INTRODUCTION

Remarks

The hand and wrist are remarkable, from an engineering perspective, in their design, versatility, and function. They facilitate our abilities as “tool users” from rudimentary levers, wheels, and wedges to complex musical and medical instruments. They are exploratory instruments in dark and/or confined spaces, and they are used as shields when we are physically threatened (Figures 1 to 3). It is important when evaluating the hand, wrist, and elbow to understand that the functional muscle structure in the hand is for delicate manipulation relative to the strength provided by the extrinsic muscles within.
Figure 1. A 75-year-old male tripped on sidewalk while walking and writing and fell onto his ballpoint pen creating a “stigmata”-type wound.

Figure 2. A 27-year-old male carpenter tested his pneumatic nail gun by holding two of the “safety grips” and trigger while pressing his hand against the other safety on the barrel resulting in an almost “functional position” nailing of his carpals to his radius.
OBJECTIVES

1. Recall the three standard elbow views, three standard wrist views, three standard hand views, two standard thumb views, and the phalanges view and their purposes.
2. Identify the normal and pathologic alignment of the standard views of the elbow, wrist, and hand.
3. Identify the normal and pathologic dimensions and densities of the elbow, wrist, and hand bones.
4. Identify normal and pathologic cartilage.
5. Identify the normal and pathologic presentation of soft tissue.
6. Identify film abnormalities, given a history and x-ray film.
7. Use x-ray film information to adjust a physical therapy treatment program.

the forearm that power the distal joints of the digits. There are no intrinsic muscles of the fingers beyond the metacarpal phalangeal joints (MCPs) or within the carpals. The phalanges are moved into extension and flexion by a dorsal hood mechanism and volar flexor forearm muscles via pulley mechanisms respectively.

The elbow is the link between the shoulder and the carpals. It allows flexion and extension and supination and pronation via an articulation, or hinge, between the distal humerus and the ulna and supination and pronation via the radial head and the capitellum.

Another useful construct is to view the carpals as a proximal row made up, from radial to ulnar, of the scaphoid, lunate, and triquetrum and a distal row made up of the trapezium (the trapeze that the thumb swings on), trapezoid, capitate, and hamate. The pisiform is largely regarded as a sesamoid bone within the flexor carpi ulnaris tendon. The integrity of the wrist is maintained by the extensive investment of the carpal ligaments. Stretching and/or damaging these ligaments results in the malalignment of the carpal bones. The bones depend upon the support of the ligaments and the other carpals for their stability. For example, the capitate alone articulates and is supported by at least eight other bones. If this support is compromised by a damaged ligament or bone, as when a scaphoid is fractured and collapses or the scapholunate ligament is torn or stretched, the delicate balance that is the wrist will shift, and multiple malalignments will ensue.
STANDARD VIEWS

Hand
The hand is evaluated with a posteroanterior (PA), a lateral, and an oblique view (Figures 4 to 6).

Figure 4. ■ An anterior to posterior view of a normal hand and wrist.

Figure 5. ■ An oblique view of a normal hand and wrist.

Figure 6. ■ A lateral view of a normal hand and wrist.
Wrist
The standard views of the wrist are a PA, lateral, and a semipronated oblique. X-ray examination of the wrist is the most important tool for diagnosis of fractures and dislocations of the wrist and the PA and lateral views provide the most useful view. The semipronated oblique allows the evaluation of the scaphoid and the distal radius. The dynamic nature of the carpal bones that accompanies movements in the wrist and hand requires multiple other views to emphasize and evaluate the slight changes that occur in the alignment of the carpals. Special views may include radial and ulnar deviation, which is helpful to visualize the carpals and specifically the scaphoid when in ulnar deviation, semisupinated oblique, dorsal and palmar flexion, scaphoid, and carpal tunnel views.

Digits
The standard views of the fingers are the lateral, PA and oblique views. (Figures 7 to 9).

Elbow
The standard views of the elbow are the anteroposterior (AP) with the hand supinated, the lateral with the hand positioned laterally, and the oblique with the hand pronated. A special view to include the olecranon, the flexion view, is taken with the elbow fully flexed, and the beam enters the distal forearm and progresses through the distal humerus and radial head views, taken in supination and pronation to allow assessment of the radial head (Figures 10 to 12).

Figure 7. A lateral view of a normal digit.
Figure 8. A PA view of a normal hand and wrist and lateral view of a normal thumb.

Figure 9. An oblique view of a normal first digit.

Figure 10. An oblique view of a normal elbow.
EVALUATION OF THE ELBOW, WRIST, AND HAND USING ABCS

Elbow AP

Alignment

Normal alignment. It is best to begin the evaluation by carefully identifying the following structures on the AP view from proximal to distal: the olecranon fossa, the medial humeral epicondyle, the lateral humeral epicondyles, the olecranon, trochlea, capitellum, coronoid process, and the radial head (Figure 13). The AP, lateral, and oblique views mentioned earlier must demonstrate that the radial head is aligned with, but not in contact with, the capitellum. The
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Olecranon should be centered on the olecranon fossa in the AP view. The "carrying angle," a valgus angle demonstrated by a line drawn down the center of the humerus that intersects a line drawn up through the center of the ulna, should be about 15 degrees.\(^5\)

Abnormal. Any evidence of a malalignment between the olecranon and its fossa, particularly in the lateral view, must be carefully evaluated. In one case, an individual sought help from an orthopedic surgeon after months of suffering with a dislocated elbow that had been "reduced" by a chiropractor.\(^6\) Children are particularly prone to dislocations of the elbow as a result of their activities and immature bone structure (Figures 14 to 16).

Figures 17 and 18 are lateral and oblique views of a young man with a dislocated elbow.

**Bone Density and Dimension**

Normal. The radial head should be carefully evaluated for any evidence of bone chips or fractures. The medial and lateral epicondyles of the distal humerus must be evaluated for any lucencies or breaks in the margins (Figure 19).

Abnormal. Radial head fractures can be difficult to recognize, particularly if they are nondisplaced. If there is evidence of swelling or occult bleeding (see "sail sign" under "Soft Tissue" later), the patient may need a CT or an MRI to definitively diagnose the injury. There are three types of radial head...
Figure 14. ■ An AP view of a dislocated left elbow in a 10-year-old male.

Figure 15. ■ A lateral view of a dislocated left elbow in a 10-year-old male.

Figure 16. ■ A lateral view of reduced dislocated elbow in a 10-year-old male who was wrestling with his older brother and sustained a dislocated left elbow.
Figure 17. Note the “markedly increased angle between the ulna and the humerus at the olecranon and the displacement of the radial head relative to the capitellum.”

Figure 18. A lateral view of the dislocated elbow seen in Figure 117.
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fractures: type I are nondisplaced, type II fractures are displaced, and type III are comminuted.\textsuperscript{7,8}

**Cartilage**

*Normal.* Cartilage is usually evaluated in the elbow with an MRI. Osteochondritis dissecans can be diagnosed with MRI or CT.

*Abnormal.* Damage to the cartilage in the elbow can be from trauma, infection, systemic disease, as in rheumatoid arthritis, trauma, or heavy repetitive use. It is diagnosed with clinical examination, arthrography and CT.\textsuperscript{9}

**Soft Tissue**

*Normal.* The lateral view demonstrates soft tissue anterior and posterior to the distal humerus that is consistent and without decreased density.

*Abnormal.* If there is an occult fracture of the radial head or epicondyle(s), the soft tissue and/or fat pad is elevated from the periosteum by the bleeding and is identified as an area of decreased density, usually anterior to the distal humerus. This was thought to resemble a sail on a boat. This is evidence of bleeding or swelling and is known as a “sail sign” or “fat pad sign” and at a minimum requires further work-up to rule out a fracture.\textsuperscript{10} (Figure 20)

**Elbow Lateral**

**Alignment**

*Normal.* The lateral view is taken with the arm abducted and the hand in neutral rotation. The structures to be identified are the overlapping trochlea and the capitellum and the overlapping radial head and the coronoid process

*Figure 19.* Lateral and AP views of the elbow reveal a supracondylar fracture in this skeletally immature individual.
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Figure 20. On this lateral view, the “sail sign” is more evident posteriorly than anteriorly, but both are visible with close inspection.

A line drawn down the center of the humeral shaft should intersect a line drawn through the center of the shaft of the radius at approximately 90 degrees.

Abnormal. As noted earlier, the lateral view is the most sensitive to dislocations and/or subluxations. In children a line drawn down the anterior shaft of the humerus will intersect the capitellum (a separate center of ossification in children). A line drawn along the shaft of the radius will intersect the line from the humerus in the capitellum. A variation in this intersection, as is found on Figure 23, indicates a potential fracture in the supracondylar region of the humerus or dislocation of the elbow joint. (Figures 22 and 23).

Bone Density and Dimension
The elbow is evaluated for changes in the bone density with particular attention paid to the radial head. When evaluating a patient for a fracture of the ulna, always look for an accompanying dislocation of the radial head known as a “Monteggia’s fracture-dislocation.” This radial head displacement may be subtle and requires careful evaluation (Figures 24 to 26).

Cartilage
Normal. The joint space is well maintained, and the articular surfaces are smooth and without osteophytes or decreased densities.

Abnormal. The joint spaces are markedly decreased or absent, there may be osteophytosis and, if severe, angulation of the joint from chronic erosion of the joint accompanied by increased bone density around the articular surfaces (Figures 27 and 28).

Soft Tissue
Normal. The soft tissue is carefully evaluated along the metaphysis of the bone for changes in density (Figure 29).
Figure 21. ■ x-ray, lateral view, normal

Figure 22. ■ Clearly the olecranon is posterior to the humeral olecranon fossa.
Figure 23. Dislocation of elbow and fracture of radial head. A. Posterior dislocation of elbow with suggestion of osteochondral fragment from radial head fracture. B. Oblique radiograph shows loose fragments of radial head entrapped within joint. C and D. After open reduction and excision of loose fragment. Obvious ossification around both collateral ligaments and callus in area of radial head and neck are seen in C. (From Canale ST, Beaty JH: Campbell’s Operative Orthopedics, 11e, St. Louis, Mosby, 2007.)

Figure 24. A lateral view of a child’s elbow with a Monteggia’s fracture-dislocation of the ulna and radial head.
Figure 25. ■ Radial head fracture on lateral view; note arrow.

Figure 26. ■ Olecranon fracture on lateral view.

Figure 27. ■ AP and oblique views of an elbow with severe osteoarthritic changes.

Figure 28. ■ A lateral view of the same individual’s elbow as seen in Figure 27.
Abnormal. Changes in density may indicate elevation of the fat pad or the periosteal soft tissue by bleeding or swelling from an occult, non-displaced fracture of the joint or the radial head. It can appear more pronounced just proximal to the joint and less so more proximally along the diaphysis of the humerus. This is referred to as the “sail sign” or “fat pad sign” (Figure 30).

Wrist PA

Alignment

Normal. Begin the initial evaluation by identifying the bones of the wrist and their relative positions to one another based upon the type of view that is evaluated. For purposes of evaluation the wrist is comprised of the distal radius and ulna, the proximal row of carpals, the distal row of carpals and the proximal metacarpals. The carpals articulate with the distal radius, the other carpals and, distally the base of the metacarpals. The dorsal and volar surfaces serve as attachment sites for the carpal ligaments that are critical for maintaining the delicate articular relationships of the bones of the wrist. For normal views of the wrist, see Figures 4, 5, and 6.

Abnormal

1. Colles’ fracture (Figure 31) and Smith’s fracture (Figure 32) are common examples of fractures of the wrist.
2. Carpal instabilities

Scapholunate dissociation (See Figure 34): This is the most common form of
carpal instability and is the result of damage or tearing of the scapholunate ligament. The damage is diagnosed on the AP film by measuring the distance between the lunate and the proximal scaphoid. If this distance is 3 mm or more, it is considered diagnostic of scapholunate dissociation. This increased gap is also known as a “Terry Thomas” sign after the British comedian who had a significant gap between his two front teeth, hence the name. Untreated, this can progress to scaphoid erosion into the distal radius, creating a painful wrist or further carpal damage (Figures 33 and 34). If there is an old fracture of the scaphoid that has collapsed or a long-standing
Figure 32. A lateral view of the wrist demonstrating a fracture of the distal radius with volar angulation, which is a Smith's fracture.

Figure 33. A positive “Terry Thomas” sign and radial erosion.
scapholunate dissociation, the scaphoid may rotate progressively into flexion and be viewed on an AP view as “on end” or along the long axis of the scaphoid. This presents itself as a scaphoid ring sign also called a “signet ring” sign. This is because when viewing the scaphoid along its axis on an AP view after the scaphoid has rotated or displaced, the “ring” is the long axis view of the cortical margins of the bone.\(^\text{14}\) (If a piece of PVC pipe were x-rayed on an AP view, the margins would be more dense the way a tibia, femur, or humerus appears; however, if these same bones are rotated to x-ray them along their long axis [an axial view], they appear circular. This same concept applies to the unstable, rotated scaphoid.)

3. Scapholunate advanced collapse (SLAC)

This is the result of a long-standing carpal instability; there is degeneration in the scaphoradial joint, and eventually the capitate subluxes onto the lunate dorsally (Figures 35 to 40).

Bone Density and Dimension

*Normal.* Normal bone should be uniform for the view that is evaluated. The hook of the hamate, for example, will appear as an increased density over the body of the bone, and the shape of the hook will be determined by the view that is evaluated.

*Abnormal.* Bones of the wrist (carpals) and hand should be carefully evaluated after trauma for the most common fractures, specifically fractures of the scaphoid, the most commonly fractured bone of the wrist. Commonly injured by a fall on an outstretched hand, it may be difficult to visualize on
Figure 35. ■ Note on zoom-in-view the cystic formation of the distal radius indicative of advanced OA and the “whitening” of the bone, also called “eburnation,” at the scaphoid distal radial joint. The eburnation is a result of “bone-on-bone” articulation indicating that all of the hyaline cartilage has been destroyed. Oblique view of the wrist showing cystic formation at the radial scaphoid joint.

Figure 37. ■ An AP view of the wrist showing an old scaphoid fracture with collapse of the scaphoid.

Figure 36. ■ An AP view of the wrist showing cystic formation at the radial scaphoid joint.

Figure 38. ■ An oblique view of the wrist showing an old scaphoid fracture with collapse of the scaphoid in the same individual seen in Figure 10-37.
plain films for the first few weeks. Any patient having sustained a fall onto an outstretched hand with tenderness and swelling in the anatomic snuff box is clinically presumed to have a fractured scaphoid until proven otherwise. If not properly treated early, this fracture has a relatively high rate of nonunion or delayed union. A bone scan or CT can be extremely helpful when in doubt and a decision is required for immediate purposes (e.g., can a soldier be scheduled for deployment to accompany his unit overseas, or can an athlete compete in the “big game” or track meet?) A bone scan will be positive within 24 to 48 hours, and a CT or MRI, although considerably more expensive than a bone scan, may also provide immediate confirmation (Figures 41 to 44).

**Cartilage**

*Normal.* The joint space will be equal between the carpals with no evidence of bone-on-bone erosion.

*Abnormal.* As a result of a fracture or carpal instability, there may be a malalignment of one or more of the carpals, and if the problem is of long-standing duration, there may be erosion and whitening, or eburnation, of the bones where they are in contact (Figures 45 to 47).

**Soft Tissue**

*Normal.* Between the distal ulna, the distal radius, and the proximal triquetrum is a fibrocartilaginous “articular disc” that is not visible on plain films and must be evaluated by MRI or injection with a dye before imaging.
**Figure 41.** An obvious fracture and displacement of the scaphoid in a skeletally immature individual.

**Figure 42.** The same individual as Figure 41, 5 weeks later after immobilization. Fracture demonstrates acceptable healing for this date after injury.
Figure 43. Oblique view of a fracture of the hamate bone. Note: The fracture is very subtle and requires magnification of this film to demonstrate fracture.

Figure 44. Three views, P/A, Oblique and lateral of the wrist demonstrating DJD of the Capitate demonstrating carpal collapse and cystic formation.
Figure 45. MRI, T2, of the proximal row of the carpals.

Figure 46. MRI, T2, of the carpals.
Wrist Lateral

Alignment

Normal. (See Figure 44 right) The lateral view demonstrates the alignment of, proximal to distal, the distal radius, the lunate, the capitate and the metacarpal of the third (long) finger. All of these bones should fall in the longitudinal line drawn through the center of the third finger. 15

Displacement of the lunate dorsally or volarly with rotation is indicative of scapholunate dissociations/instability as a result of previous carpal damage and/or ligamentous damage.

On the normal lateral view, a line drawn proximal to distal through the center of the radius and the third metacarpal should intersect the centers of the lunate and the capitate. The distal radius is normally angled toward the ulna at an angle of 15 to 25 degrees and has a palmar angulation of about the same angle. The distal radius articulates with the scaphoid and the lunate carpal bones and has concavities that reflect these articular surfaces, but they are not visible on the plain films. In scapholunate dissociation, the lateral view may be evaluated by drawing the following lines: (1) a line through the middle of the long axis of the scaphoid and (2) a line perpendicular to the long axis at the midpoint of the lunate. The angle that is formed proximally by the intersection of these two lines is measured and should be 30 to 60 degrees. An increase in this angle of greater than 20 degrees indicates increased scaphoid flexion and/or lunate extension or both and suggests carpal instability. 16
Abnormal. (Note: The examples that follow have lateral and PA views together to allow better visualization of the structures.)

**Bone Density and Dimension**

**Normal.** The carpal and metacarpal bones will overlap on the lateral view, and the alignment as discussed previously is critical. The bones should be identified and the margins carefully traced for lucencies and changes in density that may indicate early avascular necrosis of a fractured scaphoid or lunate (Kienböck’s disease, Figure 48). Kienböck’s disease, or avascular necrosis of the lunate carpal, is identified by a progressive increasing density on plain films of the lunate, when compared with the healthy bones adjacent to the lunate. Eventually the bone may undergo cystic degeneration and eventual collapse accompanied by gradual collapse of the proximal row of the carpals.  

**Abnormal.** A fracture at the junction of the diaphysis and the metaphysis in the forearm is referred to as a ‘buckle’ or torus fracture (See Figure 51). The lateral view will demonstrate the dorsal (Colles’) or volar/palmar, angulation...

*Figure 48.* A and B are dorsovolar and lateral views of the wrist demonstrating an increased density of the lunate bone. This increased density seen on x-rays is often the earliest evidence of this avascular necrosis of the lunate; ultimately the lunate will necrose and collapse resulting in destabilization of the proximal carpal row. If the wrist is painful further imaging is a mandate to search for a fracture of the lunate and bone scan and MRI should confirm the finding of Kienböck's disease. *(From Grainger & Allison’s Diagnostic Radiology, 5e, Churchill Livingstone, 2008.)*
(Smith’s) of fractures of the distal radius (Figures 49 and 50). A fracture of the metaphysis of the distal radius may compress, collapse, or telescope and appear on the AP as angulated radially or ulnarly and on the lateral view as angled in a dorsal or palmar direction. If the diagnosis is in question, comparison views of the opposite distal radius are extremely helpful (Figures 51 to 53).

Cartilage and soft tissue are not evaluated on the lateral projection of the wrist.

**Wrist Oblique**

The oblique view of the wrist will sometimes demonstrate a better view of the hand and wrist, exposing fractures, malalignments, and instabilities not seen on the AP and lateral views. There are multiple oblique views accompanying the series shown previously (see Figures 51 and 53).

ABC review for the wrist oblique view is not necessary.

**Hand and Distal Radial Fractures and Metacarpal Injuries PA, Lateral, and Oblique**

The standard views of the hand are: PA, oblique, and lateral.

**Alignment**

*Normal.* The P/A view demonstrates an ulna and radius that align distally. This alignment constitutes a “neutral ulnar variance.” The distal radius should not contact any of the carpals but its palmar angulation and concavities for

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*Figure 49.* Three views, laterol, oblique and P/A of the wrist demonstrating a fracture of the distal radius.
Figure 50. Lateral view of a casted distal radial fracture.

Figure 51. Oblique view, 5-year-old male, buckle fracture of radius.

Figure 52. A/P view, 5-year-old male, buckle fx.

Figure 53. Lateral view, 5-year-old male, buckle fx. Note the dorsal angulation of the distal radial component.
articulation with the scaphoid and lunate give the appearance on this view of a slight overlap. The distal radius is normally angled toward the ulna at an angle of 15 to 25 degrees and has a palmar angulation of about the same angle. The distal radius articulates with the scaphoid and the lunate carpal bones and has concavities that reflect these articular surfaces, but the concavities are not visible on the plain films.

**Abnormal.** If the ulna does not project far enough distally to align with the radius, that is a “negative ulnar variance,” and if the ulna projects distally past the ulnar margin of the radius, it is a “positive ulnar variance.”

The Colles’ fracture, the most common fracture of the distal radius, is a dorsal angulation and displacement with radial angulation of the distal fragment of a fracture of the distal radius. A Smith’s fracture is a palmar/volar, angulation of the distal radial fragment when the distal radius is fractured. These fractures are best assessed on the lateral view, but the PA and oblique views may demonstrate impaction of the distal fragment into the radius (a bayonet-shaped deformity) and radial or ulnar displacement resulting in shortening of the radius. The lateral view will demonstrate the dorsal (Colles’) or volar/palmar angulation (Smith’s) of any fractures of the distal radius (Figures 54 and 55).

**Bone Density and Dimension**

**Normal.** The metacarpal bones of the hand should be without a malalignment or evidence of decreased density that may represent a fracture. These bones should, except for length, be similar in shape, and the adjacent bones may sometimes be used for comparison. If a fracture is identified or suspected, additional PA, lateral, and oblique views may be necessary to define the extent and comminution components of the fracture or tumor.

**Abnormal.** The distal radius is the most commonly fractured bone of the distal arm (Figures 56 to 85).

**Cartilage**

Normal and abnormal evaluation of the cartilage is as covered previously in this chapter (Figures 86 to 88).

**Phalanges PA and Lateral**

**Alignment**

**Normal.** The PA view of the fingers should demonstrate the joint spaces of the interphalangeal joints (IPs) that are equally well maintained and aligned along a line drawn through the middle of the bones along their long axis. The lateral view provides the opportunity to isolate the lateral projection of one or more of the phalanges through positioning of the hand. The digit of interest is flexed sufficiently to bring it out of alignment with the other digits.

**Abnormal.** Fractures are normally the result of trauma. Remember that the phalanges are small bones on the ends of our hands with little or no soft tissue protection. They can be cut, crushed, twisted, hammered, etc. Examine Figures 89 to 93 and look for evidence of bony injury.

*Rheumatoid arthritis* destroys connective tissue. As joints are destroyed, they are prone to a malalignment with erosion of the joint spaces, ulnar drift of the
Figure 54. ■ Lateral view, acute distal, comminuted radius fracture with dorsal angulation (Colles’ fracture).

Figure 55. ■ Lateral view, acute distal, radial fx, comminuted with dorsal displacement (Colles’ fracture).

Figure 56. ■ P/A view of a Salter-Harris II fracture of the distal radius. Note: The fracture is not visualized on this view.

Figure 57. ■ Lateral view of a Salter-Harris II fracture of the distal radius. This view demonstrates that the fragment is buckled and displaced dorsally.
Figure 58. P/A view of a ‘greenstick fracture’ of the radius in a 5-year-old.

Figure 59. Note that a greenstick fracture occurs in skeletally immature individuals when the bone is soft enough or not mineralized enough to allow one side, in this case the dorsal side, to buckle but the palmer-ventral side gives enough to prevent breaking, hence the name a “greenstick” fracture.

Figure 60. P/A view of a Colles fracture in a child. Note the fracture line proximal to the distal growth plate.
Figure 61. Oblique view of a Colles fracture in a child.

Figure 62. Lateral view of a Colles fracture in a child. Note the dorsal angulation of the distal fracture fragment.

Figure 63. P/A and oblique views of a comminuted fracture of the distal radius in a cast.
Figure 64. This view shows the intraarticular component on one view only, the oblique view.

Figure 65. P/A view, of an acute distal radial fracture with dorsal angulation.

Figure 66. Oblique view of an acute, intraarticular, distal radial fracture.
Note that the comminution is not as readily apparent on the P/A view as on the oblique view, which demonstrates the intraarticular component of this fracture and the ulnar styloid fracture, and the lateral view demonstrates the dorsal angulation of this fracture. All three views are important.

Figure 67. ■ P/A view of a comminuted intraarticular distal radial fracture.

Figure 68. ■ P/A view of a comminuted intraarticular distal radial fracture.
Figure 69. Oblique view of comminuted, intraarticular fracture of the distal radius. Dorsal angulation is visible on this view. Demonstrates comminution and shortening of the radius and overlap of the distal fragments with proximal component of distal radius.

Figure 70. Lateral view of a comminuted, intraarticular fracture of the distal radius. Dorsal angulation of the distal fragment is clear on this view.

Figure 71. Three view, P/A, Oblique, and lateral of a comminuted, intraarticular, distal radial fracture with dorsal angulation.
**Figure 72.** Note shortening of radius accompanying this Colles’ fracture.

**Figure 73.** Oblique view of a fracture of the distal radius and ulna with shortening.

**Figure 74.** Oblique view of a Buckle fracture in a child of the distal radius and ulna. Note the angulation and radial “bump” at the fracture site.
A 23-year-old male with a fracture of the first metacarpal shaft proximally was casted and sent home and scheduled for followup. He returned 1 month later and had been noncompliant with hand protection. Follow-up x-ray (October 1999) demonstrated marked increase in angulation of fracture and showed no healing callus around fracture.

Follow-up x-ray from Figure 75 demonstrated marked increase in angulation of fracture and showed no healing callus around fracture.
Figure 77. ■ Fracture of the base of the shaft of the fifth metacarpal, sometimes referred to as a “karate chop” fracture.

Figure 78. ■ “Boxer’s fracture” of the distal fifth metacarpal shaft, also known as a “Dear John” fracture. These occur when the fisted hand forcefully strikes a firm, relatively unyielding surface, such as a wall, door, or a facial bone(s). The fracture may occur on the other metacarpals, but the fifth metacarpal is most often involved. This x-ray, although of poor quality, demonstrates rotation of the distal fragment.
Figure 79. ■ Oblique view of an intraarticular fracture of the third proximal phalanx. This was done to an adult who was playing a game where the two opponents attempt to slide their hands out from under their opponents and make a fist and crack the opponent on the knuckles before the opponent can move his hands. If they miss completely, their opponent becomes the one who attempts to strike them.

Figure 80. ■ P/A view of a fracture of the fourth proximal phalanx by an individual playing a game called ‘Mercy’ where one participant strikes the hand of another with fi sted knuckles until they ask for “Mercy”.

Figure 81. ■ Oblique view of the same injury as Figure 80.
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**Figure 82.** Lateral view of the same injury as in Figure 80. The fracture, although easily seen on the AP and the oblique, is very difficult to see on the lateral.

**Figure 83.** P/A view of a partial amputation of the distal phalanx of the third finger.

**Figure 84.** Oblique view of a partial amputation of the distal phalanx of the third finger.

**Figure 85.** Lateral view of a partial amputation of the distal phalanx of the third finger.
Figure 86. P/A view of a hand with severe degenerative joint disease (DJD).

Figure 87. Oblique view of the wrist trapezium absent.

Figure 88. The straight edge on the proximal first metacarpal (thumb) appears to be a result of surgical intervention and may explain the absence of the trapezium. Also included in the differential would be an osteolytic lesion, but unlikely a result of the straight edge on the first metacarpal base.
Figure 89. ■ Lateral view of a fracture at the volar base of the middle phalanx. Requires ‘Zoom’ function to see adequately.

Figure 90. ■ Three views: P/A, lateral and oblique. ‘Mallet’ Fracture, intraarticular, at the base of the index finger DIP.
Figure 91. ■ P/A view of a fracture of the proximal fifth phalanx.

Figure 92. ■ P/A view of a fracture of the proximal phalanx of the middle (third or long) finger.

Figure 93. ■ P/A view demonstrating a comminuted fracture of the first phalanx on the fifth/small finger.
metacarpals over time, and ultimately, dislocation of multiple joints of the wrist, metacarpals, and digits.

Figures 94 to 98 depict damage caused by rheumatoid arthritis.

Osteoarthritis is a disease of the larger joints: hips, knees, shoulders, and spine with one exception, the distal phalangeal and proximal interphalangeal joints (PIP's) of the hands. These bumps, known as Heberden’s nodes and/or Bouchard’s nodes, respectively, develop as calcific spurs as the disease progresses (Figure 99).

Bone Density and Dimension

Normal. The individual joints must be carefully evaluated for changes in density that may indicate an occult fracture. Each view must be evaluated and compared with the other PIP's, IP's, and distal interphalangeal joints (DIPs).

Abnormal. Fractures and fracture dislocations, particularly those dislocations and fractures that self-reduce, require carefully studied analysis (Figures 10-100 to 10-109).

Cartilage

Normal. Joint spaces are well maintained.

Abnormal

Soft Tissue

Abnormal. The soft tissue around the metacarpals and phalanges should be equal and demonstrate no evidence of swelling compared with the others on the hand (Figures 110 to 114).

Figure 94. P/A view of severe collapse of the wrist and destruction of the MP joints and the IP joint of the thumb in a patient with rheumatoid arthritis.
Figure 95. Bilateral P/A views of hands with rheumatoid arthritis.

Figure 96. Bilateral P/A views of hands with rheumatoid arthritis.
Figure 97. Oblique view of subluxation of MP joint of the thumb, erosion and collapse of the carpals and MP joints from rheumatoid arthritis.

Figure 98. P/A view of destruction of the joints in rheumatoid arthritis.
Heberden’s notes at the base of the distal phalanges dorsally. Indicative of osteoarthritis. (From Noble J: Textbook of primary care medicine, ed 3, St. Louis, Mosby, 2001.)
Figure 100. Magnified view of fracture of the distal phalanx and intraarticular fracture of the DIP joint in a 28-year-old female softball player who was struck on the end of her small finger by a batted ball.

Figure 101. Two views of the finger seen in Figure 100 isolating views of the two fractures.

Figure 102. Fluoroscopic view of operative pinning of distal fracture and screws to reduce the intraarticular DIP fracture. In young patients, the distal fingers may be crushed or struck directly along the long axis of the bone(s).
Figure 103. Salter-Harris fracture of the distal phalanx and a crush injury.

Figure 104. A 15-year-old male athlete with a Salter-Harris Type I injury to the distal phalanx in football.

Figure 105. P/A view demonstrating a fracture of the long finger/third digit distal phalanx. Note the soft tissue damage at this location.
Figure 106. P/A view of a Salter-Harris II fracture at the base of the proximal phalanx of the fifth/small finger in a 13-year-old male athlete.

Figure 107. P/A view of a fracture of the shaft of the proximal phalanx on the middle/third/long finger.

Figure 108. Lateral view of a transverse fracture of the proximal phalanx of the third/middle/long finger. Angulation of the fracture is dorsally to 100 degrees.
Figure 109. Oblique view of a transverse fracture of the proximal phalanx of the third/middle finger.

Figure 110. P/A view of right hand.

Figure 111. Lateral view of man vs. table saw.
Figure 112. ■ Oblique view of man vs. table saw.

Figure 113. ■ P/A view of man vs. table saw.

Figure 114. ■ Three views of a ‘Boutonnière Deformity’. This represents a soft tissue lesion that occurs when the extensor hood mechanism ruptures and subluxes volarly resulting in inability to extend the joint and hyperextension of the distal DIP joint.
The Elbow, Wrist, and Hand

Thumb AP and Lateral

Alignment

Normal. The thumb is similar to the other digits, but lacks the middle phalanx. It is the most radial of the fingers and articulates with the trapezium carpal. The thumb is the most mobile of the fingers and can assume the position of opposition to the other metacarpals and digits.

Bone Density and Dimension

Abnormal (Figures 115 and 116)

Cartilage

Normal. Joint spaces are well maintained.

Abnormal. The absence of joint space between the base of the thumb and the trapezium bone or increased density, or whitening, of the “bone-on-bone” surfaces are abnormal signs. In rheumatoid arthritis, there is a generalized destruction of the connective tissue and cartilage and demineralization of the bones resulting in unstable joints, joint subluxations and/or dislocations, and erosion of the bones around the joints. In the hand and wrist, it tends to be a disease of the carpals, metacarpals, and PIPs (see Figure 96).

Soft Tissue

Normal. No evidence of soft tissue swelling or trauma is visible.

Abnormal. The thumb is sensitive to subluxations at all joints, particularly the metacarpophalangeal joint. The ligament damaged most often is the medial (ulnar) side of the metacarpophalangeal joint as a result of tearing of the collateral ligament or avulsion on the insertion of this ligament and is commonly referred to as the “game keeper’s thumb.” This is verified by a clinical examination that demonstrates inordinate opening at the medial (ulnar) joint when compared with the noninvolved side and on stress views. A “miniarthrogram” (injection of dye) may be used to confirm suspected intraarticular imposition of the torn ligament or avulsed fragment into the joint, which would preclude normal healing (Figure 116).

Figure 115. A Bennett’s fracture is a fracture at the base of the thumb, and the pull of the abductor pollicis longus tendon will displace the portion of the fracture that it is attached to proximally.
Figure 116. ■ Gamekeeper’s thumb that reflects a damaged ulnar collateral ligament at the first metacarpophalangeal joint. In an acute injury, as occurs in skiing and falling with the thumb against the ski pole, an avulsion fracture occurs at the base of the first metacarpal. (From Adam A: Grainger & Allison’s Diagnostic Radiology, ed 5, Churchill Livingstone, 2008.)

CASE STUDY A

A/P, Lateral, and oblique views of the wrist on the same set
There are plain films and a contrast film with the same three views shown. A patient fell onto her right arm and hand. Please identify the age within 20 years, and any fractures(s) you identify with and any accompanying angulations. Figure 117 and 118.
CASE STUDY B

A/P, Lateral and Oblique Views of the Wrist
Patient fell onto wrist. Please estimate within 10 years of the age of the patient and any fracture(s) identified by location, angulation, etc. Figures 119, 120 and 121.
CASE STUDY C
A 4-year-old male fell onto his right elbow. Two views, AP and lateral and contrasting views of the left (uninvolved) elbow. Figures 122, 123, 124 and 125.
Figure 125
REFERENCES