Hand, Elbow & Shoulder: Core Knowledge in Orthopaedics

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Core Knowledge in Upper Extremity Orthopaedics

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Description:
This course is in written format. This is a mixed level learning course teaching the clinician an abundance of upper facts and information. This book reviews anatomy, evaluation, surgical indications and therapeutic intervention for hundreds of upper extremity conditions. You will use this reference for years to come, as it is a 2006 release. This is a book you won’t want to miss and why not earn 36 CEU’s for reading this delightful book? This course is priced right making it a fantastic way to earn CEU’s for less. This course is used with permission from MOSBY/Elsevier Publishing.

Objectives:

- Review anatomical features of the hand
- Review nerve innervation of the hand
- Introduction to phalangeal fracture medical and therapeutic management
- Review metacarpal fracture medical and therapeutic management
- Learn about thumb fracture medical and therapeutic management
- Understand types of thumb reconstruction options after amputation
- Review distal radius fracture anatomical consideration
- Review surgical approaches to treating distal radius fractures
- Review post injury care of distal radius fractures
- Review the anatomy of the TFCC and the distal radial ulnar joint
- Learn about TFCC medical and therapeutic intervention techniques
- Understand scaphoid fracture medical and therapeutic management
- Identify the various carpal bones and care for each of them
- Learn how to assess carpal instabilities and dislocations
- Recognize Kienboc’s disease and treatment interventions
- Identify flexor tendon intervention techniques and challenges
- Review extensor tendon repairs and reconstruction techniques
- Introduction to tenosynovitis and various management techniques
- Understand peripheral nerve physiology in its normal, injured and regenerative phases
- Understand the basic principles in treatment of nerve injuries
- Review pathophysiology of nerve compressions
- Learn about various interventions for nerve compressions
- Identify CRPS risk factors, definitions, and treatments
- Recognize various nerve palsies and tendon transfers used to treat them
- Learn about epidemiology, history, surgery and complications of Dupuytrens Disease
- Understand the anatomy of the fingernail
- Review nail bed injuries and the treatment techniques used for these injuries
• Understand soft tissue coverage in the hand and when the surgeon will use a skin graft or a various type of flap
• Identify various hand infections based on clinical presentation
• Review digit replantation
• Review the pathophysiology of OA
• Learn the various stages of OA and treatment options for the stages
• Recognize the clinical finding of RA
• Understand various implants and when they might be utilized
• Review tendon reconstruction in the rheumatoid patient
• Identify soft tissue benign and malignant neoplasms
• Review benign and malignant bone tumors
• Learn about pediatric hand trauma and management principles
• Identify congenital conditions that manifest in the upper extremity
• Recognize spasticity as the key problem that will be addressed by reconstructive surgeons after brain injury and CP
• Review tetraplegia and the surgical reconstruction of the hand
• Review anatomical features of the forearm
• Identify various forearm fractures and treatment techniques
• Review anatomical features of the elbow
• Learn about various tendon pathology about the elbow
• Understand elbow instability and treatment regimes
• Identify various fractures of the elbow
• Review the various types of elbow arthritis and treatment regimes
• Recognize humeral shaft fractures and when operative or non-operative intervention is indicated
• Review anatomical features and examinations of the shoulder
• Recognize rotator cuff tendinopathy and the various treatment plans available
• Review glenohumeral instability, adhesive capsulitis, and superior labral anteroposterior lesions
• Identify various fractures and classification systems about the shoulder
• Learn about shoulder arthritis, surgical intervention including arthroplasty and rehabilitation after the procedure
Carpal Bone Fractures Excluding the Scaphoid

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Introduction

- Diagnosis is a challenge. Complex anatomy combined with difficult radiographic interpretation requires a high index of suspicion, thorough history including mechanism of injury, precise physical examination, and specific radiographic imaging.
- The incidence of carpal fractures reported in the literature varies. In general, the order of frequency is as follows: scaphoid, triquetrum, trapezium, hamate, lunate, pisiform, capitate, and trapezoid.1–3

Mechanism of Injury

- Fall on an outstretched hand with a hyperextension moment and varying degrees of radial or ulnar deviation
- Direct impact or crush
- Indirect ligamentous avulsion

Triquetrum

- Most common carpal fracture second to scaphoid.
- Fracture patterns include dorsal rim chip fractures and triquetral body fractures (Table 9–1).4
  - Chip fractures may represent an avulsion of the dorsal radiotriquetral ligament. Other theories include compression against the ulnar styloid.
- Body fractures can be divided into medial tuberosity, sagittal, transverse proximal pole, transverse body, palmar radial, and comminuted.5
  - Medial tuberosity fractures are associated with direct blows to the ulnar border of the wrist.
  - Sagittal fractures are associated with axial dislocation and severe crush injury.
  - Proximal pole fractures are associated with perilunate/greater arc injury.
  - Transverse body fractures are associated with scaphoid injury.

History/Examination

- Dorsal hand and wrist edema usually are present. Wrist flexion tends to be more painful than extension.6
- Tenderness just distal to ulnar styloid with hand in radial deviation is noted.

Imaging

- Oblique and lateral radiographic views (Figure 9–1).
- Computed tomography (CT) or bone scan may be necessary to make the diagnosis.

Treatment

- Cast immobilization for 4 to 6 weeks. Tender nonunited fragments may require excision. Body fractures with displacement of greater arc injuries typically are treated with open reduction internal fixation (ORIF).
Trapezium

- Isolated trapezium fractures are uncommon. Usually occur in association with first metacarpal or distal radius fracture (Figure 9–2).
- Five patterns: vertical transarticular, dorsoradial tuberosity, horizontal, anteromedial trapezial ridge, and comminuted2 (see Table 9–1).
- Dorsoradial fractures occur as a result from compression between the first metacarpal and radius. Compression of the first web space (i.e., handle bar injury) may create this force.
- Trapezial ridge fractures may occur as a result of dorsopalmar crush and flattening of the transverse carpal ligament and resultant avulsion. Look for associated hook of hamate fracture in this mechanism.

History/Examination

- Palpate distal to snuffbox. Thumb flexion and extension may produce pain. Resisted wrist flexion produces pain. Weak or painful pinch. Median nerve compressive symptoms occur occasionally.1

Imaging

- Standard anteroposterior (AP)/lateral radiographs.
- Betts view: Semipronated hand with ulnar palm resting on plate and x-ray beam centered on scaphotrapeziotrapezoid (STT) joint.
- Carpal tunnel views needed to see trapezial ridge fracture.7
- CT scan may be useful.
Forearm Anatomy and Forearm Fractures

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- The rotary movements (pronation/supination) provided by the unique two-bone, dual intraarticulation structure of the forearm greatly expand the variety of ways in which objects can be positioned and manipulated by the hand.
- Loss of this motion as a result of malunion, prolonged immobilization, and/or proximal or distal radioulnar joint incongruity following trauma to the adult forearm can be disabling.
- The gradual improvement in functional outcomes and decrease in the rate of complications associated with the management of forearm fractures during this century parallels the history of the development of sound, stable techniques of internal skeletal fixation that permit mobility while assuring maintenance of skeletal alignment during fracture union.
- Forearm fractures often are the sequelae of high-energy injury, and a relatively large percentage are open fractures.
- Injury and treatment-related complications include compartment syndrome, neurovascular injury, soft tissue loss, bone loss, refracture after plate removal, and posttraumatic radioulnar synostosis. Infection is unusual, even in the case of an open fracture, partly because of the relative ease of wound debridement and the well-perfused forearm musculature.

Evolutionary Anatomy
- The pattern of evolution at both the elbow and the wrist reflects a transition from stability to mobility.\textsuperscript{1,2}
- The development of bipedalism freed the upper extremity for enhanced manipulative function.
- In conjunction with the increase in brain size and the development of the prehensile thumb, the acquisition of forearm rotation is considered one of the three most important aspects differentiating the most highly developed hominids, as these factors are important in determining the ability to manipulate one’s environment, particularly for tool use.\textsuperscript{1,3}

Skeletal Anatomy

Ulna
- There is a slight apex posterior bow along the entire length of the ulna as seen on a lateral radiograph.
- In the anteroposterior plane the ulna has a slight double curvature, apex lateral in the proximal half and apex medial distally.\textsuperscript{4,5}
- The ulna is triangular in cross section through the majority of its midportion and becomes cylindrical distally. The laterally directed apex of the triangle
corresponds with the insertion of the interosseous ligament. The posterior apex remains essentially subcutaneous as it divides the flexor and extensor musculature on the ulnar border of the forearm and is palpable along the entire length of the bone.

**Radius**

- The radius has a double curvature in both the anteroposterior and lateral planes. The bicipital tuberosity, representing the insertion of the biceps brachii tendon, is at the apex of the smaller, proximal, convex medial curve, whereas the large, distal, convex lateral curve has at its apex the insertion of the pronator teres. This circumstance provides these powerful muscles with longer lever arms through which to produce rotatory torque of the radius. According to Sage’s measurements, the proximal curvature of the radius averages approximately 13 degrees apex medial in the coronal and 13 degrees apex anterior in the sagittal anatomic planes. The distal curvature averages approximately 9.3 degrees apex lateral in the coronal and 6.4 degrees apex posterior in the sagittal plane.
- The large ulnar concavity of the distal curvature of the radius allows for overriding of the ulna without restriction of pronation. Loss of this “radial bow” was shown by Schemitch and Richards to be associated with limitation in both forearm rotation and grip strength.
- Numerous studies have demonstrated a direct relationship between the degree of forearm bone angular and rotational malalignment and restriction of rotational motion.
- The biceps inserts onto the roughened posterior aspect of the bicipital tuberosity. The orientation of the tuberosity can provide an indication of the rotation of the proximal radius, which may prove useful in the treatment of forearm fractures. Its apex is directed roughly opposite to that of the distal radial styloid. It points directly medial or ulnar in full supination and directly lateral in full pronation and is not visible when the proximal radius is in the neutral position.

**Radioulnar Articulation**

- The radius rotates about the relatively stationary ulna along an axis that passes roughly through the center of the radial head proximally and the fovea of the ulnar head distally (Figure 33–1).
- Rotation of the radius occurs via axial rotation of the radial head at the proximal radioulnar joint, whereas distally, the motion is a combination of axial rotation and translation of the radius relative to the ulna.
- The association of the radius and ulna is maintained by ligamentous structures at the proximal and distal radioulnar joints and by the interosseous ligament, a ligamentous sheet interconnecting the two bones along their midportion.
- The proximal radioulnar joint is stabilized by the annular and quadrate ligaments proximally and by the interosseous ligament.
- The quadrate ligament is described as a thin ligamentous structure that covers the capsule at the inferior margin of the annular ligament and attaches to the ulna. Its existence as a discrete entity and its contributions to

![Figure 33–1:](image)

In supination the palmar ligament supports the triangular fibrocartilage complex (TFCC) and distal radioulnar joint (DRUJ), becoming taunt whereas in pronation the dorsal ligaments bordering the TFCC become taunt to support the DRUJ.
the stability of the proximal radioulnar joint has been disputed by some authors.\textsuperscript{24}

- The distal radioulnar articulation is stabilized by the triangular fibrocartilage complex. The complex represents a combination of structures that are inseparable in anatomic dissections including the articular disc, the dorsal and volar radioulnar ligaments, and the sheath of the extensor carpi ulnaris.\textsuperscript{27}

### Muscle-Tendon Units

- Four muscles produce active forearm rotation, two that originate and insert in the forearm and two that cross the elbow joint. Both the supinator and biceps insert on the proximal radial shaft and produce supination. The pronator teres and pronator quadratus insert on the midshaft and distal radius, respectively, and produce pronation.
- Contraction of the brachioradialis encourages neutral forearm rotation.
- The power of supination exceeds that of pronation by approximately 15\textsuperscript{\%}.\textsuperscript{28}
- Malunion of the radius can decrease the mechanical efficiency of the muscles, producing forearm rotation by shortening the lever arms.\textsuperscript{8}
- The forearm musculature is commonly considered as three separate compartments based on fascial divisions and nerve supply: the volar or flexor compartment innervated by the median nerve; the dorsal or extensor compartment innervated by the posterior interosseous nerve; and the volar or extensor compartment innervated by the anterior interosseous nerve.\textsuperscript{31}
- The forearm musculature is commonly considered as three separate compartments based on fascial divisions and nerve supply: the volar or flexor compartment innervated by the median and ulnar nerves; the dorsal or extensor compartment innervated by the posterior interosseous nerve; and the mobile wad of Henry (brachioradialis and the extensor carpi radialis longus and brevis) innervated by the radial nerve. The divisions between the compartments delineate commonly used and relatively safe intervals for operative exposure.
- Anatomic studies suggest that the fascial divisions between these compartments are sufficiently pliant that fascial release of one compartment usually decompresses the remaining two.\textsuperscript{29,30} As a result, in the treatment of compartment syndrome of the forearm, pressures in the dorsal and mobile wad compartments rarely, but occasionally, remain elevated following release of the volar forearm musculature.\textsuperscript{29,30}
- Muscle tissue becomes sparse in the distal forearm where the transition from muscle to tendon is completed.
- On the extensor surface of the distal radius and ulna, the tendons organize and are confined within compartments defined by the attachment of the extensor retinaculum to the dorsal radial and ulnar periosteum. Commonly referred to by number counting radial to ulnar, the first dorsal compartment contains the abductor pollicis longus and the extensor pollicis brevis; the second contains the radial wrist extensors, the extensor carpi radialis brevis and longus; the third contains the extensor pollicis longus as it angles about the fulcrum provided by Lister’s tubercle; the fourth contains the extensor digitorum communis and extensor indicis tendons; the fifth contains the extensor digiti quinti tendon; and the sixth compartment the extensor carpi ulnaris, lying in a groove in the ulnar head, just dorsoradial to the ulnar styloid.

### Neurovascular Anatomy

- Three large nerves enter the forearm at the elbow: the ulnar, radial, and median nerves.
- For the ulnar nerve, the forearm is primarily a conduit to the hand. It passes from the extensor compartment of the arm to the flexor compartment of the forearm under the medial epicondyle of the distal humerus. It then dives below the flexor carpi ulnaris, under the fascial band formed by the connection between its humeral and ulnar heads, innervating this muscle and the ulnar half of the flexor digitorum profundus. The ulnar nerve is incorporated into the epimysium of the flexor digitorum profundus, lying between the flexor carpi ulnaris and the flexor digitorum superficialis muscles. The ulnar nerve lies just lateral to the tendon of the flexor carpi ulnaris at the wrist.
- The remainder of the flexor musculature of the hand and wrist is innervated by the median nerve. The median nerve is found medial to the brachial artery, overlying the brachialis muscle at the elbow. After entering the forearm in the cubital fossa, it passes between the humeral and ulnar heads of the pronator teres and then disappears under the superior margin of the flexor digitorum superficialis between its radial and ulnar origins. It lies between the superficial and deep digital flexor musculature, often incorporated into the epimysium of the flexor digitorum superficialis, until it reaches the wrist at which point the nerve emerges in a relatively superficial position between the flexor carpi radialis and flexor digitorum superficialis tendons.
- The anterior interosseous branch of the median nerve arises as a separate fascicle well proximal to the elbow and is a distinct branch at the level of the superior margin of the flexor digitorum superficialis muscle. This branch supplies the flexor pollicis longus and the radial half of the flexor digitorum profundus muscle and the pronator quadratus.
- The radial nerve bifurcates just proximal to the elbow. Its deep branch, the posterior interosseous nerve, courses over the radial head and dives between the two heads of the supinator muscle at the arcade of Frohse, a fibrous thickening of the fascial margin of the superficial head of the supinator. The posterior interosseous nerve typically is separated from the radial shaft by the deep head of the supinator muscle, but occasionally it lies in direct contact with the periosteum of the radial neck, making it particularly susceptible to damage when internal fixation devices are implanted in this region.\textsuperscript{31}

The posterior interosseous nerve terminates in an
The radial artery passes medial to the biceps tendon and provides sensory branches to the dorsoradial aspect of the wrist and hand.

- The superficial branch of the radial nerve runs along the undersurface of the brachioradialis with the radial artery and provides sensory branches to the dorsoradial aspect of the wrist and hand.

- The skin of the forearm is supplied primarily by three nerves: the medial, lateral, and posterior antebrachial cutaneous nerves.

- The lateral antebrachial cutaneous nerve is the continuation of the musculocutaneous nerve, which emerges from between the biceps brachii and the brachialis muscles on the lateral aspect of the distal arm. This nerve innervates the skin of the lateral half of the anterior aspect of the forearm and the direct lateral aspect of the forearm.

- The medial antebrachial cutaneous nerve is a branch from the medial cord of the brachial plexus, which runs down the arm with the brachial artery. It emerges in the middle of the arm and divides into an anterior and a posterior branch. These large branches supply the majority of the anteromedial and posteromedial skin surface of the forearm.

- The posterior antebrachial cutaneous nerve of the forearm supplies the posterolateral aspect of the forearm integument.

- The arterial supply to the upper extremity is characterized by extensive longitudinal collateralization. The brachial artery, which enters the forearm superficial to the brachialis muscle, lateral and adjacent to the median nerve, represents the primary blood supply of the forearm. However, distal branches such as the radial, ulnar and interosseous arteries also are supplied by large collaterals: the radial recurrent, anterior and posterior ulnar recurrent, and interosseous recurrent arteries, respectively. The radial recurrent artery represents the continuation of the radial collateral branch of the profunda brachii artery and travels with the radial nerve onto the anterior aspect of the elbow. The middle collateral branch of the profunda brachii becomes the interosseous recurrent artery on the posterolateral aspect of the elbow. The anterior and posterior ulnar recurrent arteries are named for their position relative to the elbow joint. They begin as the inferior and superior ulnar collateral arteries, respectively, in the arm.

- Bifurcation of the brachial artery into the radial and ulnar arteries occurs at the level of the radial neck.

- The ulnar artery is crossed by the median nerve as it courses under the pronator teres and flexor digitorum superficialis. It eventually meets the ulnar nerve with which it continues through the forearm lying between the flexor digitorum superficialis and the flexor carpi ulnaris and overlying the flexor digitorum profundus.

- The radial artery passes medial to the biceps tendon and lies on the surface of the supinator muscle, meeting the superficial radial nerve, with which it courses toward the wrist on the undersurface of the brachioradialis muscle.

- The radial artery lies radial to the flexor carpi radialis tendon, and the ulnar artery lies radial to the flexor carpi ulnaris tendon and ulnar nerve. As in most parts of the body, the nerves that course near arteries (superficial radial sensory nerve, ulnar nerve) are more peripheral and more superficial and thus more vulnerable to injury than the deeper and more central arteries.

- The common interosseous artery arises just below the bicipital tuberosity and almost immediately branches into anterior and posterior interosseous arteries at the superior margin of the interosseous ligament. These arteries, which are associated with their corresponding nerves, run along the anterior and posterior surfaces of the interosseous ligament, anastomosing in the distal forearm.

### Kinesiology

- **Pronation** is limited by compression of the flexor musculature between the radius and ulna, whereas supination is limited proximally by the restraint of the annular ligament (as reinforced by the anterior fibers of the lateral and medial collateral ligament complexes of the elbow), the quadrate ligament, the tone of the pronator quadratus, and impingement of the ulnar styloid process on the posterior margin of the sigmoid notch of the distal radius.  

  - Using simple goniometric measurements, pronation averages between 71 and 80 degrees and supination between 80 and 84 degrees. More sophisticated techniques demonstrate a total arc of forearm rotation less than 160 degrees, with supination (75–88 degrees) greater than pronation (70–71 degrees).  

- **Most simple activities of daily living can be performed within an arc of approximately 50 degrees each of pronation and supination.** On the other hand, many activities such as supporting a tray or accepting objects into the hand require near full supination, whereas many other activities such as pressing downward, leaning upon an object, and dribbling a basketball become restricted even with relatively small decreases in pronation.  

- **As a result of the translational contribution to forearm rotation at the distal radioulnar joint, the axis of rotation is not constant.** The so-called instant center of rotation, or the center of rotation at any given position of forearm rotation, translates a few millimeters about the center of the radial and ulnar heads as the forearm courses through a full arc of rotation. Distally, the average center
Tendinopathy of the Rotator Cuff and Proximal Biceps

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Rotator Cuff Injuries
- The anatomy and function of the rotator cuff were discussed in Chapter 40. The rotator cuff is the most common source of shoulder pain and disability. Most rotator cuff injuries occur without a history of trauma and result from overuse.

Etiology
Classic Teaching (Primary Extrinsic Coracoacromial Arch Impingement)
- Congenital variations in acromial morphology exist. Some acromions are flatter, whereas others have inferior subacromial spurs or hooks on them. With repetitive arm elevation, these subacromial spurs mechanically abrade or cut into the rotator cuff, progressively leading to tendon injury.
- In his classic 1972 article, Neer¹ implicated the anterior acromion and its “spurs” in the etiology of rotator cuff injuries. Subacromial abrasion caused rotator cuff inflammation, which progressed to partial-thickness tears and later full-thickness tears.¹
- In 1986, Bigliani, Morrison, and April² characterized acromial morphology as type I (flat), type II curved (parallel to the humeral head), or type III hooked (converging on the humeral head). They found that full-thickness rotator cuff tears were associated with type III acromions and anterior undersurface spurs.²
- The classic theory of the etiology of rotator cuff pathology has been challenged.

Primary Intrinsic Degenerative Tendinopathy (Tendinosis)
- The rotator cuff fails from tensile, not compressive, overload. Pathoetiology and mechanism are identical to tendon pathology in many other areas of the body (i.e., tennis elbow, patellar tendinosis, Achilles tendinosis). Evidence strongly suggests that most rotator cuff symptoms are caused by primary intrinsic degeneration, not extrinsic subacromial compression.³⁻⁵
- Histologic studies of symptomatic rotator cuff disease have repeatedly noted an absence of acute inflammatory cells. These studies have consistently noted the changes of degenerative tendinopathy, for which the pathologic name is angiofibroblastic hyperplasia.
- The term impingement syndrome has been used to describe symptoms related to the rotator cuff in the absence of a full-thickness tear. Commonly used synonyms include bursitis and tendinitis. However, use of the term tendinosis is now recommended in lieu of the histologically inaccurate term tendinitis, because it more accurately describes the true pathology.³
- Clinical and cadaveric studies have noted that more than 90% of partial-thickness rotator cuff tears occur on the articular side, away from the acromion.³⁻⁴
- Degeneration begins on the articular sides of the supraspinatus and infraspinatus tendon insertions rather than the bursal sides probably because of their poor blood supply.³
Acromial spurs form with age and are degenerative. The type III acromion is rare (2%–4%) in young, asymptomatic athletes. A higher incidence of type III acromions is seen in older populations. Cadaveric studies have demonstrated that rotator cuff pathology predates that of the acromion. Spur reformation has been noted following subacromial decompression. A study using mineral apposition analysis and quantitative cytochemical techniques demonstrated active bone formation at the acromial insertion of the coracoacromial (CA) ligament, supporting the concept that spur formation is a secondary phenomenon. Thus the spur is actually an enthesophyte (bone growth) at the CA ligament’s acromial insertion, probably in response to dynamic loading. Nonoperative management has been reported to successfully treat most full-thickness rotator cuff tears. Because therapy cannot modify pathologic osseous prominences, another etiology is implied.

Pathomechanics

- Tissue damage occurs when the stresses placed on the rotator cuff exceed its stress tolerance, which is related to its strength. The rotator cuff muscles are small and weak and therefore are vulnerable to overuse. Overuse injuries occur when the rate of tissue damage over time exceeds the body’s rate of repair. As a natural part of the aging process, the deltoid retains its strength longer than the smaller rotator cuff. When rotator cuff injury, degeneration, fatigue, or weakness occurs, the rotator cuff is unable to effectively oppose (via concavity-compression) the superior shear stresses imparted by the larger and stronger deltoid muscle. This situation leads to dynamic superior instability of the humeral head with arm elevation. This inappropriate superior migration of the humeral head causes secondary impingement of the rotator cuff against the CA arch, leading to further injury, in a self-perpetuating cycle. Therefore, subacromial impingement is a secondary and not a primary process.
- The CA ligament and undersurface of the acromion function as secondary, static stabilizers of the humeral head against anterosuperior migration. With rotator cuff dysfunction, the CA ligament may experience increased stress and undergo degenerative changes, forming a traction spur at its insertion into the anteromedial corner of the acromion. These acromial changes are the result of rotator cuff injury; they are not the cause. This traction spur often is mistaken for an abnormal acromial hook, or type III acromion.
- As rotator cuff dysfunction increases with age, the CA arch may function as a fulcrum for the superiorly migrated humeral head, allowing continued glenohumeral elevation.

Relationship to instability: In patients with anterior glenohumeral instability resulting from ligamentous insufficiency, the dynamic stabilizers, including the supraspinatus, infraspinatus, and biceps, compensate with increased activity. This overuse may predispose patients to injury.

Diagnosis

- The history and physical examination of rotator cuff disorders are discussed in Chapter 40. Concomitant loss of passive motion, instability, and scapulothoracic dysfunction should be noted.

Radiography

- Subtle superior migration of the humeral head can be detected by the presence of a “break” in the arch formed by the medial cortex of the humerus and the lateral cortex of the scapula (Figure 41–1).
- Marked elevation of the humeral head with narrowing of the acromiohumeral distance to less than 5 mm is highly suggestive of a large rotator cuff tear.
- Sclerosis, osteophytes, and subchondral cysts of the greater tuberosity are associated with rotator cuff tears.

Magnetic Resonance Imaging

- According to Frost, Andersen, and Lundorf, supraspinatus pathology as seen on magnetic resonance imaging (MRI) is related to age, not to symptoms. According to Shuman, conventional MRI has not performed well in distinguishing partial-thickness rotator cuff tears from small full-thickness rotator cuff tears or normal tendon. According to Torstensen and Hollinshead, MRI is not an effective or accurate tool for assessing shoulder pathology when the clinical picture is unclear.
- From 33% to 80% of partial-thickness rotator cuff tears can be missed on MRI.

Figure 41–1:
Model of an anteroposterior radiograph. Normal rotator cuff function presents with a smooth unbroken scapulohumeral arch. Rotator cuff dysfunction leads to superior migration of the humeral head with a broken scapulohumeral arch. (From Burkhart SS: Reconciling the paradox of rotator cuff repair versus debridement: a unified biomechanical rationale for the treatment of rotator cuff tears. Arthroscopy 10:4-19, 1994.)
Because rotator cuff pathology results from degeneration, at least 3 months of nonoperative management is recommended in most cases before undertaking operative management. Studies by Needell et al., Tempelhof, Rupp, and Seil, and Sher et al. demonstrated that between the ages of 40 and 60 years, 24% to 27% of asymptomatic volunteers had partial-thickness rotator cuff tears. Above age 60 years, 27% to 28% of asymptomatic volunteers had full-thickness rotator cuff tears, and another 26% to 27% had partial-thickness rotator cuff tears. Above age 80 years, 51% of asymptomatic volunteers had full-thickness rotator cuff tears.

Pearl: Because conservative management of full-thickness tears is identical to that for partial-thickness tears, diagnosing the thickness of the tear may be initially irrelevant. Initial treatment in most cases should not be based on the presence or absence of a full-thickness tear because most full-thickness rotator cuff tears are asymptomatic.

Decisions regarding operative treatment are best made based on the patient’s symptoms, wishes, and response to nonoperative management and not the presence or absence of a hole in the cuff.

Nonoperative Management

- Rotator cuff and scapulothoracic stabilizer strengthening reportedly was successful in treating 50% to 82% full-thickness rotator cuff tears. Nonoperative management may be considered if the patient can actively elevate the arm above the horizontal. This ability implies the tear is functional and does not involve the rotator cuff cable (described in Chapter 40).
- No significant relationship exists between the length of preoperative symptoms and the final outcome following repair of nonacute rotator cuff tears. Therefore, no evidence indicates that a “penalty” exists for attempting nonoperative management of nonacute rotator cuff tears.
- At least 3 months of nonoperative management is recommended in most cases before undertaking operative management. Because rotator cuff pathology results from degeneration and weakness, not from inflammation, nonsteroidal antiinflammatory drugs, corticosteroid injections, and modalities should be used only as adjuncts to increase patient comfort and promote effective strengthening given that they have no proven long-term efficacy or curative potential.
- The efficacy of steroid injections has been questioned. A randomized prospective trial found no difference in symptoms between patients (with medial tennis elbow; a disorder with identical histopathology) injected with steroid and lidocaine and those injected with only saline at 3 and 12 months. In addition, a meta-analysis performed by the Cochrane Database found that although subacromial steroid injections had a small benefit over placebo in some trials, no benefit of subacromial steroid injections over oral nonsteroidal antiinflammatory drugs was observed. Repetitive injections are inappropriate because they may cause cellular death, further tissue weakness, and actually slow the healing process.
- Any rest should be relative, with activity allowed within the limits of pain to prevent further deconditioning.
- Physical therapists may educate the patient and facilitate this program, but patients must assume responsibility for their own daily exercise program. Once the motivated patient can properly perform the exercises, he or she can perform therapy exclusively at home.
- Acute large traumatic tears
- Although the patient usually retains nearly full passive motion, the arm cannot be actively elevated above the horizontal, even following a lidocaine injection. The other elements in the differential diagnosis are fracture and dislocation, which are excluded by radiography, and suprascapular and axillary neuropathies, which are uncommon. Conservative management is ineffective in this setting. Early repairs performed within 3 weeks of injury have yielded better results, with greater postoperative motion and function, than repairs performed later. Therefore, the diagnosis should be confirmed by MRI and operative management strongly considered.

Treatment Specifics

- The mainstay of nonoperative management is strengthening of the rotator cuff, deltoid, and scapulothoracic stabilizers. Strengthening the rotator cuff may help decrease symptoms for the following reasons:
  - A stronger rotator cuff can better oppose superior translation of the humeral head and avoid subsequent secondary impingement.
  - Muscles are the “shock absorbers” of the musculoskeletal system and protect their tendons from excessive stress. Therefore, muscle strengthening increases the stress tolerance of the myotendinous unit.
  - Strengthening may enhance tendon healing via increased tissue turnover.
  - Scapular strengthening may help decrease symptoms by restoring normal scapular motion, which allows the acromion to clear the rotator cuff during arm elevation. Scapulothoracic weakness causes decreased acromial clearance and increased rotator cuff compression, exacerbating symptoms.
  - Rotator cuff and deltoid strengthening exercises include internal rotation, external rotation, forward flexion, abduction, and extension, and a diagonal proprioceptive
neuromuscular facilitation pattern similar to the motion used to draw a sword (Figures 41–2 and 41–3). In cases of significant weakness, closed chain exercises may be substituted, which create less stress in the rotator cuff.

- Scapulothoracic strengthening exercises include:
  - The seated row, pull-downs, the “push-up plus,” the “bench press plus,” and the “press-up plus.” These exercises should be carried out to a “four-count” to avoid substituting biceps and triceps function for scapulothoracic retraction and protraction, respectively (Figures 41–4 through 41–8).
  - The middle and lower trapezius may be strengthened by prone dumbbell flies performed with the shoulder abducted 90 and 135 degrees, respectively. A four-count is not necessary for these exercises (Figure 41–9).
  - An elastic resistance can be used in lieu of a weight.
  - Exercises optimally should be performed until the muscles fatigue, which is when mechanics become abnormal, rather than completing a specified number of sets and repetitions. For deconditioned patients, a rough goal is one set of 10 to 12 repetitions for each exercise, performed once or twice a day, to start. A well-conditioned athlete can begin with a more advanced program.
  - Exercise should not cause pain. If pain occurs during or after exercises, then (1) the resistance should be decreased, (2) the number of repetitions should be decreased, or (3) the patient should restrict the exercise motion to within the pain-free arc.

- The posterior joint capsule and pectoralis minor should be stretched (Figures 41–10 and 41–11). A tight posterior capsule may negatively affect glenohumeral biomechanics, whereas pectoralis minor tightness may exacerbate scapular protraction.30,31

**Surgical Management**

- **Pearl:** Instability should be ruled out using examination under anesthesia and/or diagnostic arthroscopy. Failure to address underlying glenohumeral instability will compromise the surgical result.

**Subacromial Decompression (Acromioplasty)**

- Subacromial decompression (SAD; acromioplasty) is the most common shoulder procedure performed today. This procedure is designed to alleviate rotator cuff problems caused by subacromial spurs, per the classic theory of extrinsic CA impingement.
- According to the theory of intrinsic degenerative tendinosis, SAD may provide pain relief by removing the CA ligament and acromial undersurface, the sources of secondary impingement, thereby removing pressure from a sensitive tendon.

Figure 41–2: