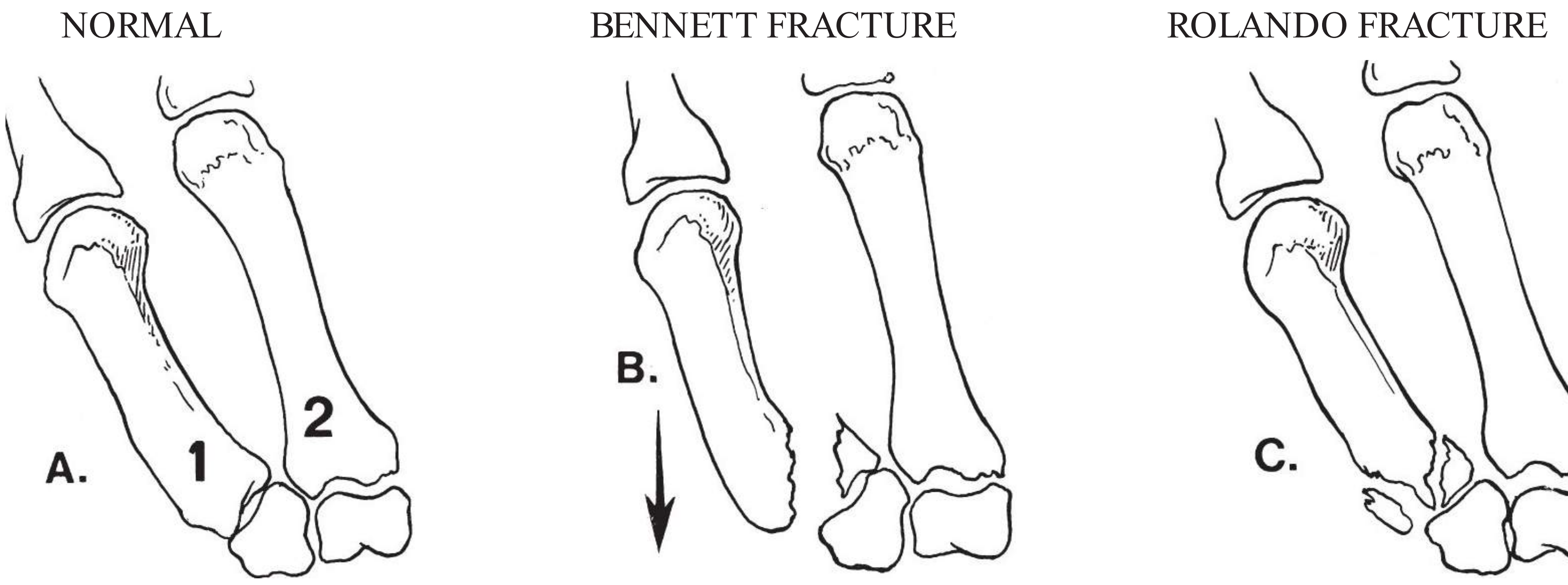

FIGURE 11.41 ■ **Intraarticular Fractures of the First Metacarpal Base.** A radial, intraarticular fracture at the base of the first metacarpal is a Bennett fracture (**B**). A comminuted intra-articular fracture at the base of the first metacarpal is a Rolando fracture (**C**). Normal anatomy (**A**).

FIGURE 11.42 ■ **Rolando Fracture.** Note the comminuted intra-articular fracture at the base of the first metacarpal. (Photo contributor: Cathleen M. Vossler, MD.)

Clinical Summary

The boutonnière deformity results from injury to the central slip insertion of the extensor hood on the dorsal surface of the middle phalanx. After a tear of the central slip, the flexor tendon is unopposed at the PIP and the lateral bands of the extensor tendon contract. With time, these displace volarly resulting in additional PIP joint flexion and DIP joint extension. The central slip rupture may result from forceful flexion of the PIP joint during full extension, a dorsal PIP joint laceration, or a palmar PIP joint dislocation. The deformity may not be immediately apparent as it takes time for the lateral bands to slide down to create extension of the DIP joint. Pain and swelling over the dorsal PIP joint, tenderness over the PIP central slip, inability to extend the PIP, and possible DIP joint hyperextension are common. Radiographically, a small bone fragment may be seen at the proximal portion of the dorsal middle phalanx.

Swan-neck deformity occurs as a result of the contracture of intrinsic hand muscles secondary to systemic diseases such as rheumatoid arthritis and SLE. The digit is contorted with hyperextension of the PIP and flexion of the DIP and MCP joints.

Management and Disposition

In dealing with a closed injury resulting in a boutonnière deformity, immobilization of the PIP joint in extension for 4 weeks is adequate, followed by active range of motion. Open injuries must be carefully explored and repaired. If the deformity is associated with a bony fragment, surgical repair may be necessary. Swan-neck deformities should be splinted and referred as an outpatient. Both deformities require outpatient referral to a hand specialist.

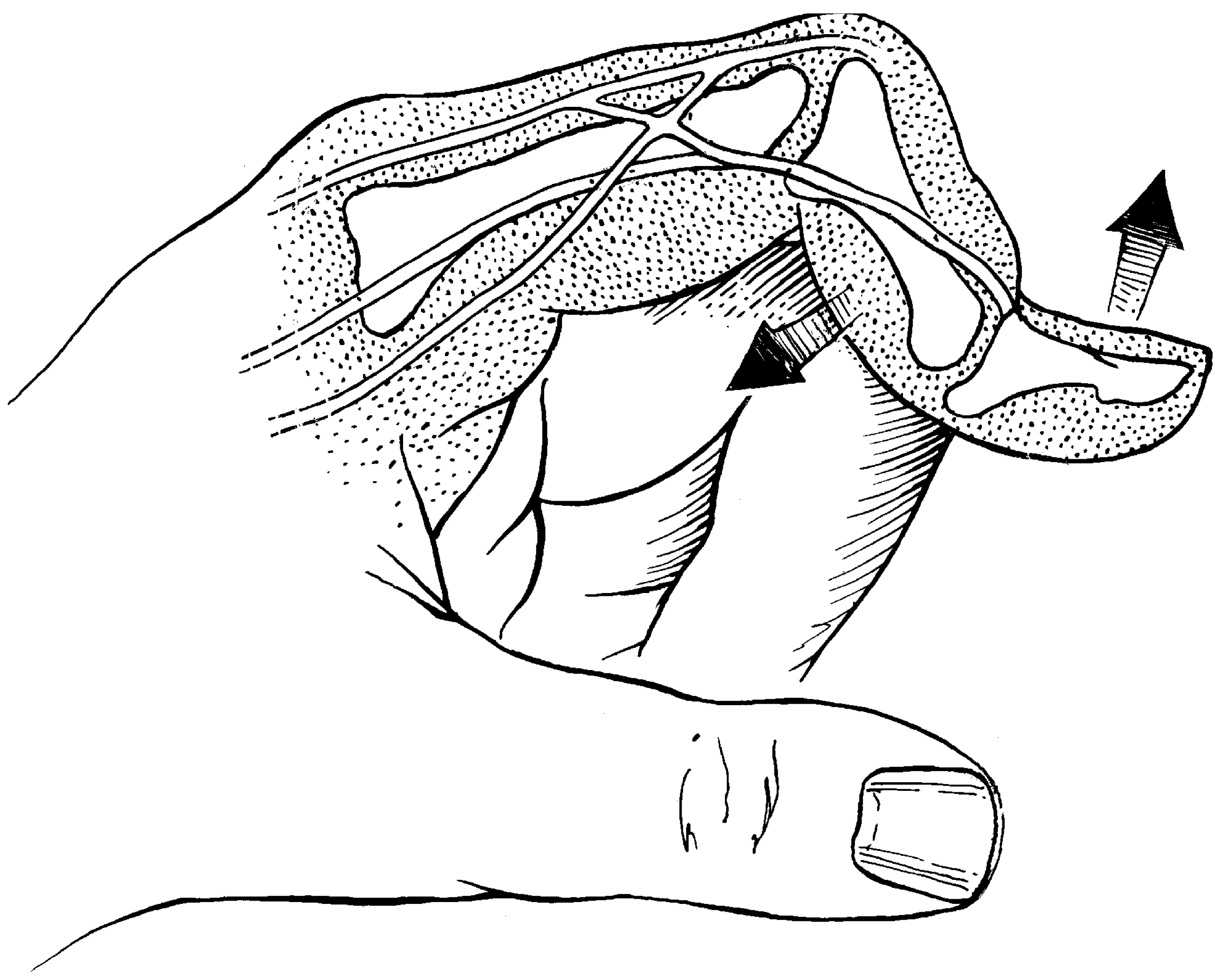

FIGURE 11.43 ■ **Boutonnière Deformity.** Illustration of the central slip rupture and the resultant subluxation of the lateral bands. The subluxation exerts a pull on the middle phalanx resulting in the deformity.

Pearls

1. Boutonnière deformity generally develops weeks after the initial injury as the lateral bands contract.
2. Surgical repair may be required for patients when conservative therapy yields inadequate results.

FIGURE 11.44 ■ **Boutonnière Deformity.** Fourth digit flexion of the PIP joint and extension of the DIP joint. (Photo contributor: E. Lee Edstrom, MD.)

FIGURE 11.45 ■ **Swan-Neck Deformity.** Hyperextension of the PIP joint and flexion of the DIP joint. (Photo contributor: Cathleen M. Vossler, MD.)

Clinical Summary

A large number of commercial devices are able to deliver liquids and gases at pressures exceeding 5000 psi. Unfortunately, these devices may accidentally introduce these substances into the body, especially the upper extremities, leading to possible ischemia. This can result as a consequence of direct chemical irritation, venous outflow obstruction, arterial compression secondary to the volume of material, spasm, or edema. Soon after the injection, the injury can appear very innocuous. The injected material spreads along fascial planes, so the extent of injury can be quite misleading and is often subtle on initial presentation. A small puncture wound, or no apparent skin break, with minimal swelling may be found. Over time, swelling and pain increase.

Management and Disposition

Immediate operative debridement is the treatment of choice; early consultation with a hand specialist is necessary. Radiographic examination to evaluate for fractures and to delineate the spread of the injected material should be considered. Tetanus, analgesia, and broad-spectrum antibiotics should be administered. The affected extremity should be elevated and splinted.

Pearls

1. Do not be misled by the "benign" appearance of the initial injury.
2. Delays in treatment can lead to compartment syndrome.
3. Digital blocks are contraindicated because of the potential for increased tissue pressure and compromise of tissue perfusion.

FIGURE 11.46 ■ **High-Pressure Injection Injury.** Injury incurred by a grease gun that accidentally discharged into a hand. Note the swelling and erythema. (Photo contributor: Richard Zienowicz, MD.)

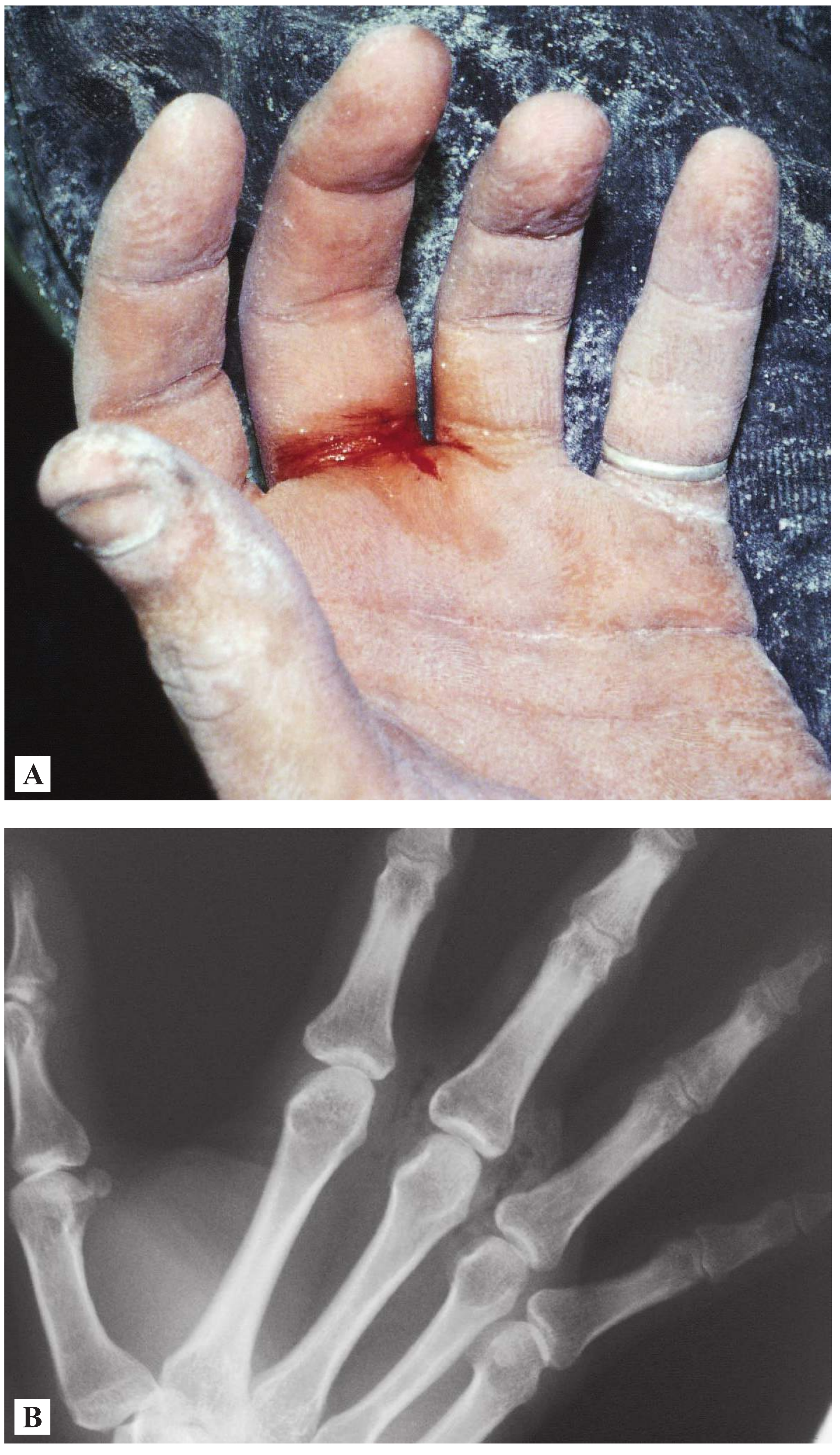

FIGURE 11.47 ■ **High-Pressure Injection Injury.** Industrial worker with initially benign appearing high-pressure injection injury at the base of his third finger (**A**). Note the spread along fascial planes demonstrated radiographically (**B**). (Photo contributor: Kevin J. Knoop, MD, MS.)

Clinical Summary

Forced radial deviation (abduction) of the thumb can cause a rupture of the ulnar collateral ligament. Known as "gamekeeper's" or "skier's" thumb, the tear usually occurs at the proximal phalanx insertion and can be associated with volar plate and dorsal capsule injury. Pain and swelling are present over the ulnar aspect of the proximal phalanx and thumb metacarpal.

Radiographs may reveal a small avulsion fracture of the proximal phalanx. Abduction stress testing (stabilizing the metacarpal with one hand while applying radial stress on the proximal phalanx) may provide additional clinical information, especially in patients with normal radiographs. Classically, more than 30 to 40 degrees radial angulation indicates complete rupture. Stress testing should be done on both sides in extension and 30 degrees of flexion while feeling for a firm endpoint.

Management and Disposition

Apply a thumb spica splint and provide analgesia. Patients with pincer function weakness, point tenderness at the volar-ulnar aspect of the thumb MCP joint, a bony fragment of >15% of the articular surface, avulsed fragment displacement of >5 mm, or significant angulation on stress testing should prompt hand surgery referral. Complete tears need repair within 1 week. A sprain without instability is commonly treated with thumb spica casting or splinting for 4 to 6 weeks followed by range of motion exercises.

Pearls

1. Radial collateral ligament rupture can also occur with forced adduction, but is uncommon.
2. Skier's thumb refers to an acute injury, while gamekeeper's has classically been associated with repetitive trauma.
3. Thumb MCP joint laxity is highly dysfunctional, painful, and may lead to late arthritis.

FIGURE 11.48 ■ **Gamekeeper's Thumb.** Laxity of 30 to 40 degrees more than the uninjured thumb, measured in neutral and 30 degrees of flexion, is strongly suggestive of a complete ulnar collateral ligament tear. There is no "endpoint" to the radial deviation of the phalanx. (Used with permission from Brunicardi FC, Anderson DK, Billar TR, et al. Schwartz's Principles of Surgery. 8th ed. New York: McGraw-Hill; 2005. © 2005 by The McGraw-Hill Companies, Inc.)

FIGURE 11.49 ■ **Gamekeeper's Thumb.** Stress x-ray of a thumb with a complete ulnar collateral ligament tear demonstrates marked instability of the ulnar side of the MCP joint and radial deviation of the proximal phalanx. (Used with permission from Brunicardi FC, Anderson DK, Billar TR, et al. Schwartz's Principles of Surgery. 8th ed. New York: McGraw-Hill; 2005. © 2005 by The McGraw-Hill Companies, Inc.)

Clinical Summary

Phalangeal dislocations are common and can occur at all three finger joints. These are generally dislocated dorsally, caused by hyperextension and axial compression, and may have associated volar plate damage. PIP volar dislocations can be irreducible secondary to rupture of the extensor tendon and herniation of the proximal phalanx through the extensor hood, requiring operative repair. MCP joint dorsal dislocations are often due to hyperextension. DIP dislocations are the rarest but can occur when an axial force is applied to the distal phalanx. Gross deformity is noted on examination, with the distal phalanx generally displaced dorsally.

FIGURE 11.50 ■ **Phalangeal Dislocation.** This patient dislocated the long finger PIP joint during an altercation. The PIP joint is displaced dorsally with an obvious deformity. (Photo contributor: Cathleen M. Vossler, MD.)

Management and Disposition

Digital nerve block for reduction and splinting is appropriate anesthesia for the PIP and DIP joints. Ulnar, median, or radial nerve blocks are necessary for the MCP joints. Reduction of dorsal dislocations is accomplished via joint hyperextension with concurrent application of horizontal traction followed by joint flexion. Flexion at the MCP joint will facilitate reduction of interphalangeal joints. Postreduction radiographs are necessary to ensure adequate reduction. After closed reduction of a dorsal dislocation, the DIP joint should be splinted in slight flexion and the PIP joint in at least 20 degrees of flexion for 3 to 5 weeks, depending on the degree of ligamentous damage. Hand specialist follow-up is recommended.

Pearls

1. All joints should be tested for instability after reduction, using a digital nerve block to facilitate testing.
2. PIP joint volar dislocation can be unstable, requiring open reduction and internal fixation.
3. Joint dislocations that have volar plate entrapment may be impossible to reduce and require surgical repair for successful reduction.

FIGURE 11.51 ■ **Phalangeal Dislocation.** Medial angulation of the ring finger suggests PIP dislocation. (Photo contributor: Daniel L. Savitt, MD.)

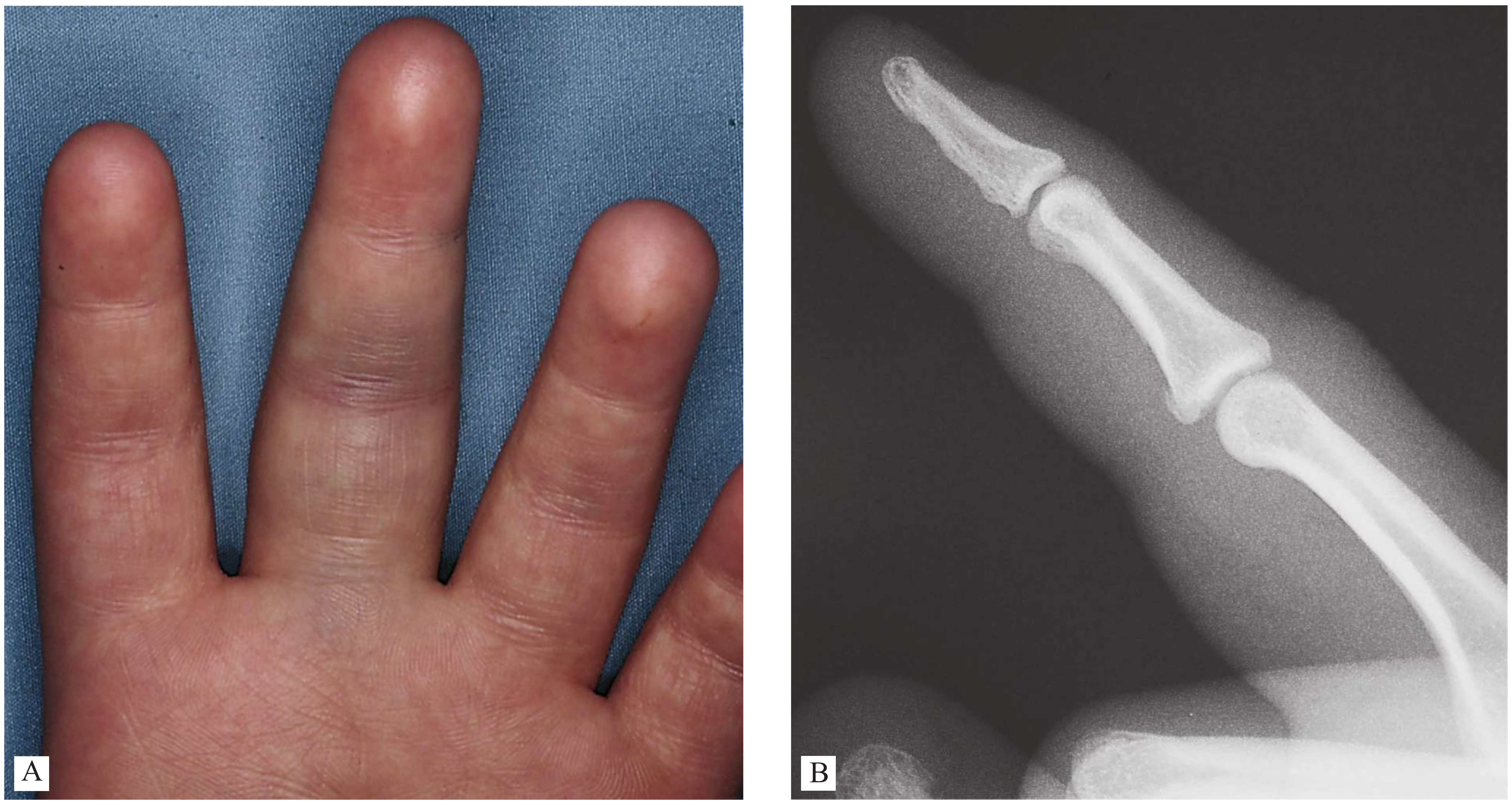

FIGURE 11.52 ■ **Volar Plate Injury.** Subtle PIP swelling and ecchymosis of the long digit seen with a volar plate injury (**A**). Radiographs of volar plate injuries often reveal a small fragment on the volar surface of the PIP joint (**B**). (Photo contributor: Cathleen M. Vossler, MD.)

Clinical Summary

Mallet finger commonly occurs after the DIP joint is forcibly flexed against an actively extended finger, tearing the extensor mechanism as it inserts on the distal phalanx. This can occur after a sudden axial blow to an extended fingertip. The patient presents with an inability to actively extend the distal phalanx while maintaining a normal passive range of motion and the DIP joint remains passively flexed. On radiography, there may be a small bony avulsion fragment on the dorsum at the distal phalanx.

A Jersey finger involves an avulsion of the distal phalanx flexor mechanism. The flexor digitorum profundus (FDP) tears as a result of forced extension of a fully flexed DIP, as would occur when someone grabs the jersey of an opponent while attempting to tackle them. Most commonly, the ring finger is involved. Clinically, the patient presents with an inability to actively flex the DIP joint while maintaining a full passive range of motion. Radiographically, a bony avulsion fragment may be present.

Management and Disposition

A closed mallet finger without involvement of the joint can be treated by splinting the DIP joint in extension; the PIP joint should not be splinted. This splint should be worn continuously for at least 6 weeks. Operative treatment is not usually required.

Jersey finger often requires surgical repair; early referral is recommended. Prognosis worsens if treatment is delayed or severe tendon retraction is present.

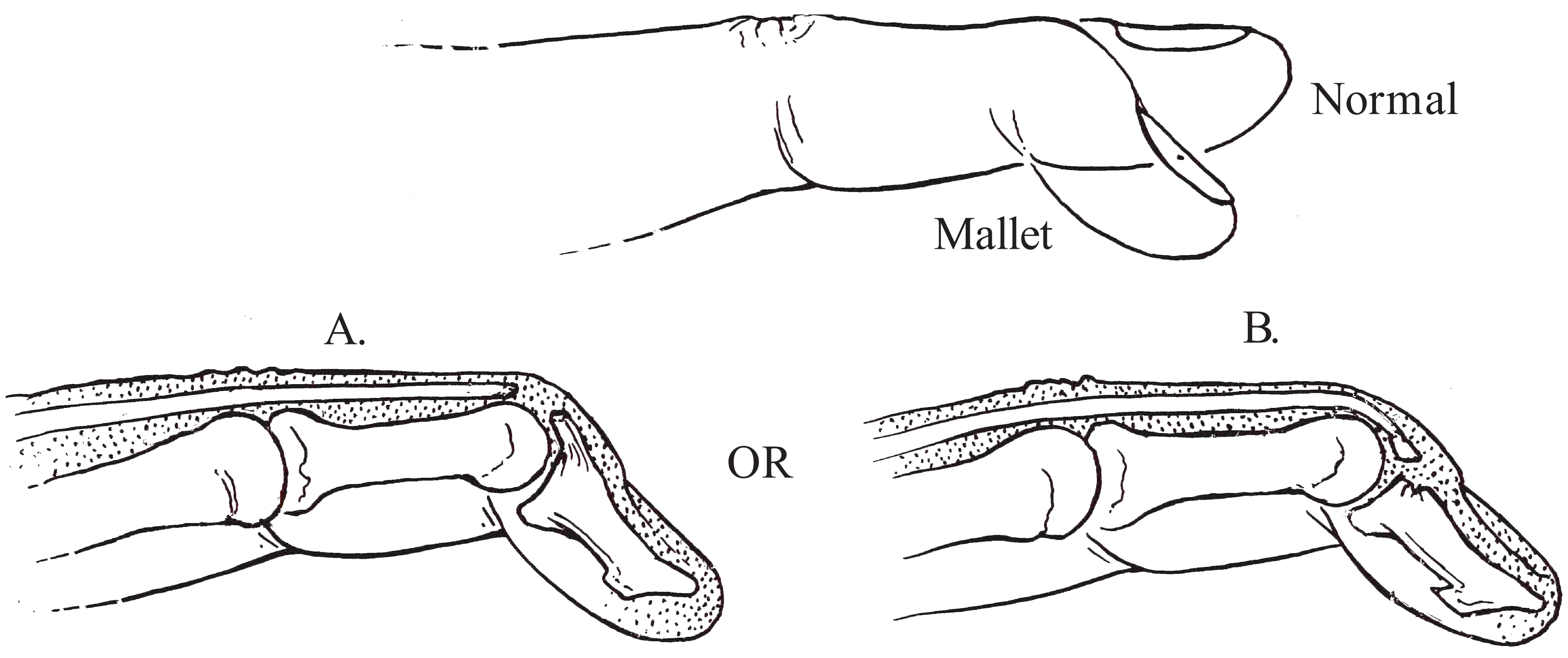

FIGURE 11.53 ■ **Mallet Finger.** This illustration demonstrates that the unopposed flexion of the DIP joint is secondary to the complete tear of the tendon (**A**), or an avulsion of a small chip fragment (**B**).

FIGURE 11.54 ■ **Mallet Finger.** The distal phalanx is held in flexion and the patient is unable to extend it. (Photo contributor: Kevin J. Knoop, MD, MS.)

Pearls

1. Avulsion of a significant portion of the articular surface of a mallet finger (more than one-third) may require open reduction with internal fixation.
2. The Jersey finger involves the FDP tendon at the DIP joint. It may be tested by isolating the affected DIP (ie, holding the MCP and PIP joints in extension while the other fingers are in flexion) and asking the patient to flex the DIP joint.

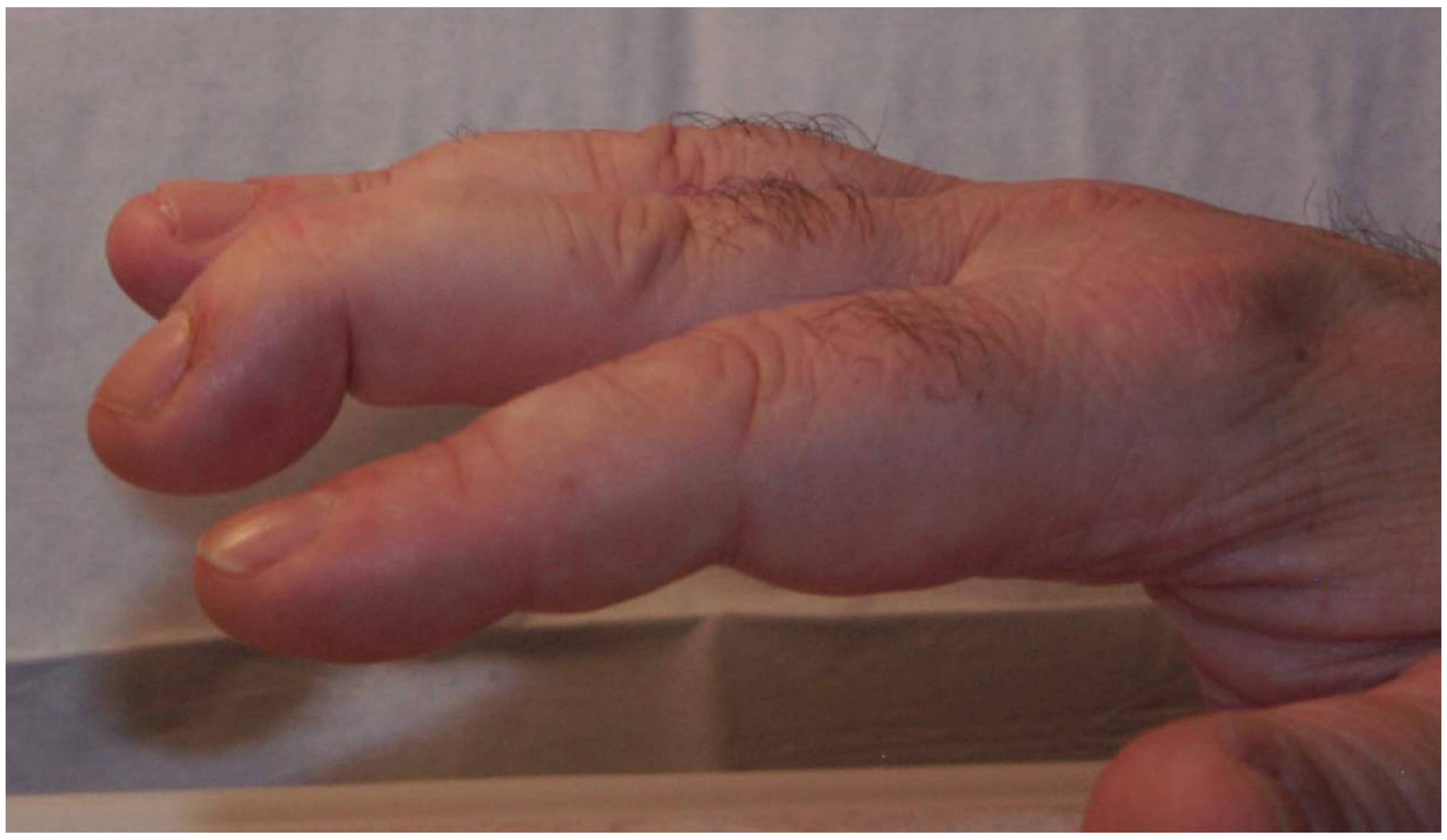

FIGURE 11.55 ■ **Mallet Finger.** Classic mallet finger—the long finger remains flexed at the DIP joint while the patient is attempting to actively extend his fingers. (Photo contributor: Matthew Kopp, MD.)

FIGURE 11.56 ■ **Jersey Finger.** The normal cascade of flexion is disrupted in the injured hand, consistent with a Jersey finger. (Used with permission from Brunicardi FC, Andersen DK, Billiar TR, et al. Schwartz's Principles of Surgery. 8th ed. New York: McGraw-Hill; 2005. © 2005 by The McGraw-Hill Companies, Inc.)

COMPARTMENT SYNDROME

Clinical Summary

Compartment syndrome develops when the pressure in the inelastic fascial space increases to a point where it causes compression and dysfunction of venous outflow. Major vascular and neural compromise lead to the classic five "Ps" that characterize late compartment syndrome: pallor, paresthesias, poikilothermia, paralysis, and pulselessness. Compartment syndrome may result from exertion, circumferential burns, frostbite, constrictive dressings, arterial bleeding, severe soft tissue injury, and fracture. It can occur anywhere in the body, most commonly in the anterior compartment of the leg.

The earliest symptom is severe pain out of proportion to the physical findings. The involved compartment is extremely firm. The pain is worsened with passive range of motion due to ischemic muscle fiber stretch. Consequently, the patient often holds the injured part in a position which relaxes the involved muscle groups.

Paresthesia is a late sign of nerve compromise, commonly with vibratory sensation lost first. Motor weakness, pallor, poikilothermia, and pulselessness are very late signs and only occur after irreversible muscle, nerve, and vascular damage have occurred. The goal of the emergency physician is to identify compartment syndrome before these late signs occur.

The diagnosis is confirmed by measuring the compartment pressures; >30 mm Hg are suggestive of compartment syndrome and should prompt surgical consultation for fasciotomy consideration.

A serious complication is Volkmann ischemic contracture, classically following a supracondylar fracture. Postischemic swelling, producing increased pressure within the enclosed osteofascial forearm compartment, reduces capillary blood perfusion below the level necessary for tissue viability. If not addressed, muscle and nerve necrosis, and eventual replacement by fibrotic tissue, produces a contracture. Refusal to open the hand, pain with passive extension of the fingers, and forearm tenderness are signs of impending Volkmann ischemia.

Management and Disposition

The initial treatment is removal of constrictive dressings and jewelry as well as frequent reevaluation. If there is no improvement, decompression via a fasciotomy should be considered. Aside from muscle and nerve damage, complications of compartment syndrome include myonecrosis which can cause myoglobinuria and renal failure.

Pearls

1. The diagnosis of compartment syndrome should be made early and be based on clinical evaluation and the mechanism of injury. Crush or compression injuries should heighten suspicion.
2. The most common areas of the extremities affected by compartment syndrome are the anterior compartment of the leg due to proximal tibial fractures, and the volar compartment of the forearm secondary to ulna, radius, or supracondylar fractures.

FIGURE 11.57 ■ **Compartment Syndrome.** A swollen and tense right forearm as a result of compartment syndrome. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 11.58 ■ **Compartment Syndrome.** Late anterior compartment syndrome of the left lower extremity is manifested by anterior tibial pain and tense "woody" swelling. (Photo contributor: Timothy Coakley, MD.)

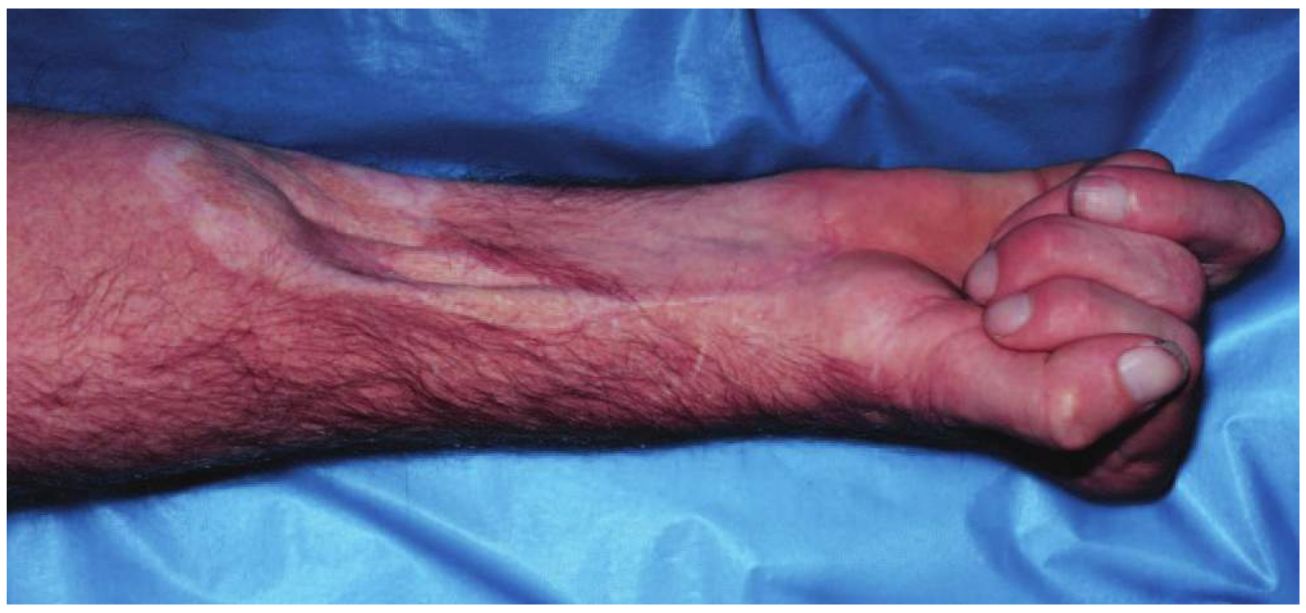

FIGURE 11.59 ■ **Compartment Syndrome.** Volkmann contracture is a serious late complication of unrelieved compartment syndrome. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 11.60 ■ **Compartment Pressures.** Intracompartmental pressure monitoring can be accomplished with commercially available devices. Normal tissue pressures should be less than 10 mm Hg; orthopedic consultation is recommended when pressures exceed 30 mm Hg. (Photo contributor: Selim Suner, MD, MS.)

Clinical Summary

A subungual hematoma is a collection of blood underneath the nail, usually occurring secondary to distal digit trauma. Such patients usually present with throbbing pain secondary to pressure beneath the nail. Associated injuries include nail bed trauma and distal tuft fractures. When fractures are present, these are considered open.

Management and Disposition

A radiograph should be done to evaluate for fracture. Acutely, if the subungual hematoma involves less than 50% of the nail matrix, trephining the nail with a sterile needle or electrocautery is adequate to relieve pain by allowing drainage. A digital block may be required prior to trephination. The involved digit can be soaked in sterile water with peroxide after trephination to encourage drainage.

Management of larger hematomas is controversial. Some authors advocate nail removal for bed injury repair if the hematoma covers more than 50% of the nail, or if there is an associated fracture. Some believe nail removal is best reserved for injuries damaging the nail plate and surrounding tissues, regardless of the size of the hematoma or presence of fracture. After removal, the patient's clean nail, a piece of foil, or petroleum gauze should be placed between the eponychial nail fold and the germinal matrix.

The patient with a fracture should be discharged with a splint supporting the distal joint in extension and all dressings should be kept dry. Antibiotics are not required unless the area is contaminated.

FIGURE 11.61 ■ **Subungual Hematoma.** Two subungual hematomas secondary to crush injury. (Photo contributor: R. Jason Thurman, MD.)

Pearls

1. Subungual hematomas are a sign of nail bed injury.
2. Subungual hematomas with surrounding nail bed and nail fold injuries require nail removal and evaluation of the nail bed for injury and careful repair if needed.
3. A hand-held, high-temperature, portable cautery device is a good tool for trephination.

FIGURE 11.62 ■ **Nail Bed Laceration.** Bleeding from a nail bed laceration causes a subungual hematoma. This image depicts a nail bed laceration seen after nail removal. (Photo contributor: Alan B. Storrow, MD.)

Clinical Summary

Hip dislocations are often associated with fractures of the acetabulum, ipsilateral femur, or knee, and can be anterior, posterior, or inferior. Ninety percent are posterior, resulting from significant forces exerted on a flexed hip and knee (eg, a passenger in a motor vehicle accident whose knees hit the dashboard). Anterior hip dislocations occur when there is forced external rotation of the extended hip, which forces the head out of the acetabulum, either by tearing the anterior capsule or by fracturing the anterior wall of the acetabulum.

Patients complain of severe hip pain and decreased range of motion. Posterior dislocations present with the extremity shortened, internally rotated, adducted, and flexed. With anterior dislocations, the leg is often abducted, externally rotated, and slightly flexed; however, this presentation can vary.

Management and Disposition

Treatment for dislocations is early closed reduction, often with conscious sedation, although ultrasound-guided femoral nerve blocks are a popular option. A neurovascular and radiographic evaluation should occur before and after any reduction attempts. Since the muscles around the hip are so strong, a general anesthetic with complete paralysis may be required. Posterior dislocations are reduced using in-line traction with the hip and knee flexed to 90 degrees, followed by gentle internal to external rotation. Anterior dislocations are reduced using strong in-line traction with the hip in neutral flexion extension or slight extension, slight adduction and internal rotation, followed by abduction.

Orthopedic consultation should be obtained as early as possible. These patients require admission, with frequent neurovascular evaluation.

Hip replacements have a tendency to dislocate more easily than native hips and usually require less energy for reduction. Radiographs should be done pre- and postreduction to evaluate for periprosthetic fractures.

Pearls

1. Complications of posterior hip dislocations include sciatic nerve injury and avascular necrosis.
2. In the young patient, immediate reduction of a native hip is imperative and should be accomplished within 6 hours.

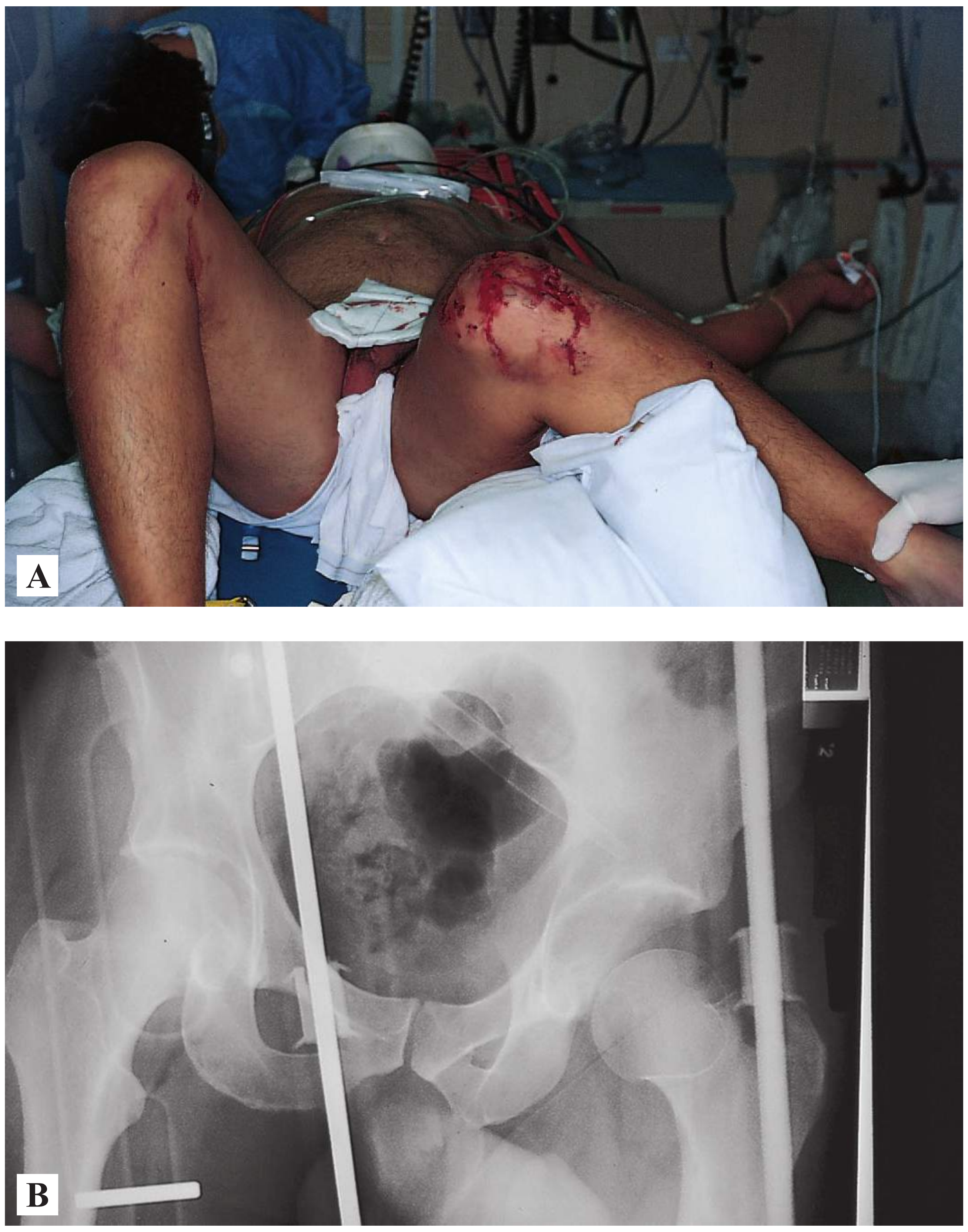

FIGURE 11.63 ■ **Hip Dislocation.** Typical patient appearance of a left posterior hip dislocation. Note internal rotation of the affected extremity (**A**). Radiograph (**B**). (Photo contributor: Cathleen M. Vossler, MD.)

Clinical Summary

Fractures above the level of the lesser trochanter are termed hip fractures. The femoral head has a tenuous blood supply and fractures can compromise blood flow, resulting in avascular necrosis. For classification, hip fractures are generally divided into intracapsular (femoral head and neck fractures) and extracapsular (trochanteric, intertrochanteric, and subtrochanteric). Accurate classification is important because intracapsular fractures are more likely to have vascular disruption.

Complaints include groin or buttock pain, tenderness, and an inability to bear weight on the affected side. There can be shortening of the affected leg, as well as abduction and external rotation.

Both the Shenton line (the curved line formed by the top of the obturator foramen and the inner side of the neck of the femur) and the neck shaft angle should be evaluated, but can be normal in nondisplaced fractures.

Management and Disposition

Fractures of the hip require early orthopedic consultation for admission and, in most cases, surgical reduction and fixation. Femoral head fracture-dislocations are an orthopedic emergency and require immediate reduction. A neurovascular examination should be carefully performed before and after any reduction attempts.

Pearls

1. Fracture-dislocation of the femoral head requires great forces; intra-abdominal and retroperitoneal injuries should be considered.
2. Hip fractures may be diagnosed by auscultation of differences in bone conduction between the two extremities. This is performed by placing the stethoscope's diaphragm on the anterosuperior iliac spine and giving the patella soft taps.
3. Any elderly patient with an inability to bear weight has a hip fracture until proven otherwise. Hip fractures can be secondary to osteoporosis, so there does not need to be a history of trauma. Since plain films may not be sensitive enough to identify some hip fractures, other imaging such as CT or MRI should be considered.

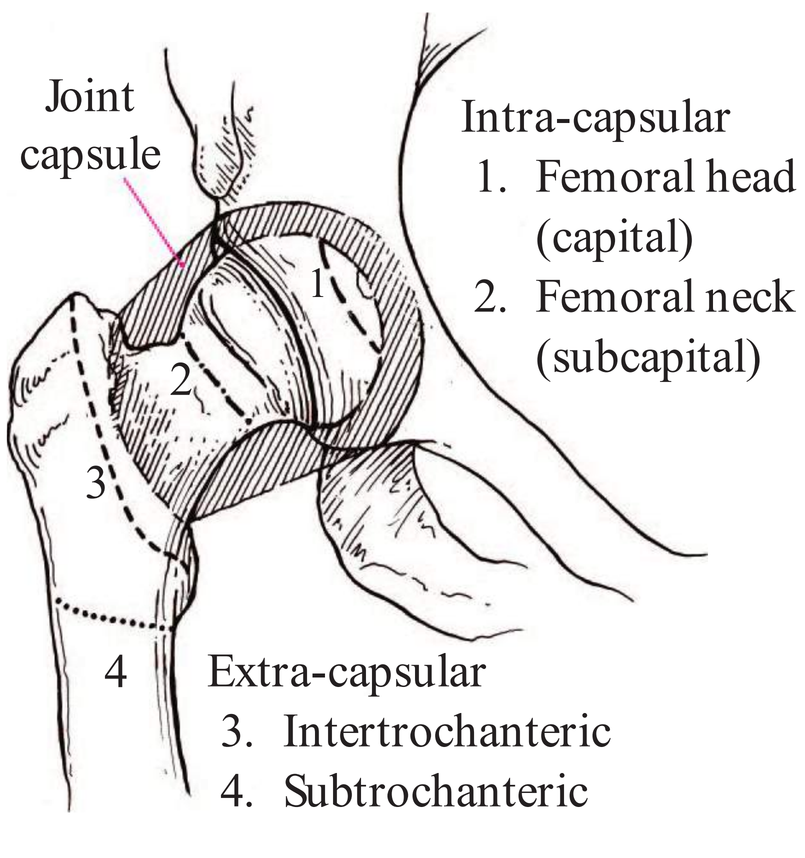

FIGURE 11.64 ■ **Hip Fractures.** This illustration depicts the different types of proximal femoral fractures.

FIGURE 11.65 ■ **Hip Fracture.** Patients with hip fractures often present with the affected extremity shortened, externally rotated, and abducted. Note the rotation and shortening in this patient with a right intertrochanteric fracture. (Photo contributor: Cathleen M. Vossler, MD.)

FIGURE 11.66 ■ **Hip Fracture.** Radiographic examination reveals an intertrochanteric fracture. (Photo contributor: Cathleen M. Vossler, MD.)

Clinical Summary

Knee extensor injuries usually occur from three different mechanisms: quadriceps tendon tear, patellar tendon tear, and patellar fracture. Extension may be limited by any disruption of these three elements. Patients with a history of trauma, other systemic conditions, steroid injections, or fluoroquinolone use are predisposed to tendon disruptions.

Quadriceps tendon ruptures are the most common extensor failure and are more often seen in the elderly. Forced flexion during quadriceps contraction may cause rupture; patients may experience sudden buckling and pain. The patella is inferiorly displaced with proximal patellar tenderness and swelling. A soft tissue defect at the distal aspect of the quadriceps is often apparent.

Patellar tendon rupture occurs in the younger, more active population and results in proximal displacement of the patella with inferior pole tenderness and swelling.

Patellar fractures may be transverse (most common), comminuted, or vertical. They may be caused by direct trauma or as a result of high eccentric tension forces. Tenderness, swelling, and sometimes a palpable defect are present.

Examination will reveal weakness of knee extension against gravity. Patients with complete tears will not be able to extend their knee.

FIGURE 11.67 ■ **Quadriceps Tendon Rupture.** Inferior displacement of the patella and a distal quadriceps defect suggest quadriceps tendon rupture. (Photo contributor: Robert Trieff, MD.)

FIGURE 11.68 ■ **Patellar Tendon Rupture.** Proximal displacement of the patella and inferior pole tenderness in a patient with right patellar tendon rupture. (Photo contributor: Kevin J. Knoop, MD, MS.)

Management and Disposition

Lateral radiographs may help distinguish between the two tendon injuries. Patients demonstrating either partial or complete tendon ruptures can be discharged with their knee in extension and follow up with orthopedics. Care must be taken to differentiate between a bipartite patella and a fracture. Nondisplaced and displaced patellar fractures should receive splinting in full extension and orthopedic referral.

Pearls

1. MRI may distinguish partial from complete tears.
2. Patellar fractures may be complicated by future degenerative arthritis.

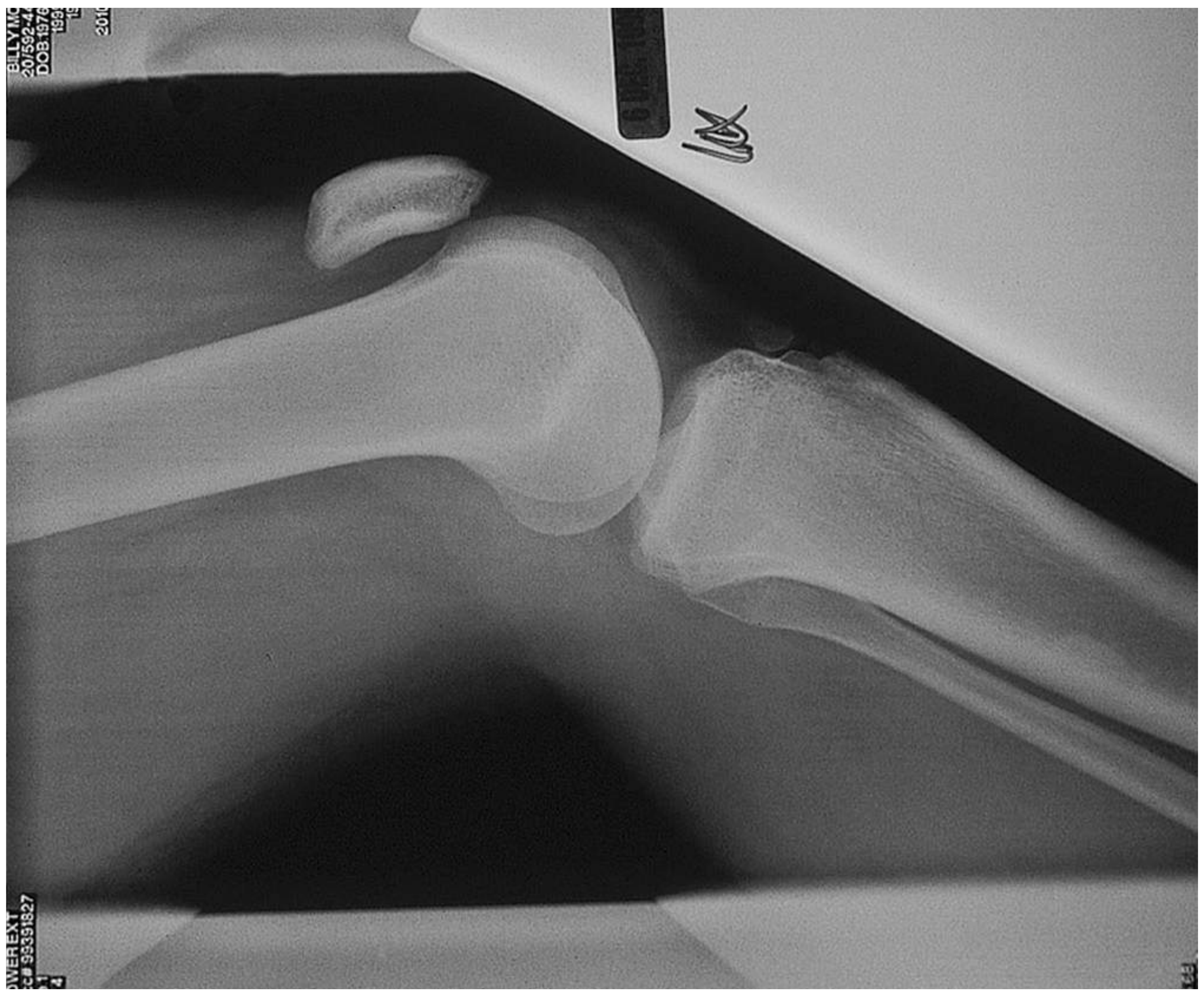

FIGURE 11.69 ■ **Patellar Tendon Rupture.** A lateral radiograph reveals the proximal patellar displacement seen with complete patellar tendon rupture. (Photo contributor: Kevin J. Knoop, MD, MS.)

FIGURE 11.70 ■ **Patella Fracture.** The inferior pole of the patella is comminuted and displaced. Internal fixation is indicated if the patient cannot actively extend the knee. (Used with permission from Brunicardi FC, Andersen DK, Billiar TR, et al. Schwartz's Principles of Surgery. 8th ed. New York: McGraw-Hill; 2005. © 2005 by The McGraw-Hill Companies, Inc.)

Clinical Summary

Patellar dislocations can result from either direct trauma or powerful quadriceps contraction with knee flexion. Most commonly, the patella dislocates laterally. Patients who present after a patellar dislocation may state their knee dislocated and spontaneously reduced. A hemarthrosis can be present. Common complaints include pain, swelling, and knee deformity. Examination reveals fullness or deformity in the lateral aspect of the knee. The patellar apprehension test (gently displacing the patella laterally or medially while in extension) is often positive in spontaneously reduced patellar dislocations. The patient will become apprehensive as you attempt to reproduce the dislocation. Radiography will confirm the dislocation and help rule out associated fracture. Fractures of the patella or lateral femoral condyle occur in 5%.

FIGURE 11.71 ■ **Patellar Dislocation.** An obvious lateral deformity of the right patella in a patient with dislocation. (Photo contributor: Cathleen M. Vossler, MD.)

Management and Disposition

Lateral dislocations are reduced by flexing the hip, extending the knee, and gently directing pressure medially on the patella. Reduction is easily accomplished and results in immediate relief of pain. Postreduction films should be taken. After successful reduction, patients require a knee immobilizer in full extension for 4 to 6 weeks. Outpatient referral to a musculoskeletal specialist should be obtained for long-term follow-up

FIGURE 11.72 ■ **Patellar Dislocation.** Lateral deformity of the right patella in a patient with dislocation. (Photo contributor: Lawrence B. Stack, MD.)

Pearls

1. A dislocated patella may reduce spontaneously prior to presentation; it is a possibility in any patient who presents with knee pain. This may be elucidated by inquiring about a knee deformity at the time of injury that is no longer present.
2. Complications of patellar dislocation include degenerative arthritis, recurrent dislocations, and chondral or osteochondral loose bodies.

Clinical Summary

Knee dislocations are classified by the direction of tibial displacement relative to the femur (anterior, posterior, medial, lateral, or rotatory), invariably cause multiple ligamentous injuries, and are usually the result of motor vehicle crashes, falls, sports, and industrial injuries. Anterior dislocations are more common and usually occur after high-energy hyperextension injuries. Knee dislocations are associated with popliteal artery and common peroneal and tibial nerve injuries. Popliteal artery injury can result from both anterior and posterior dislocations, is more common than nerve injury, and is more devastating. Injury can be present despite normal pulses and, if not identified and repaired within 8 hours, amputation may be necessary. Common peroneal nerve injury can cause decreased sensation on the lateral foot, impaired dorsiflexion and eversion, and impaired sensation over the first dorsal web space. Knee dislocations can spontaneously relocate, so the physician must maintain a high index of suspicion. If a patient presents with a grossly unstable knee after trauma, this may be a reduced dislocation and should be evaluated as such.

Injuries are painful and visually striking. An effusion will often be absent since the capsule has been violated. On examination, the knee will be grossly unstable since dislocations tend to injure most of the surrounding ligaments.

Management and Disposition

Management includes early reduction, immobilization, assessment of distal neurovascular function, and emergent orthopedic referral. Reduction of anterior dislocation is accomplished by flexing the hip 20 degrees and having an assistant apply longitudinal traction on the leg while keeping one hand on the tibia and simultaneously lifting the femur back into position. A posterior splint with the knee in 20 degrees of flexion is used for immobilization and to avoid tension on the popliteal artery. The patient should be admitted for observation and, likely, arteriography.

Pearls

1. Knee dislocations are often associated with a fracture of the tibial plateau.
2. The presence of distal pulses in the foot does not rule out an arterial injury.
3. Vascular repair after 8 hours of injury carries an amputation rate of greater than 80%.

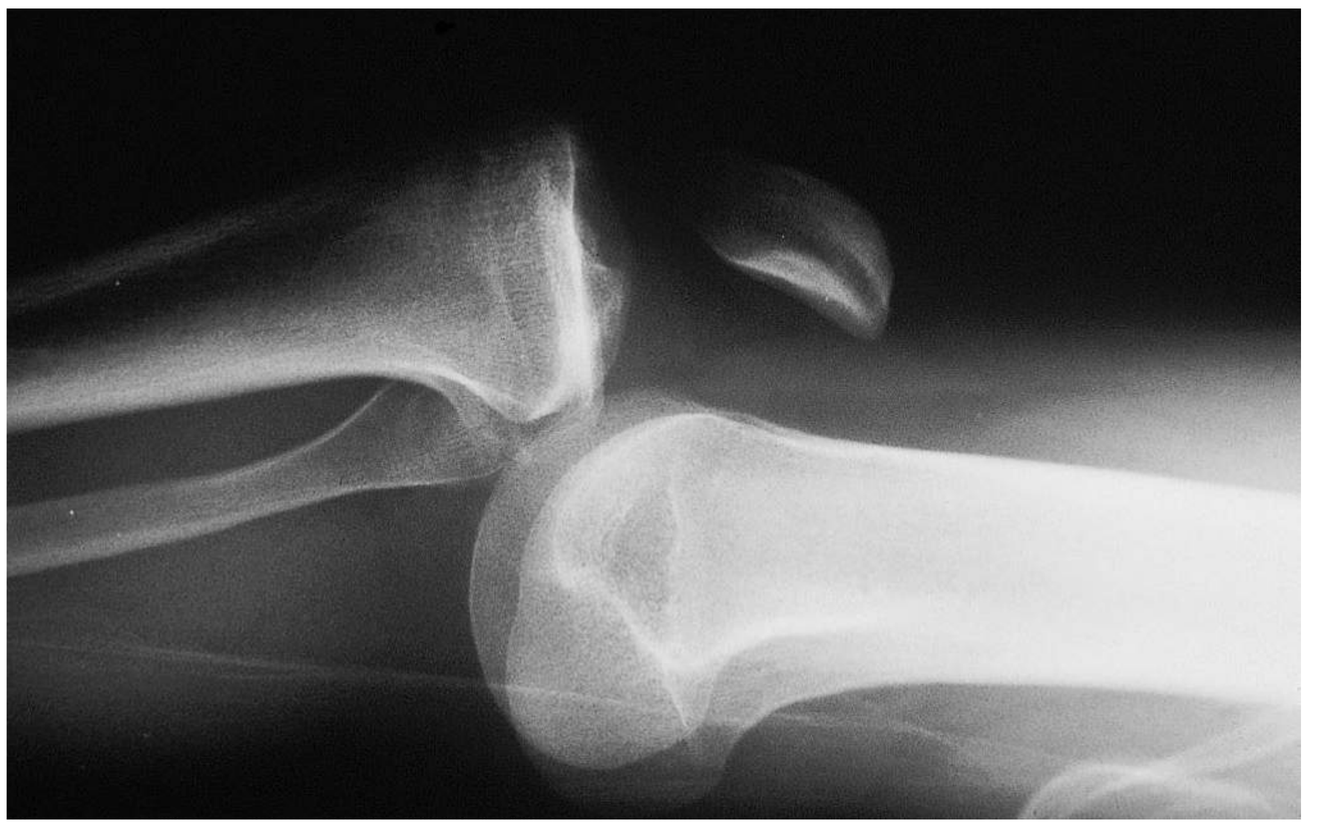

FIGURE 11.73 ■ **Anterior Knee Dislocation.** Anterior displacement of the tibia in relation to the femur. (Photo contributor: Selim Suner, MD, MS.)

FIGURE 11.74 ■ **Posterior Knee Dislocation.** Posterior displacement of the tibia in relation to the femur. (Photo contributor: Paul R. Sierzenski, MD.)

FIGURE 11.75 ■ **Posterior Knee Dislocation.** Posterior displacement of the tibia in relation to the femur. (Photo contributor: David Effron, MD.)

Clinical Summary

While femoral fractures often occur secondary to serious trauma, they can be seen in low-energy injuries associated with the elderly, osteoporosis, or bone cancer. Diagnosis is usually evident on visualization and confirmed radiographically. Significant hematoma formation and blood loss is common. Patients with comminuted femoral shaft fractures are at risk for fat emboli syndrome. For distal fractures, it is important to rule out intra-articular involvement.

Management and Disposition

Initial management includes stabilization and evaluation for any life-threatening injuries. A large amount of blood loss (average 1000 mL) can occur; patients should have two large-bore intravenous lines and be cross-matched. Radiography should include the hip and knee. In-line traction may be required for initial stabilization, and to reduce blood loss and pain. This can be held temporarily in the acute setting with a Hare traction splint.

An open fracture is an orthopedic emergency; these patients require tetanus prophylaxis, antibiotic coverage, and emergent irrigation and debridement in the operating room. Orthopedic consultation should be obtained with any femur fracture since the majority requires operative fixation and stabilization.

Pearls

1. Pain can be referred. Any injury between the lumbosacral spine and the knee can be referred to the thigh or knee.
2. Vascular compromise can occur and should be suspected with an expanding hematoma, absent or diminished pulses, or progressive neurologic signs.
3. Femur fractures can mask the clinical findings of a hip dislocation; thus, radiographs of the pelvis, hips, and knees should be obtained routinely.

FIGURE 11.76 ■ **Midshaft Femur Fracture.** A closed midshaft femoral fracture. Note the deformity in the middle of the thigh. (Photo contributor: Daniel L. Savitt, MD.)

FIGURE 11.77 ■ **Femur Fracture.** Radiographic examination reveals a comminuted displaced distal femoral fracture. (Photo contributor: Cathleen M. Vossler, MD.)

FIGURE 11.78 ■ **Pathologic Femur Fracture.** A varus-angulated and mildly displaced fracture through an aggressive, moth-eaten, lytic lesion in the proximal left femoral diaphysis. (Reproduced with permission of Block J, Jordanov MI, Stack LB, Thurman RJ. The Atlas of Emergency Radiology. McGraw-Hill; 2013.)

Clinical Summary

Fibular fractures may be isolated or associated with tibia injuries. Isolated fibular fractures are caused by direct lateral leg trauma and are anatomically splinted by an intact tibia. Distal fibular fractures may include a disrupted ankle joint, as evidenced by a widened mortise on the AP radiograph. Tibial fractures are classified by their location, amount of displacement, and presence of comminution.

Compartment syndrome can be seen following a tibia fracture; distal neurovascular status should be documented. Suspect tibial fractures with trauma to the lower extremity, pain, and inability to bear weight.

The Maisonneuve fracture is a combination of an oblique proximal fibular fracture, disruption of the interosseous membrane and tibiofibular ligament distally, and a medial malleolar fracture or tear of the deltoid ligament. It occurs when an external rotational force is applied to the foot, producing a proximal third fibula fracture. Findings include tenderness at the medial and anterolateral ankle joint in combination with proximal fibular tenderness.

FIGURE 11.79 ■ **Tibial-Fibular Fracture.** Deformity associated with a midshaft tibial and fibular fracture. (Photo contributor: Kevin J. Knoop, MD, MS.)

Management and Disposition

Treatment of fibular fractures is dictated by the degree of pain and the involvement of the ankle joint. Nondisplaced fractures can be treated with an air cast; those with displacement should receive a sugar-tong splint and referred for short-term orthopedic evaluation. Treatment of a Maisonneuve fracture is most commonly operative.

Treatment of tibial fractures depends on whether they are open or closed, and on the degree of displacement. All open fractures require immediate orthopedic evaluation. Closed fractures that cannot be reduced may also need open reduction. Patients with isolated nondisplaced tibial fractures may be splinted, started on ice therapy, and referred for outpatient treatment. Displaced tibial fractures should also be evaluated by an orthopedics due to risk for compartment syndrome.

Pearls

1. Early follow-up is required for all tibial fractures owing to the risk of compartment syndrome.
2. The peroneal nerve crosses over the head of the fibula and is subject to injury with a Maisonneuve fracture.
3. Some patients with Maisonneuve fracture may complain only of ankle pain; always examine the proximal fibula in patients complaining of ankle pain.

FIGURE 11.80 ■ **Maisonneuve Fracture.** (**A**) Abnormal widening of the medial aspect of the ankle mortise and distal tibiofibular syndesmosis, as well as slight lateral subluxation of the talar dome. Because no "exit" fracture is present on the distal fibula, a fracture of the proximal fibula (**B**) was suspected and confirmed. (Reproduced with permission of Block J, Jordanov MI, Stack LB, Thurman RJ. The Atlas of Emergency Radiology. McGraw-Hill; 2013.)

FRACTURE BLISTERS

Clinical Summary

Fracture blisters are vesicles or bullae secondary to swelling from soft tissue injury. The most commonly affected areas include the tibia, ankle, and elbow. Patients note formation within 1 to 2 days after trauma and complain of pain, swelling, ecchymosis, and decreased range of motion. Complications include infection, deep venous thrombosis, and compartment syndrome.

Management and Disposition

Blisters are generally left intact, and the underlying fracture is treated.

FIGURE 11.81 ■ **Fracture Blisters.** This patient fell down four steps on the evening prior to presentation. Upon awakening the next morning, he noted ecchymosis, swelling, and blister formation. Radiographs revealed fracture of the fibula. (Photo contributor: Daniel L. Savitt, MD.)

Pearls

1. Blisters can be seen with other conditions, including barbiturate overdose and burns. In the setting of trauma, however, they frequently indicate an underlying fracture.
2. Blisters are managed in a similar fashion to second-degree burns.

FIGURE 11.82 ■ **Fracture Blisters.** Blisters associated with an underlying ankle fracture. (Photo contributor: R. Jason Thurman, MD.)

FIGURE 11.83 ■ **Fracture Blisters.** Blisters associated with an underlying ankle fracture. (Photo contributor: Selim Suner, MD, MS.)

Clinical Summary

Rupture of the Achilles tendon occurs most frequently in middle-aged males involved in athletic activities, but patients with other systemic conditions, steroid injections, or fluoroquinolone use are predisposed. Rupture occurs 2 to 6 cm above the tendon's attachment to the calcaneus. Patients may hear or feel a pop. There is weakness when pushing off of the foot; pain, edema, and ecchymosis may develop. Note that loss of plantar flexion is not necessarily seen as there are other tendons that can compensate. Thompson test can be diagnostic of an Achilles rupture. The patient should be placed in a prone position, the knee and ankle flexed to 90 degrees, and the gastrocnemius muscle should be grasped and squeezed. If the Achilles tendon is even partially intact, then the foot will plantar flex; if completely ruptured, there will be no movement of the foot. Radiographic analysis should include a lateral view of the ankle as the Achilles tendon can sometimes be seen.

FIGURE 11.84 ■ **Achilles Tendon Rupture.** Note the loss of the normal resting plantar flexion due to right Achilles tendon rupture. Swelling is also apparent over the injury site. (Photo contributor: Kevin J. Knoop, MD, MS.)

Management and Disposition

Treatment is either operative or conservative. In either case, the extremity is immobilized in slight plantar flexion and the patient is made non-weight bearing upon ED discharge. Acute treatment also involves elevation, analgesia, and ice. These patients can be discharged home with follow-up with orthopedics.

Pearls

1. Approximately 25% of these injuries are initially misdiagnosed as ankle sprains.
2. Palpation of the tendon alone may not detect rupture, as the tendon sheath is often intact.

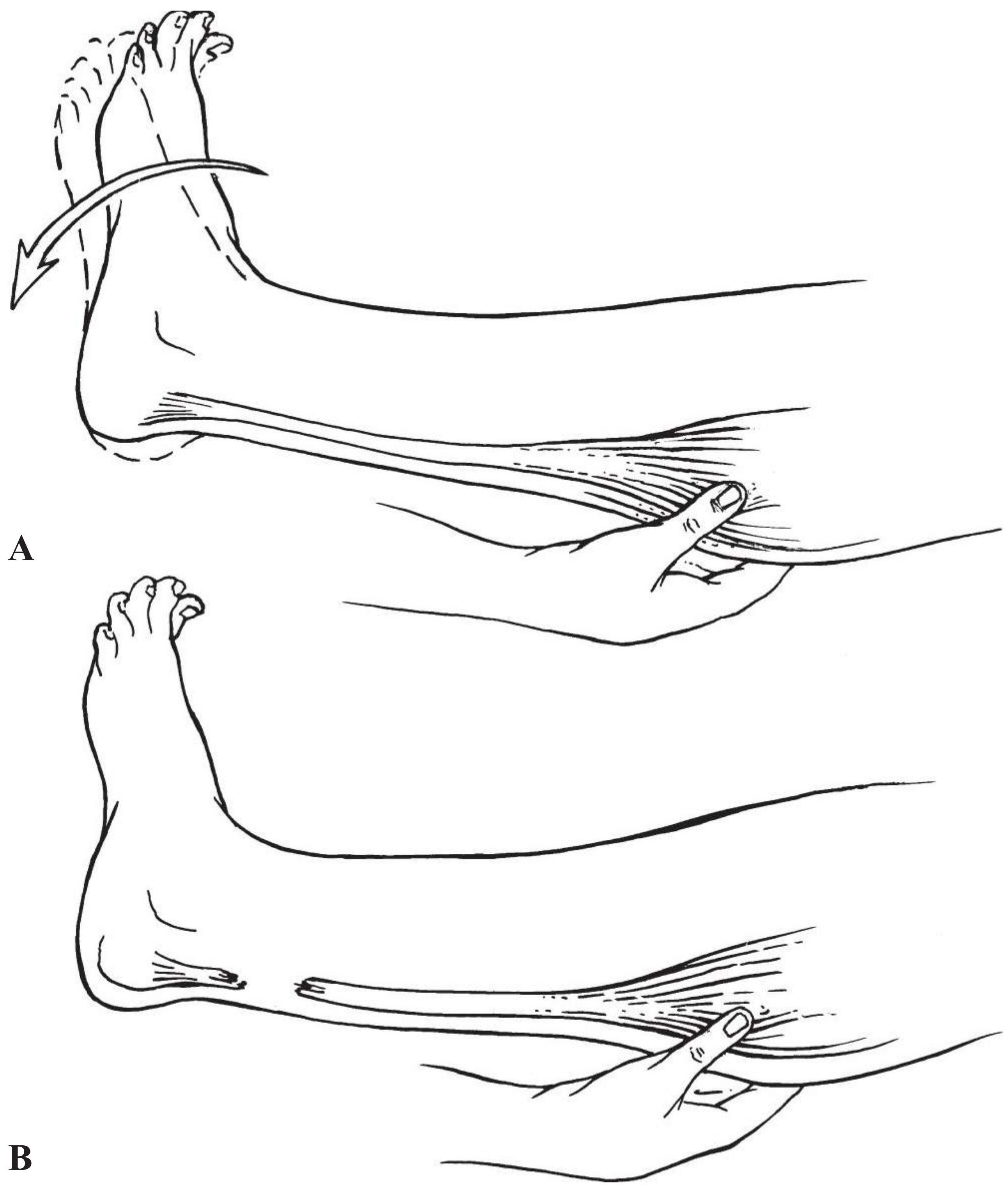

FIGURE 11.85 ■ **Thompson Test.** Compression of the gastrocnemius-soleus complex normally produces plantar flexion of the foot (**A**). If the tendon is completely ruptured, this will not occur (**B**).

Clinical Summary

The ankle is a hinge joint with the talus sitting in the mortise formed by the distal tibia and distal fibula. Ankle dislocations require forces of great magnitude and usually the malleoli are also fractured. Posterior and lateral dislocations are the most common, but the ankle can also dislocate medially, superiorly, or anteriorly. A posteriorly dislocated ankle is locked in plantar flexion with the anterior tibia easily palpable. The foot has a shortened appearance, with the ankle very edematous. Anterior dislocations present with the foot dorsiflexed and elongated. Lateral dislocations present with the entire foot displaced laterally. Ankle dislocations are frequently associated with fractures and may be open.

Management and Disposition

A complete neurovascular examination should be performed and, if vascular compromise is present, the ankle should be emergently reduced, even if it is open. The skin may also be taut and can be at risk for necrosis. If time permits, radiography should include AP and lateral ankle views.

To reduce the ankle, gentle traction is applied to the foot with one hand cupping the heel and the other hand on the dorsal aspect of the foot while an assistant applies countertraction. Neurovascular status should be checked before and after any attempts at reduction or immobilization. Reduction usually requires conscious sedation or general anesthesia. Patients should be placed in a posterior splint with immediate referral to an orthopedic surgeon for hospitalization.

FIGURE 11.86 ■ **Posterior Ankle Dislocation.** Deformity associate with posterior dislocation. (Photo contributor: Mark L. Madenwald, MD.)

FIGURE 11.87 ■ **Posterior Ankle Dislocation.** The talus is dislocated posteriorly in relation to the tibia. (Photo contributor: Kevin J. Knoop, MD, MS.)

Pearls

1. These injuries are commonly associated with malleolar fractures and often require open reduction and internal fixation.
2. Fifty percent of ankle dislocations are open and require surgical debridement.
3. The subtalar joint may also dislocate and appear clinically similar. The lateral x-ray will show overlap of the talus and calcaneus, while the AP mortise view will show an intact mortise.
4. The worse the ankle appears clinically and radiographically, the easier it is to reduce due to more severe ligamentous disruption.

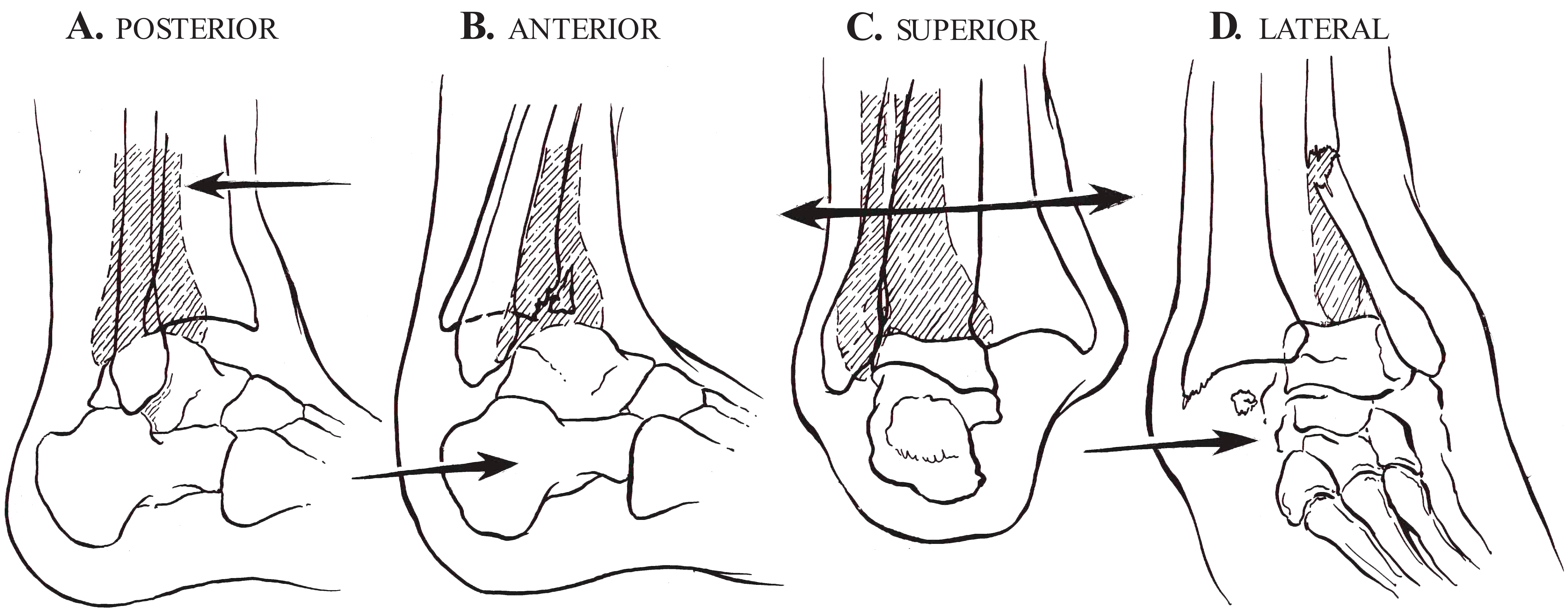

FIGURE 11.88 ■ **Ankle Dislocations.** This illustration depicts different types of ankle dislocations. Arrows denote direction of the injury force. (Adapted with permission from Simon R. Emergency Orthopedics: The Extremities. Norwalk, CT: Appleton & Lange; 1987: p 402.)

FIGURE 11.89 ■ **Lateral Ankle Dislocation.** The talus is laterally displaced in relation to the tibia. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 11.90 ■ **Subtalar Dislocation.** Complete dislocation of the hindfoot at the subtalar joints while playing basketball. Neurovascular status was intact, and the ankle, which was promptly reduced after x-ray, showed no associated fracture. (Photo contributor: Kevin J. Knoop, MD, MS.)

Clinical Summary

Most ankle fractures are isolated malleolar, but bimalleolar and trimalleolar occur in up to one-third. While there are numerous classification systems, the simplest is based on the radiographic appearance of these malleoli.

Management and Disposition

Essential treatment is directed at stability and exclusion of associated injuries. Neurovascular status (deep peroneal, superficial peroneal, medial and lateral plantar nerves, posterior tibial artery, and dorsalis pedis artery) should be assessed. The entire length of the fibula, including the proximal portion should be palpated to rule out additional fractures. All ankle fractures, with the exception of fibular avulsions, require immobilization by cast, or reduction followed by casting. With the exception of unimalleolar fractures, most require open reduction and fixation, thus orthopedic consultation is recommended. In the ED, fractures should be splinted with a posterior mold, kept non–weight bearing, elevated, and iced for 24 hours. Appropriate analgesia and consultation is addressed. The overall goal is to restore anatomic relationships, maintain them during healing, and institute early mobilization. Complications, although rare, include skin necrosis, osteomyelitis, osteoarthritis, and malunion.

Pearls

1. Postreduction arthritis can occur in up to 30%.
2. Avulsion fractures may be treated as stable ankle sprains if they are <3 mm in diameter, minimally displaced, and there is no evidence of significant ligamentous injury.

FIGURE 11.91 ■ **Trimalleolar Ankle Fracture.** (**A-C**) A tiny avulsion fracture of the medial malleolus tip, an oblique fracture of the lateral malleolus, and an oblique fracture of the distal tibia's posterior lip. (**D-E**) Reformatted CT images nicely demonstrate the same fractures. (Reproduced with permission of Block J, Jordanov MI, Stack LB, Thurman RJ. The Atlas of Emergency Radiology. McGraw-Hill; 2013.)

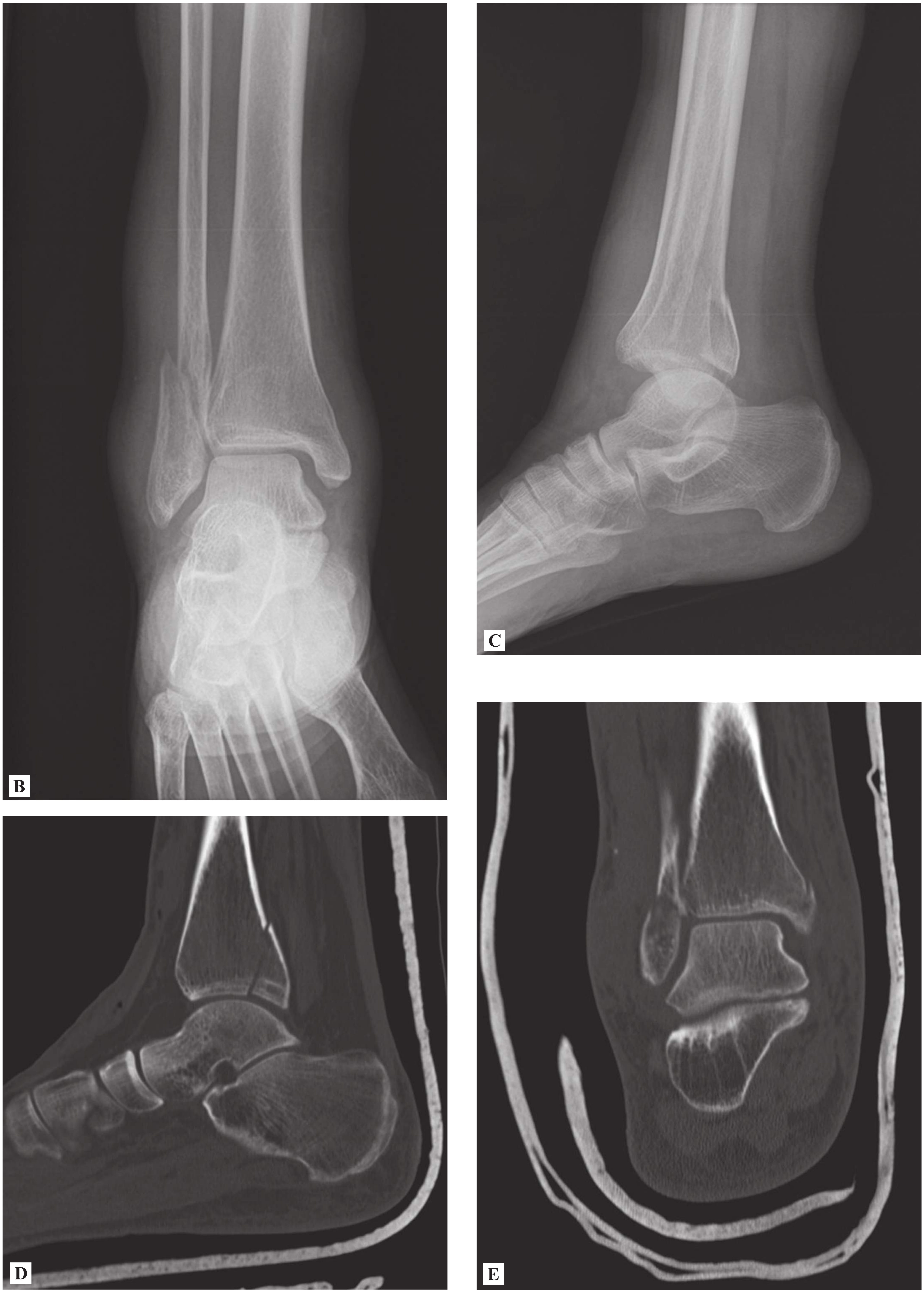

FIGURE 11.91 ■ **Trimalleolar Ankle Fracture.** (Continued)

Clinical Summary

Classification of these injuries is based on examination; radiographs are often not required to guide management. The most common mechanism is an inversion stress that injures, in order, the anterior talofibular, calcaneofibular, and posterior talofibular ligaments. The medial deltoid is the strongest ligament; therefore, isolated injuries are rare and medial ankle sprains are often associated with lateral malleolar or syndesmotic injuries.

Management and Disposition

Examination should include an anterior drawer test to assess the integrity of the anterior talofibular ligament. The Ottawa Ankle Rules recommend for the following: (a) tenderness over the lateral or medial malleolus, or (b) inability to bear weight for four steps both immediately postinjury and in the ED.

If able to bear weight, injuries are treated with ice packs, elevation, air cast or splint, and early mobilization. If unable to bear weight despite normal radiographs, use a posterior splint, crutches, and close follow-up with orthopedics.

Pearls

1. Ankle injuries are the most common musculoskeletal problem in emergency medicine.
2. Complications include instability, persistent pain, recurrent sprains, and peroneal tendon dislocation.
3. Both malleoli, the proximal fibula, and the fifth metatarsal should be examined for tenderness when evaluating a patient with an ankle sprain.

FIGURE 11.93 ■ **Medial Ankle Sprain.** An eversion injury in a professional athlete caused this rare isolated deltoid ligament sprain. Note localized ecchymosis. Tarsal tunnel syndrome developed over several weeks, taking months to resolve. (Photo contributor: Mimi Knoop.)

FIGURE 11.92 ■ **Ankle Sprain.** Note the dependent ecchymosis and swelling in this patient with a Grade 2 left lateral ankle sprain. (Photo contributor: Lawrence B. Stack, MD.)

FIGURE 11.94 ■ **Ankle Sprain.** Marked swelling and ecchymosis in a patient with a probable Grade 3 ankle sprain. (Photo contributor: Selim Suner, MD, MS.)

Clinical Summary

The calcaneus is the most frequently fractured tarsal bone. Patients present with severe heel pain in association with soft tissue swelling and ecchymosis extending to the arch. The normal contour of the heel can be distorted. Radiographs should include AP and lateral views of the foot and, if possible, a Harris axial view. Fractures can involve the tuberosities, the sustentaculum, or the body and are classified as intra- or extra-articular. Bohler angle should be calculated for all fractures involving the body to rule out a depression, as this will change management. It is normally between 20 and 40 degrees; if approaching or less than 20 degrees, a depressed fracture should be suspected.

Management and Disposition

CT scans should be obtained to further delineate fracture patterns and rule out involvement of the subtalar joint. Intra-articular fractures require orthopedic consultation; open reduction and internal fixation are usually needed.

Nondisplaced extra-articular fractures generally heal well with bulky compressive dressings, rest, ice, elevation, and non-weight bearing for 8 weeks. Orthopedic referral is necessary since some may require open reduction. Complications include fracture blisters, nonunion, and chronic pain.

Pearls

1. Calcaneal fracture warrants a diligent search for associated injuries. Twenty percent are associated with spinal fractures, 7% have contralateral calcaneal fractures, and 10% are associated with compartment syndromes. The subtalar joint is disrupted in 50% of cases. A high index of suspicion for thoracic aortic rupture and renal vascular pedicle disruption must be maintained.
2. Minimally displaced fractures of the anterior calcaneus are easily missed and should be suspected in a patient who does not recover appropriately from a lateral ankle sprain.
3. CT scanning is the optimal imaging technique for characterizing fracture dislocations, while MRI may be used to evaluate ligamentous injury.

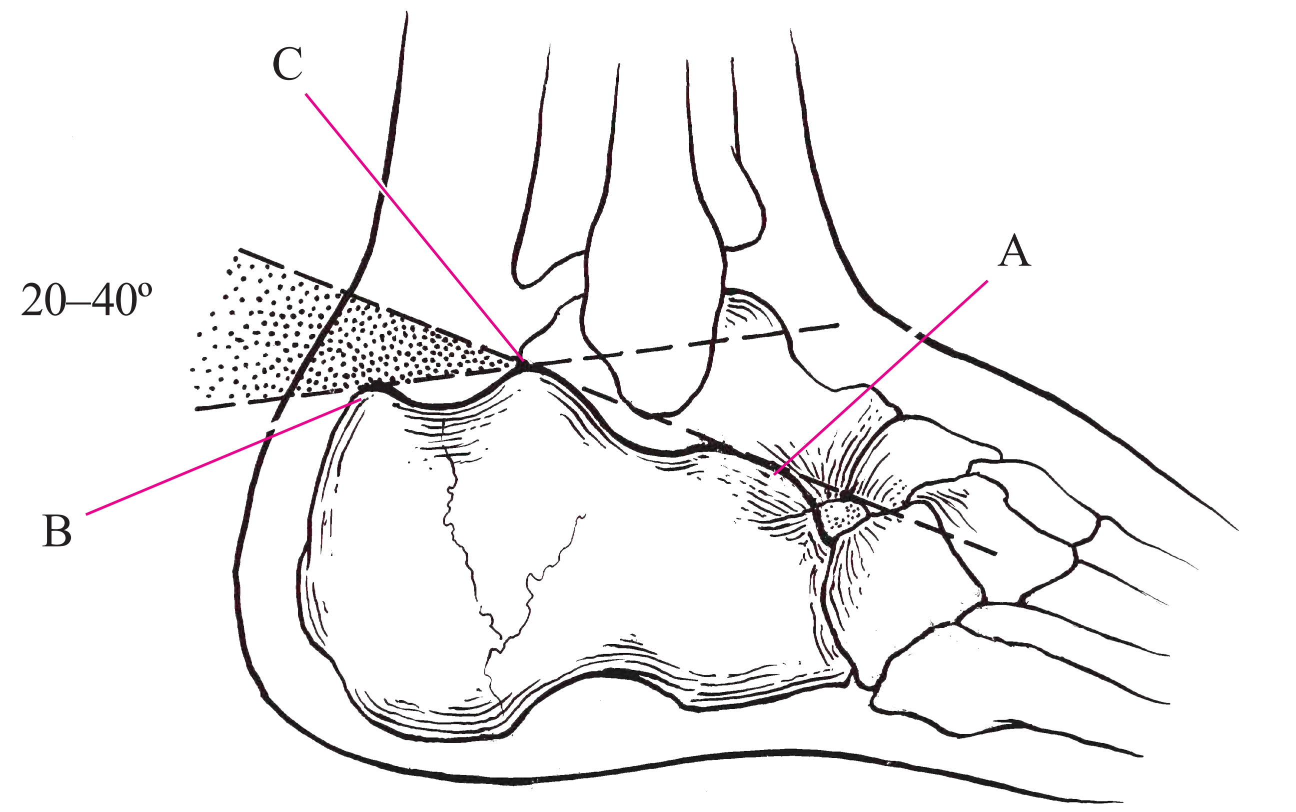

FIGURE 11.95 ■ **Calcaneus Fracture: Bohler Angle.** The Bohler angle is formed by the intersection of lines drawn tangentially to the anterior (**A**) and posterior (**B**) elements of the superior surface of the calcaneus (**C**). A normal angle is approximately 20 to 40 degrees.

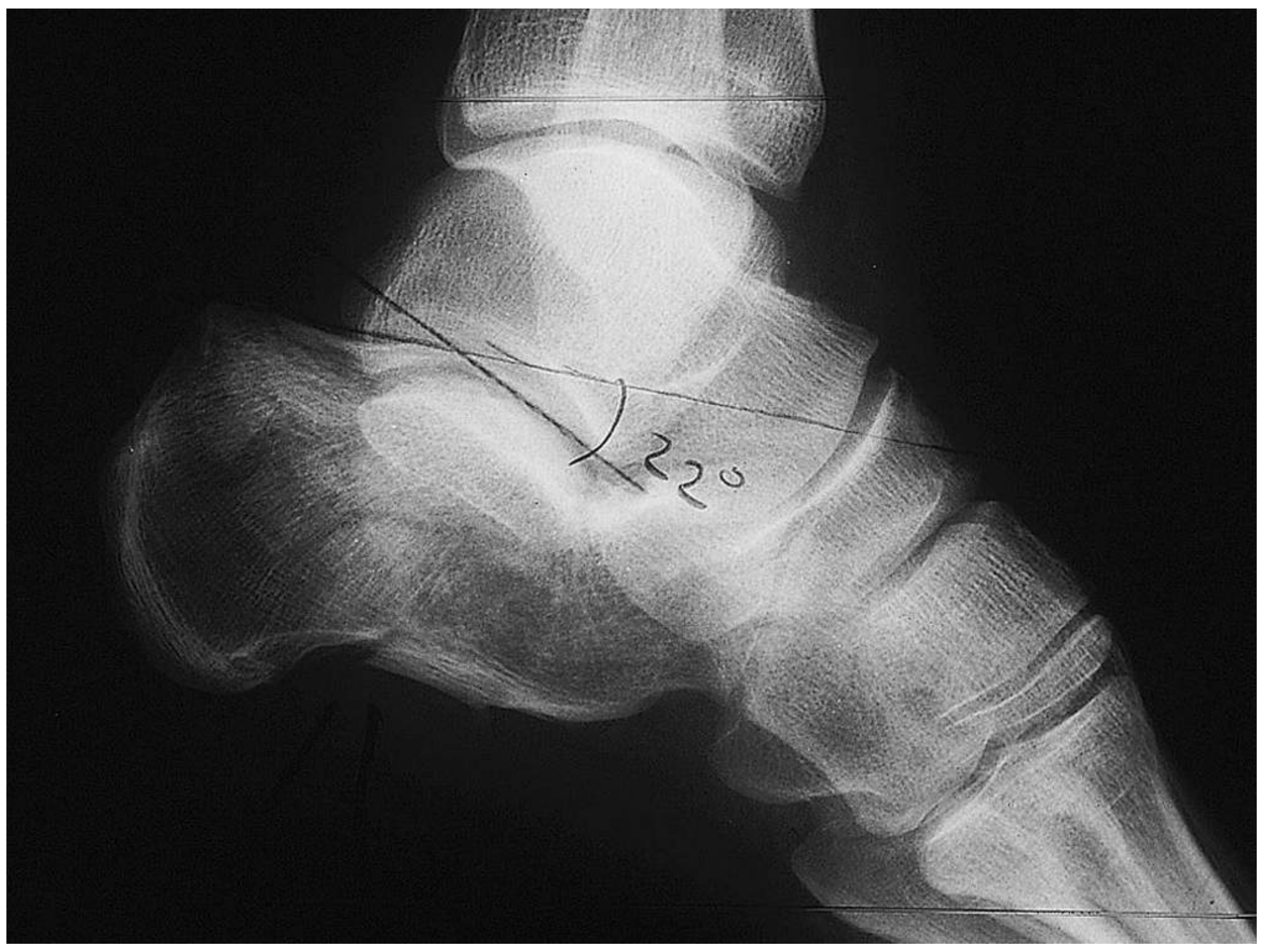

FIGURE 11.96 ■ **Calcaneus Fracture.** This patient fell from a ladder and struck his heel. A cortical step-off is seen on the inferior aspect of the calcaneus. The Bohler angle has been calculated at approximately 22 degrees. (Photo contributor: Alan B. Storrow, MD.)

FIGURE 11.97 ■ **Bilateral Calcaneal Fracture.** A fall from a ladder caused bilateral calcaneal fractures. Note swelling and ecchymosis. (Photo contributor: Lawrence B. Stack, MD.)

Clinical Summary

Patients complain of pain, swelling, decreased range of motion, and tenderness over the lateral aspect of the midfoot. Fractures of the fifth metatarsal base have been generically referred to as Jones fractures. However, acute fractures can be divided into two types, depending on their anatomic location. Treatment is determined by this delineation.

The classic Jones fracture is a transverse fracture of the fifth metatarsal at the metadiaphyseal-diaphyseal junction, just distal to the fourth and fifth intermetatarsal joint. It occurs when a force is applied to a plantar flexed and inverted foot.

This is not to be confused with an avulsion fracture of the fifth metatarsal base, resulting from sudden foot inversion. The avulsion injury is caused by traction on the lateral cord of the plantar fascia.

Management and Disposition

The patient with a Jones fracture should be discharged in a posterior splint and crutches and be non-weight bearing for 6 to 8 weeks. Surgical treatment is sometimes required since there is a risk of nonunion.

The avulsion fracture usually heals rapidly and seldom leads to permanent disability. This patient can be discharged in a hard-soled shoe or walking cast for 2 to 3 weeks and can bear weight as tolerated. A significantly displaced fracture may require operative intervention. Both types of patients should be referred to a musculoskeletal specialist as an outpatient.

Pearls

1. The original description of these fractures was by Sir Robert Jones, who personally sustained this injury while dancing. The avulsion fracture is sometimes referred to as a dancer's fracture.
2. The classic Jones fracture has a high incidence of delayed healing and nonunion.

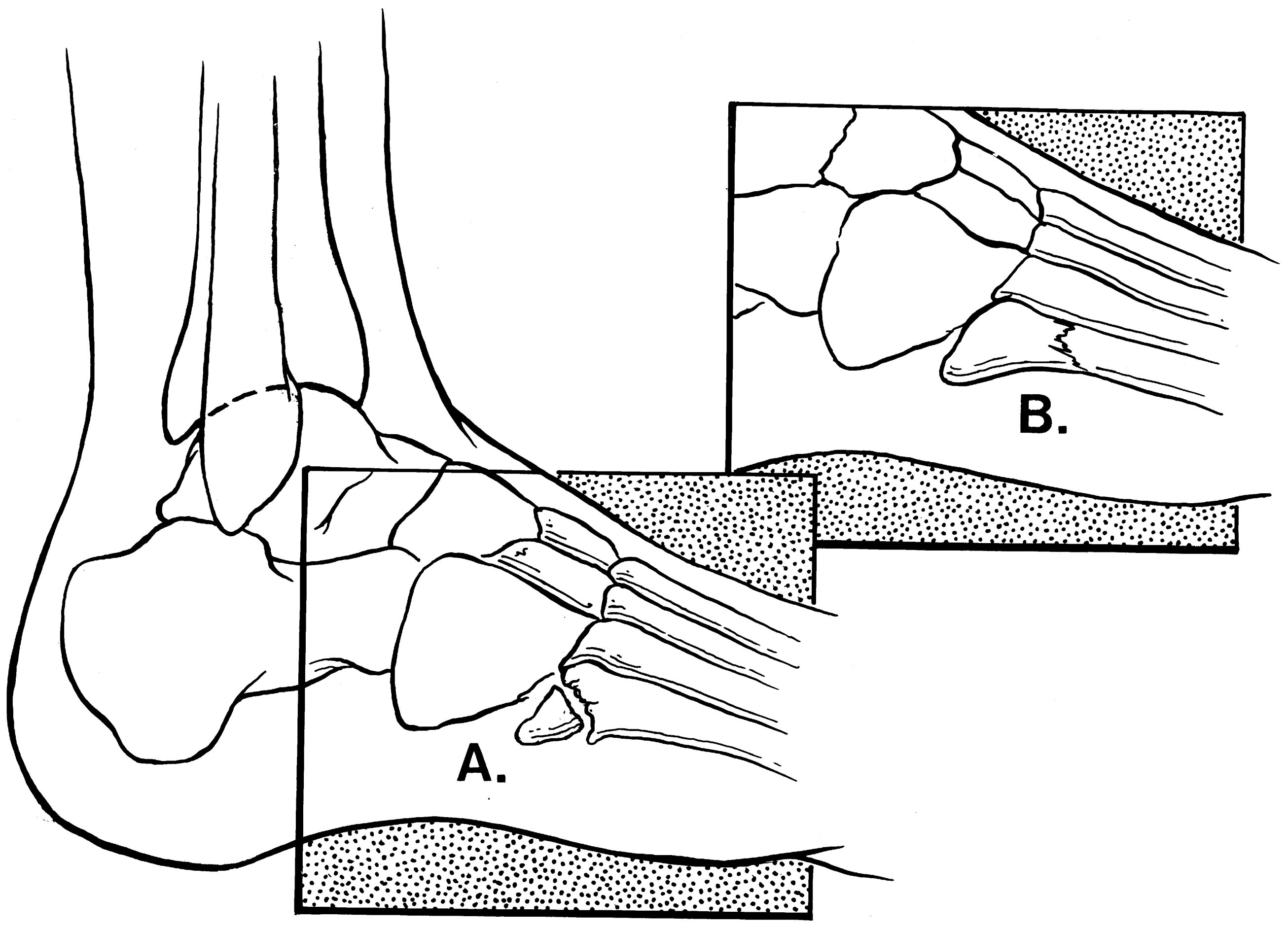

FIGURE 11.99 ■ **Fifth Metatarsal Base Fractures.** This illustration depicts an avulsion fracture (**A**) and a classic Jones fracture (**B**).

FIGURE 11.98 ■ **Jones Fracture.** This patient sustained an injury of the fifth metatarsal and presented with pain and swelling over this site. His radiograph revealed a fracture. (Photo contributor: Cathleen M. Vossler, MD.)

FIGURE 11.100 ■ **Jones Fracture.** Radiograph with typical appearance for a diaphyseal fracture of the fifth metatarsal base. (Photo contributor: Alan B. Storrow, MD.)

FIGURE 11.101 ■ **Fifth Metatarsal Avulsion Fracture.** Radiograph illustrating an avulsion-type fracture of the fifth metatarsal base. (Photo contributor: Alan B. Storrow, MD.)

Clinical Summary

The Lisfranc joint (tarsometatarsal joint) connects the midfoot and forefoot. It is defined by the articulation of the bases of the first three metatarsals with the cuneiforms and the fourth and fifth metatarsals with the cuboid. The Lisfranc ligament anchors the second metatarsal base to the medial cuneiform. Disruption of the Lisfranc joint is typically associated with high-energy mechanisms; however, they may occur with less force. Clinical presentation is variable, but severe midfoot pain and the inability to bear weight are usually present. Radiographs may reveal displacement of the metatarsals in one direction (homolateral) or a split, usually between the first and second metatarsals (divergent).

FIGURE 11.102 ■ **Lisfranc Fracture-Dislocation.** This patient presented with extreme midfoot pain and swelling. (Photo contributor: Lawrence B. Stack, MD.)

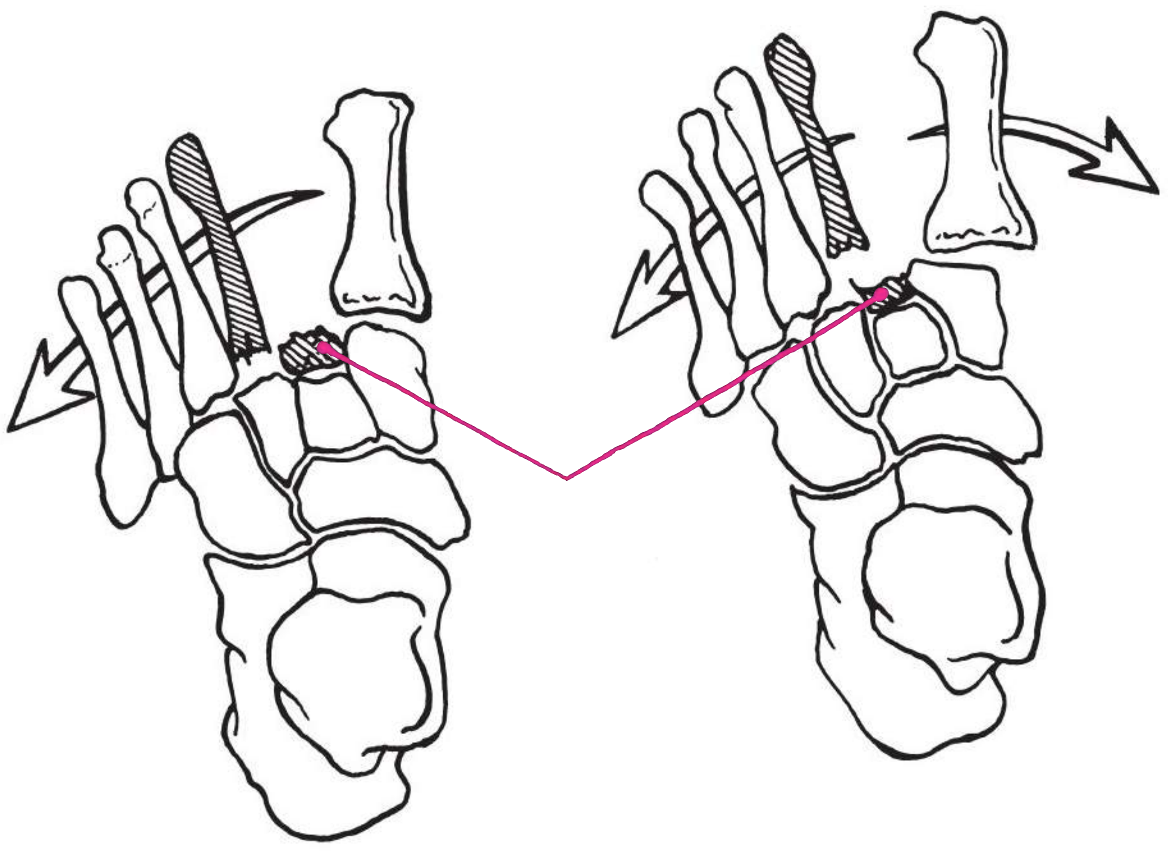

FIGURE 11.103 ■ **Lisfranc Fracture-Dislocations.** Two different types of Lisfranc fracture-dislocations. Homolateral (left) and divergent (right).

Management and Disposition

Meticulous evaluation of foot radiographs is the key to diagnosis. There are three radiographic findings that suggest a Lisfranc injury. Normally, the medial aspect of the second metatarsal should align with the medial borders of the middle cuneiform on the dorsoplantar (DP) foot x-ray. Second, on a DP and an oblique view, there should not be any widening between the first and second metatarsals. Third, on the oblique view of the foot, the medial aspect of the fourth

FIGURE 11.104 ■ **Homolateral Lisfranc Fracture-Dislocation.** (**A-C**) DP, oblique, and lateral views demonstrate the radiographic hallmark: lateral subluxation of the second metatarsal base in relationship to the middle cuneiform. The first and third metatarsal bases have also migrated laterally. (**C**) The lateral view demonstrates superior subluxation in relationship to the cuneiform bones. (Reproduced with permission of Block J, Jordanov MI, Stack LB, Thurman RJ. The Atlas of Emergency Radiology. McGraw-Hill; 2013.)

metatarsal should align with the medial aspect of the cuboid. A disruption of these relationships is suggestive of a Lisfranc injury and warrants orthopedic evaluation in the ED. Closed reduction can be attempted; however, due to significant ligamentous disruption, the injury is often unstable and necessitates operative stabilization. Tenderness over the Lisfranc complex with normal radiographs can reflect a strain of the complex. Weight-bearing radiographs may unmask joint instability, but is often not tolerated in the acute setting.

Pearls

1. Early recognition of Lisfranc fracture-dislocations is facilitated by assessing for normal bony alignments on x-ray.
2. Fractures of the second metatarsal base are considered pathognomonic of a Lisfranc injury since these fractures are often associated with Lisfranc ligament disruption.

FIGURE 11.105 ■ **Lisfranc Fracture-Dislocation.** A divergent Lisfranc fracture-dislocation. Note the disruption of the alignment of the second metatarsal and the medial cuneiform. Sometimes these injuries are not as apparent and comparison radiographs are necessary. (Photo contributor: Alan B. Storrow, MD.)

FIGURE 11.106 ■ **Lisfranc Fracture-Dislocation, weight-bearing view.** Weight-bearing DP view of both feet reveals a subtle malalignment of the right midfoot with subtle lateral subluxation of the second metatarsal base. The alignment was normal on the non–weight bearing view. Notice the normal alignment of the medial cortices of the second cuneiform and second metatarsal on the left. (Reproduced with permission of Block J, Jordanov MI, Stack LB, Thurman RJ. The Atlas of Emergency Radiology. McGraw-Hill; 2013.)

Clinical Summary

Major trauma may result in partial or complete removal of a limb. The high kinetic injury, crush, or avulsion forces required often cause extensive damage and heavy contamination. Other significant injuries to the thorax and abdominal cavities should be considered, and may be life-threatening.

Management and Disposition

Advanced trauma life support protocols should be rapidly initiated. The injury should be managed as an open fracture with appropriate antibiotics and tetanus prophylaxis. The amputated part should be kept clean, irrigated with sterile saline, wrapped in a sterile dressing, placed in a plastic bag, and put on ice. With the possible exception of minor digit amputations, patients should be admitted under trauma and orthopedic consultation for close monitoring of neurologic and vascular status.

While reimplantation is often not possible due to tissue loss and contamination, all patients should receive consideration. Young, healthy individuals with sharp, guillotine injuries without significant avulsion or crushing damage are the best candidates. Radiographs may help delineate the exact spot of injury and reveal associated dislocations or fractures.

Pearls

1. Cooling the amputated part will increase viability from approximately 6 to 8 hours to 12 to 24 hours.
2. Postreimplantation limb shortening may create significant disability. Proper use of postinjury prosthetics may be the better option.

FIGURE 11.107 ■ **Lower Extremity Amputation.** A below-the-knee amputation from a motorcycle accident. These injuries are often associated with significant, and potentially life-threatening, abdominal or thoracic trauma. (Photo contributor: Selim Suner, MD, MS.)

FIGURE 11.108 ■ **Lower Extremity Amputation.** Amputation from a motor vehicle accident. (Photo contributor: Selim Suner, MD, MS.)

FIGURE 11.109 ■ **Finger Amputation.** Digit avulsion and tendon rupture. (Photo contributor: Selim Suner, MD, MS.)

FIGURE 11.110 ■ **Table Saw Amputation.** The high kinetic injury of a table saw can produce significant avulsion forces and contamination. (Photo contributor: Selim Suner, MD, MS.)