PERSPECTIVE

The shoulder joint is a unique and complex articulation unit. It has the largest range of motion of any appendicular joint in the body and can be moved through a space that exceeds a hemisphere in extent. The nature of shoulder injuries has been long recognized; Wall paintings in Egyptian tombs from 3000 BCE show accurate drawings of manipulations (similar to the Kocher technique) used to reduce shoulder dislocations.1 Hippocrates outlined the oldest known method for reduction of shoulder dislocations.2

Shoulder injuries are commonly encountered in emergency medicine. Statistical studies show that 8 to 13% of all athletic injuries involve the shoulder and that shoulder dislocations account for more than 50% of all major joint dislocations seen in the emergency department (ED). Almost every major sport or athletic activity involves use of the shoulder joint in one way or another. The shoulder can be injured by trauma (indirect or direct) or by overuse. Traumatic injuries tend to occur in contact sports such as football and ice hockey, whereas overuse injuries (impingement syndromes) are more common in swimming and baseball. Shoulder injuries also are common in wrestling, tennis, volleyball, and javelin throwing.3

In general, children are vulnerable to the same injuries as those incurred by adults; however, the presence of the epiphysis and its growth plate changes the pattern of injuries.4 The strength of the joint capsule and its ligaments is two to five times greater than that of the epiphyseal plate. An injury that produces a sprain or dislocation of the epiphyseal plate in an adult often causes a fracture through the hypertrophic zone of the growth plate in a child. The shoulder girdle has the largest range of motion of any appendicular joint. The major ligamentous structures is immediately posterior to the joint.

PRINCIPLES OF DISEASE

Anatomy

The shoulder girdle connects the upper extremity to the axial skeleton (Fig. 53-1). It consists of three bones, the clavicle, humerus, and scapula; three joints, the acromioclavicular, glenohumeral, and sternoclavicular joints; and one pseudoarticulation, the scapulothoracic pseudoarticulation.

The sternoclavicular joint (SCJ) represents the only true articulation between the upper extremity and the axial skeleton (Fig. 53-2). Stabilizers of this diarthrodial joint include the anterior and posterior sternoclavicular ligaments, the interclavicular ligament, and the costoclavicular ligament. The costoclavicular ligament opposes the pull of the sternocleidomastoid and is considered the most important stabilizing ligament.5 The SCJ participates in all movements of the upper extremity and is the most moved joint in the body. The superior mediastinum with its great vessels, trachea, esophagus, thoracic duct, lung apices, and other important structures is immediately posterior to the joint.

The clavicle is an S-shaped bone that acts as a strut to support the upper extremity and keep it away from the chest wall. It articulates medially with the sternum and laterally with the acromion process. The clavicle provides the neck with an acceptable cosmetic appearance and protects the subclavian vessels and brachial plexus. Its middle third, which is thin and untethered, is the most commonly fractured segment.6

The acromioclavicular joint (ACJ) connects the lateral end of the clavicle with the medial aspect of the acromion process (Fig. 53-3). The diarthrodial ACJ has little or no bony stability and is dependent on the associated ligaments and muscles for support.7 The weak acromioclavicular ligaments provide posterior support while the clavicular and acromial attachments of the deltoid and trapezius muscles provide static and dynamic support for the superior aspect of the joint. The most important stabilizers are the coracoclavicular ligaments (conoid and trapezoid), which provide vertical and anterior support.

The scapula is a flat triangular bone that forms the posterior aspect of the shoulder girdle. The thin body of the scapula lies flat against the posterior thorax and widens laterally to form the glenoid fossa. The scapula’s thickened borders are the attachment sites for 18 muscle origins and insertions.8 The thick muscle coat and ability to recoil along the posterior chest wall protect the scapula from both direct and indirect trauma.

A synovial membrane extends from the glenoid fossa to the humeral head. The membrane is large and redundant inferiorly to accommodate the extensive range of movement. Overlying the synovial membrane is a loose and redundant fibrous capsule. Anteriorly, the capsule is thickened to form the superior, middle, and inferior glenohumeral ligaments. The anterior band of the inferior glenohumeral ligament is the most important restraint to anterior glenohumeral dislocations.9

The glenohumeral articulation is a ball-and-socket—type joint that depends largely on associated capsule, muscles, and ligaments for stability (Fig. 53-4). A negative intracapsular pressure completes the stabilization mechanism.10 The absence of bony stability permits a range of motion, however, that is greater than that of any other joint in the body.

The proximal humerus articulates with the glenoid fossa and provides for the attachment of many important muscles. The
supraspinatus, infraspinatus, and teres minor insert onto facets of the greater tuberosity, whereas the subscapularis inserts onto the lesser tuberosity. Together, this group of muscles forms the rotator cuff, which helps stabilize the humeral head within the glenohumeral joint (Fig. 53-5). The long head of the biceps tendon originates from the supraglenoid tubercle and ascends over the humeral head to enter the arm via the bicipital groove. The long head acts as an additional stabilizer for the superior
and anterior aspects of the glenohumeral joint (see Fig. 53-5). Long muscles that cross the articulation are involved primarily in movements of the glenohumeral joint. The pectoralis major, latissimus dorsi, and teres major muscles all insert into the humeral intertubercular groove. Displacements encountered with fractures of the humerus usually reflect the pull of these attached muscle groups. The proximal humerus is composed primarily of trabecular bone with a thin cortical shell. Changes in bone density with age (osteoporosis) greatly increase the risk of fractures in this area.

The brachial plexus and subclavian vessels enter the shoulder girdle complex superiorly between the clavicle and the first rib, traverse under the coracoid process, and exit anterior to the inferior aspect of the glenohumeral joint as the median, ulnar, and radial nerves and axillary vessels. These nerves represent the final branches of the upper brachial plexus (nerve roots C5 to C8), and injuries to the brachial plexus invariably result in significant shoulder weakness.

**CLINICAL FEATURES**

**History**

Most complaints usually involve some combination of pain, stiffness, instability, and weakness. Pain can result from many different conditions extrinsic and intrinsic to the shoulder. Extrinsic sources of shoulder pain include disorders of the cervical spine, thoracic outlet syndromes, and Pancoast tumors. In addition, pain can be referred to the shoulder from myocardial processes, diaphragmatic irritation (e.g., subphrenic abscess, lower lobe pneumonia, splenic hematoma, ruptured ectopic pregnancy, gallbladder disease), and gastric or pancreatic diseases.

Acute intrinsic pain usually is associated with a traumatic event. The most important factors to determine are the time and mechanism of injury, its precise location, the intensity of the pain, and associated sensorimotor complaints. Occasionally, the patient may have acute pain in the absence of associated trauma (e.g., with calcific tendinitis). Shoulder pain also can manifest in an insidious manner, unrelated to any precipitating factor. In these instances, the duration, location, character, and aggravating and alleviating factors of the pain should be noted. Intrinsic shoulder pain in general does not radiate past the elbow.

Stiffness usually signifies a restricted range of motion resulting from an underlying painful condition of the shoulder. Instability can be seen in the form of an obvious subluxation or dislocation. Alternatively, the patient may describe the sensation of the shoulder’s almost “going out.” A rotator cuff tear or an underlying nerve lesion usually causes significant shoulder weakness.

**Physical Examination**

The shoulder should be inspected from the anterior, posterior, and lateral positions. Any obvious deformity, ecchymosis, laceration, swelling, or hematoma should be noted. The masses of the trapezius, deltoid, infraspinatus, and supraspinatus muscles should be compared with the unaffected side to detect any atrophy.

Palpation of the shoulder should be performed systematically, beginning at the SCJ and moving laterally along the clavicle to the ACJ. Next, the scapula, glenohumeral joint, and humerus are palpated. Any point tenderness, crepitus, swelling, or deformity should be noted.

Active and passive ranges of motion should be tested. Active range of motion is best determined with the patient in the sitting position, which eliminates the contributions of the lumbar spine and lower extremity joints. Passive range of motion is best evaluated with the patient in the supine position. The degrees of abduction, forward flexion, extension, and internal and external rotation should be recorded and compared with those for the unaffected extremity. In addition, the motion of the scapulothoracic articulation should be observed carefully in all cases. After 45 degrees of abduction, the scapula moves approximately 1 degree for every 2 degrees of glenohumeral motion.
The examination is completed with an assessment of the neurovascular function. A complete sensory (light touch and pin-prick) and full motor examination of the brachial plexus should be performed. This examination is best performed by assessing the myotomes and dermatomes (Table 53-1) pertinent to each nerve root within the brachial plexus. The radial pulse should also be checked, although collateral circulation may preserve this in the presence of a vascular injury. The presence of pallor, paresthesias, or an expanding hematoma should raise suspicion for a vascular injury. The neurovascular examination should be repeated after any manipulation in the ED, and the findings recorded.

### Diagnostic Strategies

#### Radiology

The initial assessment of traumatic injuries includes a three-view series of radiographs consisting of true anteroposterior (AP) (45-degree lateral), transcapular lateral ("Y" view), and axillary lateral views (Figs. 53-6 and 53-7). The true AP view (see Fig. 53-7B) is preferred over standard AP views because it shows the glenohumeral joint without any bony overlap. Standard AP views taken with the joint in internal and external rotation profile the lesser and greater tuberosity and are more useful in the evaluation of soft tissue conditions.

**Table 53-1**

<table>
<thead>
<tr>
<th>Spinal Level</th>
<th>Sensory Area</th>
<th>Muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2-4</td>
<td>—</td>
<td>Trapezius</td>
</tr>
<tr>
<td>C5</td>
<td>Lateral arm</td>
<td>Deltoid</td>
</tr>
<tr>
<td>C6</td>
<td>Lateral forearm and thumb</td>
<td>Biceps</td>
</tr>
<tr>
<td>C7</td>
<td>Tip of long finger</td>
<td>Thumb extensors</td>
</tr>
<tr>
<td>C8</td>
<td>Tip of little finger and medial forearm</td>
<td>Finger flexors</td>
</tr>
<tr>
<td>T1</td>
<td>Medial arm</td>
<td>Hand interossei</td>
</tr>
</tbody>
</table>

Acceptable orthogonal views include the axillary lateral, transcapular lateral, and apical oblique. The preferred view is the axillary lateral (see Fig. 53-7A), which projects the glenohumeral joint in a cephalocaudal plane. This view is particularly useful for defining the relationship of the humeral head with the glenoid fossa and in identifying lesions of the coracoid process, humeral head, and glenoid rim. Some degree of abduction is required for the axillary view, and patient cooperation with this position may be limited by pain. The difficulty in obtaining this view has led to the popularity of the transcapular view (see Fig. 53-7B). Advantages of this projection include its simplicity and reproducibility and a clear delineation of anatomic structures. In this view the scapula is projected as a Y, with the body forming the lower limb and the coracoid and acromion processes forming the upper limbs. The humeral head normally is superimposed over the glenoid, which is located at the junction of the three limbs. This view is particularly useful in identifying anterior and posterior glenohumeral dislocations. The apical oblique view (obtained by having the patient stand bending forward, and angling the central ray 45 degrees caudally) shows the glenohumeral joint in a unique coronal projection. This view can be obtained easily and painlessly and has been found to be useful in evaluating for Hill-Sachs lesions in shoulder dislocations, and displacement and angulation of proximal humerus fractures.

Plain radiographs are the mainstay of the radiologic examination in the ED, but in selected circumstances, additional bone and soft tissue details may be obtained via computed tomography (CT) or magnetic resonance imaging (MRI). Bedside ultrasonography is emerging as a reliable screening and diagnostic imaging modality for selected injuries, in particular fractures of the clavicle.

### Specific Injuries

#### Fractures

**Clavicle**

Pathophysiology. The clavicle accounts for 5% of all fractures and is the most commonly fractured bone in children. Epidemiologic
studies in adults have documented an annual incidence rate of 29 to 64 per 100,000 population, with a 2:1 male-to-female ratio.\textsuperscript{13} Clavicular fractures are classified anatomically and mechanically into three groups. Fractures of the medial third are uncommon (5%) and occur as a result of a direct blow to the anterior chest. Fractures of the middle third are the most frequent (Fig. 53-8), accounting for 80% of all injuries. The usual mechanism of injury involves a direct force applied to the lateral aspect of the shoulder as a result of a fall, sporting injury, or motor vehicle collision (MVC). Fractures of the lateral third (15%) result from a direct blow to the top of the shoulder and are classified further into three subtypes.\textsuperscript{15} Type I fractures are stable and minimally displaced because the coracoclavicular ligament remains intact. Type II fractures are associated with a torn coracoclavicular ligament and have a tendency to displace because the proximal fragment lacks any stabilizing forces. Type III injuries involve the articular surface (Fig. 53-9).

**Clinical Features.** The patient has pain over the fracture site, and the affected extremity is held close to the body. With fractures of the middle third, the shoulder typically is slumped downward, forward, and inward. This positioning is a result of the effect of gravity and the pull of the pectoralis major and latissimus dorsi on the distal fragment. The proximal fragment often is displaced upward by the action of the sternocleidomastoid. The head is often tilted toward the injured side in an attempt to relax the effects of these displacing muscular forces. Ecchymosis, crepitus, and a palpable or visible deformity may be noted over the fracture site.

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**Figure 53-7.** Normal: axillary (A), true anteroposterior (B), and transscapular lateral (C) radiographic views (i.e., trauma series) of the shoulder.

**Figure 53-8.** Displaced midclavicular fracture.
Examine thoroughly for any tenting of the skin, as this can cause pressure necrosis and progression to an open fracture. Although associated neurovascular injury is rare, the close proximity of the subclavian vessels and brachial plexus demands a thorough assessment. Associated pneumothorax and pulmonary injuries are also rare unless an open or medial third fracture is present.14 Clavicle-specific plain radiographs should be obtained to confirm the presence of a fracture.12 The newborn clavicle fracture sustained during birth classically manifests as an uneventful “lump,” representing the area of subsequent callus formation, in a child brought in by a concerned parent. Fractures in children, especially neonates, can also be reliably diagnosed or ruled out by bedside ultrasound, sparing the infant exposure to radiation (Fig. 53-10).

Management. Principles of initial management include pain control, immobilization, and proper follow-up care. Fractures of the clavicle can be immobilized with supportive devices, such as a simple sling or sling and swathe (Fig. 53-11). Another immobilization technique for midclavicular fractures still recommended in the orthopedic literature, although its efficacy is not supported by evidence, is the clavicular (figure-of-eight) splint (Fig. 53-12). This splint is applied after closed reduction of the fracture, which is accomplished by pulling the shoulders up and back. Such reductions are difficult to maintain and may be associated with increased discomfort at the fracture site. Use of clavicular splints also can lead to skin irritation and compression of the neurovascular bundle in the axilla. Because some degrees of malunion and shortening are associated with an acceptable functional and cosmetic outcome, treatment with a simple sling is a valid and appropriate alternative to the clavicular splint in the ED.

Disposition. Immediate orthopedic consultation should be sought for open fractures or fractures associated with neurovascular injuries, skin tenting, or interposition of soft tissues. More urgent orthopedic consultation (before 72 hours) is recommended for type II lateral clavicle fractures because these fractures have up to a 30% incidence of nonunion and may require surgical repair.15 Severely comminuted or displaced fractures of the middle third (defined as over 20 mm of initial shortening) may also benefit from early orthopedic referral for consideration of operative reduction, because these have been associated with a higher incidence of nonunion and long-term functional deficits.14,15 Additional risk factors that have been associated with nonunion in midclavicular fractures include female gender and advancing age.16

Figure 53-9. Type III lateral clavicular fracture (intra-articular). (Courtesy David Nelson, MD.)

Figure 53-10. Ultrasound images of the clavicle. A, Normal. B, Midclavicular fracture. (Courtesy Keith Cross, MD.)
Greenstick fractures of the midclavicle are common in children (Fig. 53-13). Most of these fractures are nondisplaced and heal uneventfully. Initial radiographs may appear normal despite suggestive clinical findings. In these instances, the arm should be immobilized in a simple sling and the radiographic evaluation repeated in 7 to 10 days if pain persists, to evaluate for early callus formation.

Most fractures of the clavicle heal uneventfully, and follow-up can be provided by a primary care physician. A sling should be worn until repeat radiographs show callus formation and healing across the fracture site. Early passive shoulder range-of-motion exercises (Fig. 53-14) are encouraged to reduce the risk of adhesive capsulitis (so-called “frozen shoulder”). Younger children generally require shorter periods of immobilization (2 to 4 weeks) than adolescents and adults (4 to 8 weeks). Vigorous competitive play should be avoided until the bone healing is solid. Full range of motion of the shoulder and an absence of pain are two good clinical signs that the fracture has healed.

Complications. The most common complications are delayed union, nonunion, and symptomatic malunion.\(^\text{13,17}\) Displaced fractures of the middle third have a 15 to 20% rate of nonunion and up to 25% rate of symptomatic malunion.\(^\text{15}\) Vascular complications after fractures of the medial third can resemble those associated with posterior sternoclavicular dislocations. Articular surface injuries (type III lateral clavicle fractures) can lead to subsequent osteoarthritis of the ACJ.

An uncommon but important association is that between clavicle fractures and atlantoaxial rotatory displacement (AARD). Most cases occur in girls younger than 10 years. The pathophysiology may involve a lax or disrupted alar ligament along with sternocleidomastoid spasm. Early diagnosis is important because delayed diagnosis can lead to a chronic deformity requiring surgical correction. AARD should be suspected if the child has a clavicle fracture and demonstrates a “cocked-robin” position with the head bent toward the fractured side but rotated in the opposite direction. The injury is best demonstrated by CT and, if recognized early, can be treated with a soft cervical collar or halo traction.\(^\text{18}\)

Scapula

Pathophysiology. Fractures of the scapula are rare, with an annual incidence of 10 to 12 per 100,000 population.\(^\text{19}\) They account for 1% of all fractures and occur primarily in men 30 to 40 years old.\(^\text{8}\) In general, considerable force and energy are required to

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**Figure 53-13.** Greenstick fracture of the clavicle (arrow).

**Figure 53-14.** Types of active and passive shoulder exercises. Top left, active flexion; top right, active external rotation; bottom left, pendular; and, bottom right, active internal rotation.
fracture the body and neck of the scapula. Common mechanisms of injury include high-speed MVCs and falls from height.\textsuperscript{20} Coracoid process fractures are usually avulsive, and glenoid rim fractures are commonly associated with anterior glenohumeral dislocations. Acromial or spinous process fractures result from blunt trauma to the top of the shoulder.\textsuperscript{21} 

The most important aspect of scapular fractures is the high incidence (75-98\% of associated injuries to the ipsilateral lung, chest wall, and shoulder girdle complex).\textsuperscript{8,20} The most common associated orthopedic injuries are fractures of the ribs, proximal humerus, and clavicle. Associated lung injuries, including pneumothorax, hemothorax, and pulmonary contusion, usually occur acutely but may manifest in delayed fashion, 2 to 3 days after the initial injury. Associated injuries of the head, spinal cord, brachial plexus, and subclavian or axillary vessels are more significant but less common.\textsuperscript{8,20} Of note, in a large series of blunt trauma admissions, the prevalence of aortic injury was similar in patients with or without a fractured scapula.\textsuperscript{20} 

Fractures of the scapula have traditionally been classified according to their anatomic location. Fractures can involve the acromion process, scapular spine, or coracoid process. Fractures can also involve the scapular neck (Fig. 53-15), glenoid fossa (intra-articular), and scapula body. Recently the Orthopaedic Trauma Association proposed a more comprehensive classification system that allows for a better understanding of severity and prognosis associated with these fractures. Fractures are divided into two main types: extra-articular and intra-articular (with partial or total glenoid involvement).\textsuperscript{22} 

Clinical Features. In a conscious patient, the shoulder is adducted and the arm is held close to the body. Any attempts at movement result in significant pain. Associated tenderness, crepitus, or hematoma may be noted over the fracture site. The clinical findings occasionally mimic those with a rotator cuff tear. Hemorrhage into the rotator cuff associated with the scapula fracture can result in spasm and a temporary reflex inhibition of function (pseudo-rupture).\textsuperscript{21} The presence of a scapula fracture should prompt a thorough search for associated thoracic, intracranial, orthopedic, and neurovascular injuries.

Diagnostic Strategies: Radiology. The three-view trauma shoulder series will reveal most scapular fractures, as will careful examination of the scapula on the trauma chest radiograph. The true AP view best evaluates the glenohumeral joint, glenoid neck, and scapular body. The transscapular lateral view may demonstrate displacement of the glenoid and scapular body. The axillary lateral view is especially useful in evaluating fractures of the glenoid fossa and the acromion or coracoid process.\textsuperscript{8,21} An os acromiale (unfused acromial process epiphysis) is present in 3\% of the population and should not be confused with a fracture of the acromion.\textsuperscript{8} A comparison film can be useful because the abnormality is present bilaterally in 60\% of cases. In many patients, fractures of the scapula initially are overlooked despite being readily apparent on the initial supine trauma chest radiograph because of the life-threatening nature of the associated injuries.\textsuperscript{8} Although additional dedicated scapula views can be obtained in the ED, the presence as well as the extent of scapular injury is best determined by CT. In the event that a trauma chest CT scan has been obtained to search for associated injuries, a three-dimensional reconstruction of the scapula should be requested to further define the nature and extent of the injury.\textsuperscript{21,23} 

Management. Most fractures, including fractures with severe comminution and displacement, heal rapidly with conservative therapy.\textsuperscript{8,22} Initial therapy consists of analgesia and immobilization in a sling to support the ipsilateral upper extremity. Passive (see Fig. 53-14) followed by active range-of-motion shoulder exercises should be initiated as soon as discomfort subsides, to reduce the risk of adhesive capsulitis. Most patients require a sling for 2 to 4 weeks and close radiographic follow-up for assessment for delayed displacement.\textsuperscript{21} 

Fractures of the body and spine usually require no further therapy. Nondisplaced fractures of the acromion process also respond well to conservative therapy. Displaced acromial fractures that impinge on the glenohumeral joint require surgical management. Rarely, the acromion is fractured as part of a superior dislocation of the humeral head. In these instances, an accompanying tear of the rotator cuff is invariably present and requires surgical repair. If the coracoclavicular ligaments remain intact, fractures of the coracoid process respond well to conservative therapy. Severely displaced coracoid fractures with ruptured coracoclavicular ligaments usually require open reduction and internal fixation. Scapular neck and glenoid fossa fractures present the most difficult management issues. Although most of these injuries also do well with conservative therapy, open reduction and internal fixation may be recommended for severely displaced or angulated fractures.\textsuperscript{21} 

In a review of 520 scapula fractures from 22 case series, Złowodzki and co-workers reported that 80\% of all fractures with glenoid involvement were treated operatively, whereas 83\% of all neck injuries and 99\% of all isolated scapula body fractures were treated nonoperatively.\textsuperscript{19} 

Complications. Associated injuries of the ipsilateral lung, chest wall, and shoulder girdle account for most complications after fractures of the scapula. A shear-type brachial plexus injury has been associated with fractures of the acromion process. Neurovascular (brachial plexus, axillary artery) injuries also have been reported with fractures of the coracoid process, scapular neck, body, or spine fractures that extend into the supraspinal notch to injure the supraspinatus nerve. The most common presenting symptom of a supraspinal nerve injury is dull posterior shoulder pain that is worsened by activity. The characteristic examination finding is atrophy of the scapular muscles along with weakness in abduction and external rotation. Delayed complications include adhesive capsulitis and rotator cuff dysfunction.

Proximal Humerus 

Pathophysiology. Fractures of the proximal humerus are common and account for 4 to 5\% of all fractures.\textsuperscript{24} An epidemiologic Swedish study reported an incidence of 14 to 60 per 100,000 per year, with a mean age at occurrence of 63 years and a female-to-male ratio of 1.5:1.\textsuperscript{25} These fractures occur primarily in the older population, in whom structural changes associated with aging (osteoporosis) weaken the proximal humerus, predisposing it to
injury. Although most of these injuries involve minimal displacement and are adequately managed with conservative therapy, significantly displaced fractures may require operative intervention. Displacements encountered with fractures of the humerus usually reflect the pull of the attached muscle group.

Fractures of the proximal humerus separate along old epiphyseal lines, producing four distinct segments consisting of the articular surface (anatomic neck), greater tuberosity, lesser tuberosity, and humeral shaft (surgical neck). Neer’s classification system (Fig. 53-16) is based on the relationship of these fracture fragments. In this system, a segment is considered displaced if it is angled more than 45 degrees or separated more than 1 cm from the neighboring segment. Because this classification system considers only displacement, the number of fracture lines is irrelevant. There are four major categories of fracture: minimal displacement (Fig. 53-17), two-part displacement (Fig. 53-18), three-part displacement, and four-part displacement. When present, anterior and posterior dislocations are included as part of the classification. Impaction and head-splitting fractures are classified separately.

The classic mechanism of injury involves a fall on an outstretched abducted arm. Concurrent pronation limits further abduction and levers the humerus against the acromial process; this produces a fracture or dislocation, depending on the tensile strengths of the bone and surrounding ligaments. Older patients are prone to fracture, whereas younger persons are apt to have dislocations. The combined injury (fracture and dislocation) may be seen in middle-aged patients. Proximal humerus fractures also may result from a direct blow to the lateral side of the arm or from an axial load transmitted through the elbow. High-energy mechanisms and polytrauma are more common in younger persons.

Clinical Features. The affected arm is held close to the body, and movement is restricted by pain. Tenderness, hematoma, ecchymosis, deformity, or crepitus may be noted over the fracture site. A


![Figure 53-17. Three-part minimally displaced fracture of the proximal humerus involving the greater and lesser tuberosities.](image)

![Figure 53-18. Anteroposterior (A) and axillary (B) radiographic views of a two-part displaced fracture of the proximal humerus. The degree of displacement often is better visualized on the axillary view. (Courtesy David Nelson, MD.)](image)
thoracic neurovascular examination is essential to identify associated injuries of the axillary nerve, brachial plexus, or axillary artery (see Table 53-1). The three-view trauma series of shoulder radiographs will allow for assessment of the number of fracture fragments and degree of displacement or angulation.

Management. Minimally displaced fractures (see Fig. 53-17) constitute 80 to 85% of all cases. In these instances, limited displacement or angulation is present, and the fracture segments are held together by the capsule, periosteum, and surrounding muscles. Initial treatment consists of adequate analgesia and immobilization with a sling or sling and swathe device. The former is more comfortable, and a Cochrane review of 16 randomized trials found only limited evidence that use of special bandage immobilization affected time to fracture union or functional outcome.26 Traditionally, it has been recommended that immobilization be continued until clinical union is achieved (head and shaft are seen to move together). The Cochrane review also noted that immediate or earlier commencement of physiotherapy (within 1 week) resulted in less pain and did not compromise long-term outcome. Initial passive exercises (see Fig. 53-14) are gradually replaced by more active and resistive exercises. Most nondisplaced fractures heal over 4 to 6 weeks.

The treatment of two-part, three-part, and four-part displaced fractures is beyond the scope of this discussion. An orthopedic surgeon should be consulted, because many of these injuries require operative repair.24 Prospective and retrospective observational studies, however, have failed to show a significant functional difference between operative and nonoperative treatment of displaced two-part and three-part fractures in elderly patients. Current literature continues to support operative treatment of four-part fractures in the elderly; the procedure of choice is hemiarthroplasty.26

Fracture-dislocation injuries (Fig. 53-19) are best managed in consultation with an orthopedic surgeon before attempts at reduction (except in cases of neurovascular compromise or unavailability of an orthopedic surgeon). Of note, reductions of these injuries in the ED often are unsuccessful, and these manipulations can cause separation of previously undisplaced segments. Closed reduction under radiologic control and general anesthesia may be preferable.

Posterior glenohumeral dislocations usually are associated with anteromedial impression fractures of the articular surface. A similar fracture of the posterolateral aspect of the humeral head is present with anterior dislocations (Hill-Sachs deformity). Impression fractures involving less than 20% of the articular surface usually are stable. With more than 20% involvement, the reduction usually is unstable and requires surgical repair.

Complications. The most common complication of proximal humeral fractures is adhesive capsulitis. This complication can be prevented by the early initiation of pendular shoulder exercise, along with a thorough rehabilitation program. One of the most devastating complications is avascular necrosis (AVN) of the humeral head. The highest rate of AVN (up to 90%) has been documented for four-part fractures.27 Repeated forceful attempts at reduction of fracture-dislocations may be associated with subsequent heterotopic bone formation (myositis ossificans). Neurovascular injuries (axillary nerve, brachial plexus, and axillary artery) may be encountered with displaced surgical neck fractures and fracture-dislocations.

Proximal Humeral Epiphysis

Pathophysiology. Fractures of the proximal humeral epiphysis are uncommon and account for less than 1% of all pediatric fractures.28 The injury can occur at any age while the epiphysis remains open but is most common in adolescent boys. The most common mechanism of injury involves a fall onto the outstretched hand, and the fracture typically occurs through the zone of hypertrophy in the epiphyseal plate. Injuries can be classified according to their location (Salter system), stability, and degree of displacement.

Clinical Features. The patient holds the injured arm tightly against the body by the opposite hand. The area over the proximal humerus is swollen and extremely tender to palpation. Radiographs obtained at 90 degrees to each other confirm the diagnosis.

Figure 53-19. Two-part fracture and dislocation of the proximal humerus; anteroposterior (A) and transscapular lateral (B) radiographic views.
Clinical suspicion is the most important factor.

Comparison views may be helpful with minimally displaced fractures. Bedside ultrasound has also been shown to detect these injuries. In one series of 100 shoulder injury subjects, all three cases of proximal humerus fractures were detected by ultrasound imaging (sensitivity 83–93%) before shoulder radiographs had been obtained.12

Management. Fractures of the proximal humeral epiphysis should not be taken lightly, because the physis accounts for 80% of the growth of the bone. The active healing process at the site of an epiphyseal injury makes delayed reduction extremely difficult. Early orthopedic consultation should be obtained for all such injuries. Children younger than 6 years usually have Salter I epiphyseal injuries (Fig. 53-20), which can be treated conservatively with sling and swathe immobilization and analgesic agents. Children older than 6 years usually have a Salter II epiphyseal injury. Salter II injuries with more than 20 degrees of angulation may benefit from reduction, which is accomplished by reversing the mechanism of injury.16 Imperfect reductions often are acceptable because growth and remodeling correct the deformity with time. After reduction, unstable injuries should be immobilized in a shoulder spica cast, whereas stable lesions can be immobilized with a sling and swathe. Fractures of the proximal humeral epiphyses generally heal in 3 to 5 weeks.19

Complications. Complications are rare and include malunion, growth plate disturbances, and injuries to the neurovascular bundle. Markedly displaced or angulated fractures are more likely to result in a residual loss of mobility.

Dislocations

Sternoclavicular

Pathophysiology. SCJ dislocations are infrequent and account for less than 1% of all dislocations.28 Significant forces are required to disrupt the strong ligamentous stabilizers of this joint. The most common causes are MVCs and injuries sustained in contact sports. The SCJ can dislocate in an anterior or a posterior direction.

Anterior dislocations, which result from indirect forces, are more common (9:1 ratio).2 The usual mechanism of injury (Fig. 53-21) involves an anterolateral force to the shoulder, followed by backward rolling, which lever the medial clavicle out of its articulation. Posterior dislocations (Fig. 53-22) can result from a direct blow to the medial clavicle (30%) or from delivery of a postero-lateral force to the shoulder, followed by inward rolling (70%). Posterior dislocations can be associated with life-threatening injuries within the superior mediastinum, including acute airway compression.

Injuries to the SCJ can be graded into three types.5 A grade I injury is a mild sprain secondary to stretching of the sternoclavicular and costoclavicular ligaments. A grade II injury is associated with subluxation of the joint (anterior or posterior) secondary to rupture of the sternoclavicular ligament. The costoclavicular ligament remains intact. Complete rupture of the sternoclavicular and costoclavicular ligaments results in a grade III injury (dislocation). In patients younger than 25 years, these actually represent Salter type I injuries, because the medial epiphysis of the clavicle has not yet fused.30

Clinical Features. Clinical suspicion is the most important factor in diagnosing these injuries, and prompt diagnosis is vital because
Strategies: Tent pain. All grade III injuries should be managed by closed reduction expeditiously. Ideally, reduction of posterior dislocations is benign neglect.

Functional, the current treatment of choice for recurrent anterior dislocations is associated with more severe pain, and the neck is often flexed toward the injured side. The clavicular notch of the sternum may be palpable, and complaints of hoarseness, dysphagia, dyspnea, and weakness or paresthesias in the upper extremities have been documented. Rarely, airway complications caused by tracheal injury may be present. If present, airway compromise should be attended to promptly. These patients should also be examined thoroughly to identify any injuries to superior mediastinal or intrathoracic structures. The presence of cyanosis and venous congestion of the neck and arm is typical of an innominate vein injury. When necessary, appropriate consultation should be obtained.

Diagnostic Strategies: Radiology. Although the diagnosis of sternoclavicular dislocation can be made clinically, it should be confirmed radiologically. Findings on standard AP, oblique, and specialized (40-degree cephalic tilt) views often are difficult to interpret because of overlapping rib, sternum, and vertebral shadows. These dislocations and associated injuries are best visualized by CT (see Fig. 53-22). Ultrasound imaging also may be a useful adjunct in some circumstances.

Management. Treatment of grade I injuries includes immobilization (simple sling), adequate analgesia, and primary care follow-up. Immobilization generally is maintained (1-2 weeks) until full painless motion is restored. Grade II injuries should be immobilized with a sling or soft clavicular (figure-of-eight) splint (see Fig. 53-12) and the patient referred for orthopedic follow-up care. The figure-of-eight splint is preferred because it maintains the clavicle in a more anatomic position and permits ligament healing. Grade II injuries require a longer course of immobilization (3-6 weeks) and are more likely to be associated with persistent pain. All grade III injuries should be managed by closed reduction.

Anterior dislocations may be reduced in the ED after orthopedic consultation and intravenous analgesia (Fig. 53-23). A rolled sheet is placed posteriorly between the shoulder blades to elevate both shoulders approximately 5 cm above the table. Traction is applied to the arm in an extended (10- to 15-degree) and abducted (90-degree) position. If reduction does not occur, an assistant can add inward pressure on the medial end of the clavicle. Stable reductions should be maintained in a clavicular splint, and the patient referred for orthopedic follow-up care. Most reductions are unstable. Because the deformity is primarily cosmetic and not functional, the current treatment of choice for recurrent anterior dislocations is benign neglect.

Posterior dislocations constitute true orthopedic emergencies and should be reduced expeditiously. Ideally, reduction of posterior dislocations should be attempted in the operating room with the patient under general anesthesia, although it can be attempted in the ED with use of procedural sedation. Emergency reduction may be required for patients with airway obstruction or vascular compromise. The patient is positioned as described previously, and traction is applied in an extended and abducted position. If traction alone does not reduce the dislocation, concurrent clavicular manipulation may be helpful. After sterile preparation of the skin and administration of local anesthesia, the clavicle shaft is grasped with a sterile towel clip and pulled out anterolaterally. Once reduced, these injuries generally are stable and can be immobilized with a clavicular splint. An alternate method of reduction involves traction to the adducted injured arm while both shoulders simultaneously are forced posteriorly with direct pressure. This technique levers the clavicle into place and requires much less force than the traditional abduction-extension method.

Complications. Complications of anterior injuries are primarily cosmetic. By contrast, 30% of posterior dislocations may be complicated by life-threatening injuries to intrathoracic and superior mediastinal structures. Complications include compression or laceration of the great vessels, tracheoesophageal fistula, tracheal compression, pneumothorax, thoracic outlet syndrome, and brachial plexus injuries. These injuries are best visualized though a chest CT angiogram. A potential long-term complication of both anterior and posterior injuries is degenerative osteoarthritis, which manifests with pain and swelling over the joint or pain on shoulder movement.

Acromioclavicular Joint

Pathophysiology. Injuries of the ACJ occur primarily in young men as a result of participation in contact sports, such as football, rugby, ice hockey, and wrestling. A small percentage of injuries are caused by MVCs and falls.

The most common mechanism of injury involves a fall or direct blow to the point of the shoulder with the arm adducted. The resultant force drives the scapula downward and medially to produce the injury. The weak acromioclavicular ligaments rupture first. With increasing force, the coracoclavicular ligament ruptures, and the attachments of the deltoid and trapezius muscles are torn from the distal clavicle. The ACJ also can be injured after a fall onto the outstretched hand. In this instance, the force is...
transmitted to the acromioclavicular ligaments only, and the coracoclavicular ligament, which is relaxed, remains uninjured.

Classification is based on the degree of damage sustained by the acromioclavicular and coracoclavicular ligaments (Fig. 53-24). The most commonly used system is that modified by Rockwood. Type I injuries are sprains of the acromioclavicular ligaments with no separation of the acromion and clavicle. Type II injuries are often subtle and can be easily overlooked. With type I injuries, the radiographic appearance of the clavicle but a normal coracoclavicular distance. Type II injuries are associated with mild tenderness and swelling over the ACJ margin, with minimal deformity. A full range of motion is possible, although painful. Patients with type III, IV, V, and VI injuries usually have severe pain and hold the arm tightly adducted to reduce traction stress across the joint. In type III injuries, the shoulder hangs downward and the clavicle rides high, producing a characteristic clinical deformity. In type IV injuries, the clavicle may be palpable posteriorly, and in type V injuries, the clavicle may be palpable subcutaneously above the acromion. In type VI injuries, the shoulder assumes a flattened clinical appearance as seen from the side.

**Clinical Features.** Patients should be examined while they are in the sitting or standing position because the supine position can mask ACJ instability. It is helpful to visualize both shoulders simultaneously to assess symmetry. Type I and type II injuries are associated with mild tenderness and swelling over the ACJ margin, with minimal deformity. A full range of motion often is possible, although painful. Patients with type III, IV, V, and VI injuries usually have severe pain and hold the arm tightly adducted to reduce traction stress across the joint. In type III injuries, the shoulder hangs downward and the clavicle rides high, producing a characteristic clinical deformity. In type IV injuries, the clavicle may be palpable posteriorly, and in type V injuries, the clavicle may be palpable subcutaneously above the acromion. In type VI injuries, the shoulder assumes a flattened clinical appearance as seen from the side.

**Diagnostic Strategies: Radiology.** The energy settings used for the three-view shoulder trauma series usually overpenetrate the ACJ. Specific ACJ views that use one-third to two-thirds less intensity should be ordered. The recommended projections include an AP view of both joints on a single wide film, an axillary lateral view, and a 15-degree cephalic tilt view. The axillary lateral view is useful for identifying associated fractures and posterior dislocation of the clavicle. The normal coracoclavicular distance ranges from 11 to 13 mm. A difference of more than 5 mm between the injured and uninjured sides is diagnostic of a complete coracoclavicular disruption. With type I injuries, the radiographic appearance is essentially normal. With type II injuries, radiographs show widening of the joint and a slight upward or posterior displacement of the clavicle but a normal coracoclavicular distance. Type II injuries are often subtle and can be easily overlooked. With type III, IV, and V injuries, radiographic features include a widened joint, an increased coracoclavicular distance, and either superior or posterior displacement of the clavicle (Fig. 53-25). Historically, stress views of the ACJ have been recommended to differentiate between type II and type III injuries. Such views lack efficacy for this purpose, and their routine use is unnecessary.

**Management.** Type I and II injuries should be immobilized in a sling for comfort and to protect against further injury. Patients with these injuries should be referred for follow-up with their primary care physician. When pain has subsided (1 to 3 weeks), range-of-motion and strengthening exercises can begin, with a return to sports when pain-free function has been achieved.
Type IV, V, and VI injuries require early surgical treatment. The management of type III injuries has changed dramatically since the 1980s. Most studies have concluded that conservative treatment provides functional results equivalent to or, in some cases, better than those obtained with surgical intervention. In addition, surgical patients have longer recovery times and higher complication rates. The main complications of conservative therapy are the persistence of nuisance symptoms (clicking or minor pain) and a cosmetic deformity. Selected patients who are young, have severe displacement (more than 2 cm), and perform repetitive overhead activities may be candidates for surgical intervention.

Treatment of type III injuries in the ED should consist of sling immobilization and early orthopedic referral (within 72 hours) if the patient is deemed to be a potential surgical candidate. The initial therapy in all cases should include adequate analgesia. The patient is in severe pain, with the anterior shoulder appearing full. The patient leans away from the injured side and cannot adduct or internally rotate the shoulder even slightly without severe pain. A neurovascular examination is performed to identify associated injuries of the brachial plexus, axillary nerve, radial nerve, or axillary artery. The reported incidence of axillary nerve injuries after anterior glenohumeral dislocation ranges from 5 to 54%, and they are more frequent in patients older than 50 years. Axillary nerve function can be assessed by testing for sensation over the lateral aspect of the shoulder and by testing motor function of the teres minor and deltoid muscles. Deltoid function is tested by having the patient attempt shoulder abduction while the examiner feels for muscle contraction. Motor testing is more accurate because sensory testing can be misleading owing to the presence of overlapping cutaneous nerve root dermatomes.

Diagnostic Strategies: Radiology. The trauma series of radiographs will confirm the clinical diagnosis and identify the position of the humeral head (Fig. 53-27). Associated fractures may be present in 50% of cases. The most common of these is a compression fracture of the posterior aspect of the humeral head caused by forceful impingement against the anterior rim of the glenoid fossa. This defect in the humeral head, or Hill-Sachs deformity (see Fig. 53-27), is reported to be present in 11 to 50% of all anterior dislocations. The actual incidence is probably much higher, because minor compression fractures are difficult to visualize on plain radiographs. The defect is best visualized on an internal rotation AP view of the glenohumeral joint. Although common, Hill-Sachs fractures are of limited clinical significance unless they are large enough to cause recurrent shoulder instability or painful clicking or catching, in which case surgical repair may be necessary. A corresponding fracture of the anterior glenoid rim (Bankart’s fracture) is present in approximately 5% of cases.

Avulsion fractures of the greater tuberosity are present in 10 to 20% of anterior dislocations. The actual incidence is probably much higher, because minor avulsion fractures are difficult to visualize on plain radiographs. The defect is best visualized on an internal rotation AP view of the glenohumeral joint. Although common, Hill-Sachs fractures are of limited clinical significance unless they are large enough to cause recurrent shoulder instability or painful clicking or catching, in which case surgical repair may be necessary. A corresponding fracture of the anterior glenoid rim (Bankart’s fracture) is present in approximately 5% of cases.

Management. Reduction of the dislocation should be accomplished expeditiously, because the incidence of neurovascular complications increases with time. Radiographic documentation of the type of dislocation and any associated fractures should
Most of these techniques are quite effective, but approximately 5 to 10% of dislocations cannot be reduced in the ED. Traction techniques use steady force applied in various directions (forward flexion, abduction, overhead, lateral) to overcome the muscle spasm that holds the humeral head in its dislocated position. In the Stimson or hanging weight technique (Fig. 53-28), the patient is placed prone with the dislocated arm hanging over the edge of the examining table. A 10- or 15-pound weight attached to the wrist or lower forearm provides traction in forward flexion. Reduction usually occurs over 20 to 30 minutes. In the traction-countertraction method (Fig. 53-29), traction is applied along the abducted arm while an assistant using a folded sheet wrapped across the chest applies countertraction. Another simple and effective traction technique is the Snowbird technique, which has a reported success rate of 97%. In this method, the patient is seated in a chair and the affected arm is supported by the patient’s unaffected extremity. A 3-foot loop of 4-inch cast stockinette is placed generally be obtained before reduction is attempted. Reduction can be accomplished with various techniques, most of which involve traction, leverage, or scapular manipulation principles. The ideal method should be simple, quick, and effective; require little assistance; and cause no additional injury to the shoulder. It is wise to be familiar with several techniques of reduction, because none is uniformly successful.

Analgesia and muscle relaxation through procedural sedation are often used to facilitate reduction in the ED. Muscle relaxation and analgesia also can be provided through intra-articular injection of a local anesthetic agent. This technique is especially useful when procedural sedation is contraindicated. Under sterile technique, the joint is entered 2 cm inferior to the lateral edge of the acromion with an 18-gauge or 20-gauge needle. Any associated hemarthrosis is aspirated; then 20 mL of 1% lidocaine is injected over 30 seconds. The patient is allowed to relax for 15 minutes before reduction is attempted. The published studies to date all have used lidocaine, although it would be reasonable to expect similar results with other local anesthetic agents such as bupivacaine.

Fitch and Kuhn recently reviewed six randomized controlled trials comparing intravenous sedation and intra-articular lidocaine. Outcomes in these studies included success rates, complications, and time spent in the ED. Although the reduction techniques were not controlled in these studies, none showed a statistical difference in the reduction success rates, which averaged 92% for both the intra-articular lidocaine and intravenous sedation groups. Complication rates were quite different, however, averaging 0.67% in the intra-articular lidocaine group and 13.3% in the intravenous sedation group. The most common in the lidocaine group was “psychological agitation,” whereas the sedation group experienced nausea, vomiting, and respiratory depression. Time spent in the ED was significantly less for the intra-articular lidocaine group. Depending on the duration of the dislocation, nature (primary vs. recurrent) and technique, reduction can also be attempted and accomplished successfully without the use of any analgesia or muscle relaxation.

There are many techniques that can be used for reduction of an anterior shoulder dislocation, some of which are highlighted here.

**Figure 53-27.** Recurrent anterior subcoracoid dislocation with Hill-Sachs deformity of the humeral head (arrow).

**Figure 53-28.** Stimson or hanging weight method of reduction for anterior shoulder dislocations.

**Figure 53-29.** Traction-countertraction method for reducing anterior shoulder dislocations.
along the proximal forearm of the involved extremity with the elbow at 90 degrees. The patient is assisted or instructed to sit up, and the physician’s foot is placed in the stockinette loop to provide firm downward traction. The physician’s hands remain free to apply any gentle external pressure or rotation as needed until reduction is accomplished.

The most commonly recommended leverage technique is the external rotation method of Leidelmeyer. With the patient in the supine position, the involved arm is slowly and gently adducted to the side. The elbow is flexed to 90 degrees, and slow, gentle external rotation is applied to achieve reduction (Fig. 53-30). Success rates with this method range from 80 to 90%. With the Milch technique, the patient is placed supine on the gurney and the head of the bed is elevated 20 to 30 degrees. The affected arm is held by the wrist and slowly abducted and externally rotated. The operator stops whenever resistance to motion is encountered and continues when the patient is relaxed. If the humerus has not reduced by the time 90 degrees of abduction and 90 degrees of external rotation have been reached, gentle longitudinal traction is applied along the humerus while the free hand is used to exert lateral and superior pressure on the humeral head to complete the maneuver. Reduction usually takes 5 to 10 minutes and can be accomplished without an assistant or procedural sedation. O’Connor and colleagues recently reported a 100% success rate on first attempt with the Milch technique. The effectiveness of this method has been attributed in part to more conical symmetry of the muscle forces acting across the glenohumeral joint. Several variants of the Milch technique have been reported in the literature.

Scapular manipulation accomplishes reduction by repositioning the glenoid fossa rather than the humeral head and can be successful with minimal analgesia or muscle relaxation. Manipulation can be combined with the Stimson or traction-countertraction techniques. After the application of traction (manual or hanging weights), the scapula is manipulated by rotation of the inferior tip medially (Fig. 53-31) while the superior and medial edges are stabilized with the opposite hand. Scapular manipulation can also be used in a seated position in which a second operator applies traction in the forward horizontal position. Scapular manipulation can be difficult in heavyset patients, in whom it is difficult to palpate and grasp the inferior tip of the scapula.

More traditional techniques, such as the Hippocratic method (traction with the foot in the axilla) and the Kocher maneuver (leverage, adduction, and internal rotation), are no longer recommended because of a high incidence of associated complications (axillary nerve injury, humeral shaft and neck fractures, capsular damage). Comparative studies of the efficacy, safety, and reliability of reduction techniques are limited. In a recent randomized study, a variation of the Milch technique called FARES (Fast, Reliable, and Safe) was found to be more effective, faster, and less painful than the traction-countertraction and Kocher methods. FARES adds oscillation in a vertical direction while the affected arm is abducted. In this study, reductions were performed by junior residents without any anesthesia, sedation, or analgesia. The neurovascular examination should ideally be repeated and findings recorded after any attempt at reduction.

Traditional teaching has been to obtain prereduction and postreduction radiographs. Shuster and colleagues investigated the need for prereduction radiographs. In one study, they found that when the emergency physician was clinically confident of the diagnosis, the radiographs were 100% accurate. In a follow-up study, the researchers demonstrated that implementation of voluntary guidelines based on physician certainty allowed for the elimination of prereduction radiographs in 88.9% of cases. It also is generally recommended that radiographic studies be performed after reduction to confirm reduction and identify any associated fractures. Some studies have questioned the need for and cost-effectiveness of routine postreduction radiographs. These investigators did not find any new clinically significant fractures on postreduction radiographs and argued that in most instances...
a successful reduction can be determined clinically by the presence of a palpable clunk, decrease in pain, and improvement in the range of motion. Reduction in the number of postreduction radiographs also decreases costs and shortens the ED throughput times. The findings on most of these studies are very subjective, however, and one cannot assume that all practitioners will have the same clinical acumen. Other studies show that as many as 7.5% of fractures initially were detected only on postreduction films. Plain radiography of the shoulder is readily available and presents little or no risk to the patient. Unfortunately, failure to confirm reduction with radiographs and failure to diagnose all associated fractures could lead to malpractice claims. For these reasons, imaging of suspected shoulder dislocations remains advisable in most cases, with the possible exception of some patients with a history of recurrent dislocations in the absence of trauma. In these cases, prereduction films may not be necessary; however, a postreduction film may be advisable. In addition, imaging can also identify Bankart’s lesions (avulsion of the antero-inferior glenohumeral ligament with capsulolabral detachment), which are an indication for surgery, as well as Hill-Sachs deformities, which when large can be associated with subsequent shoulder instability.

After reduction, the affected extremity is immobilized with a sling and swathe bandage or a Velpeau sling (see Fig. 53-11). Patients should be discharged with adequate analgesia and appropriate follow-up referral. Primary dislocations and complicated cases (associated fracture, rotator cuff tear, axillary nerve injury) should receive orthopedic follow-up care. Conventionally, the shoulder is immobilized for 3 to 6 weeks in younger patients and for 1 to 2 weeks in those older than 40 years. A recent meta-analysis, however, found no added benefit from more prolonged immobilization in younger populations.

The traditional position of immobilization is with the shoulder in internal rotation. Studies suggest that this positioning may delay healing and is associated with a higher recurrence rate. External rotation may allow for better alignment of injured soft tissues (Fig. 53-32). In a randomized clinical trial with a minimum follow-up of 2 years, Itoi and colleagues found that 3 weeks of immobilization in 10 degrees of external rotation was associated with a 26% recurrence rate, compared with a 42% recurrence rate with sling immobilization in internal rotation. Similar findings were reported in a recent systematic review of the literature on immobilization position.

Other investigators, however, have failed to confirm this finding, and so the optimal postreduction immobilization position remains unclear. Early initiation of shoulder exercises (see Fig. 53-14) helps reduce the risk of adhesive capsulitis. A meticulous rehabilitation program aimed at restoring the static and dynamic stabilizers of the glenohumeral joint follows the period of immobilization.

Complications. Complications include the aforementioned fractures and neurovascular injuries. Most axillary nerve injuries are neurapraxic, management is expectant, and the prognosis for recovery of function is good. Rotator cuff tears may be present in 10 to 15% of cases. Rotator cuff tears are especially common in primary dislocations in patients older than 40 years. In this setting, failure to abduct the arm often is misdiagnosed initially as an axillary nerve injury. Most of these patients require tendon and capsular repair to restore shoulder stability. Recurrence also is a common complication after anterior dislocation, and patients younger than 30 years have a reported recurrence rate of 79 to 100%. A Hill-Sachs deformity, Bankart’s lesion, or a glenoid rim fracture are all associated with increased risk of recurrence. Recent studies suggest that the traditional method of treatment (immobilization followed by physical therapy) is ineffective in preventing redislocation in young, highly athletic persons. Arthroscopic studies of primary anterior dislocations in such patients have detected a high incidence of anterior-inferior capsulolabral avulsions (Bankart’s lesion) from the glenoid rim. This avulsion is believed to be the primary predisposing factor for recurrence, and affected patients seem to benefit from early arthroscopic repair of the lesion. Recurrence rates decline with increasing age and in the presence of a greater tuberosity fracture, and possibly immobilization in external rotation.

Anterior Subluxation. Transient anterior subluxation of the shoulder is encountered often in young athletic adults. The patient reports sudden sharp shoulder pain and weakness (“dead arm syndrome”) that occurred while performing an abduction and external rotation maneuver. The patient also may relate a sensation of the shoulder’s slipping in and out. The radiographic appearance usually is normal, and presence of an apprehension sign confirms the diagnosis. For this sign to be elicited, the injury motion (abduction and external rotation of the arm) is gently reproduced while an anterior force is applied to the posterior shoulder (Fig. 53-33). This maneuver increases the pain and may cause anterior displacement of the humeral head. With a positive test result, the patient will actively resist further external rotation and appear apprehensive. A lax or redundant anterior capsule is thought to be responsible for this syndrome, and recurrent episodes are common. These patients should be referred for orthopedic follow-up care because definitive therapy (capsulorrhaphy) is surgical.

Figure 53-32. Postreduction immobilization with an external rotation splint

Figure 53-33. Technique for performing the shoulder apprehension test. (From Simon RR, Koenigsknecht SJ: Emergency Orthopedics: The Extremities, 2nd ed. Norwalk, Conn, Appleton & Lange, 1987.)
Posterior Dislocation

Pathophysiology. Posterior dislocations are rare and account for 2 to 5% of all glenohumeral dislocations. This rarity is explained partly by the anatomy of the shoulder girdle. The 45-degree angulation of the scapula on the thoracic cage positions the glenoid fossa posterior to the humeral head, which serves as a partial buttress against posterior dislocation. More than 50% of posterior dislocations are missed on initial evaluation, and many remain unrecognized (“locked posterior dislocations”) for weeks or months.

A posterior dislocation can result from several distinct mechanisms of injury. Convulsive seizures (epileptic or after electrical shock) have been associated with unilateral or bilateral posterior dislocations. In this instance, the larger and stronger internal rotator muscles (latissimus dorsi, pectoralis major, teres major, subscapularis) overpower the weaker external rotators (teres minor, infraspinatus) to produce the injury with or without associated trauma. A posterior dislocation also can occur after a fall onto the outstretched hand with the arm held in flexion, adduction, and internal rotation or after a direct blow to the anterior aspect of the shoulder. A seizure disorder should be suspected in cases of unexplained nocturnal posterior dislocations. Acute posterior dislocations are anatomically classified into three types—subacromial (most common), subglenoid, and subspinous—based on the final resting position of the humeral head.

Clinical Features. Early diagnosis is essential to prevent long-term functional and therapeutic complications. As mentioned, the initial examining physician misses the diagnosis with some regularity, in part because of an over-reliance on radiologic findings and an under-reliance on the clinical examination. The most common misdiagnosis is adhesive capsulitis. The patient holds the affected arm across the chest in adduction and internal rotation. Although usually painful, the injury can be relatively painless. The normal shoulder contour is replaced by a flat, squared-off appearance and the coracoid process is prominent and easily palpated. The humeral head may be palpable posteriorly beneath the acromion process. Abduction is severely limited, and external rotation is completely blocked because the humeral head remains impacted against the posterior glenoid rim.

Diagnostic Strategies: Radiology. True or standard AP radiographs can appear deceptively normal with posterior dislocations. The common difficulty with identifying posterior dislocation in the frontal plane has led to the description of several characteristic radiographic features. Standard AP films show loss of the half-moon elliptic overlap of the humeral head and glenoid fossa. In addition, the distance between the anterior glenoid rim and the articular surface of the humeral head is increased (the rim sign). The humeral head is profiled in internal rotation and takes on a “lightbulb” or “drumstick” appearance (Fig. 53-34). A true AP film shows abnormal overlap of the glenoid fossa with the humeral head (Fig. 53-35). Finally, an impaction fracture of the anteromedial humeral head (reverse Hill-Sachs deformity) is invariably present (see Fig. 53-35). This fracture may produce a curvilinear density on the frontal projection parallel to the articular cortex of the humeral head (the trough sign). An orthogonal view, such as an axillary lateral, transscapular Y (see Fig. 53-34), or apical oblique view, confirms the diagnosis. The axillary lateral view or apical oblique view also identifies associated fractures of the humeral head and posterior glenoid rim. If an adequate orthogonal view cannot be obtained, shoulder CT should be considered.

Management. Closed reduction may be attempted in the ED with procedural sedation. The technique of reduction incorporates internal rotation and lateral traction to disimpact the humeral head from the glenoid rim. The humeral head can also be disimpressed with use of the “lever principle”—adducting the arm as much as possible, pulling the forearm in internal rotation to the opposite side of body while simultaneously pushing the medial side of the proximal arm laterally. Once the humeral head is disimpacted, reduction can be accomplished with slow external rotation in conjunction with gentle pressure on the posteriorly displaced head. If this technique fails, reduction with the patient under general anesthesia is indicated. After reduction the shoulder should be immobilized in external rotation with slight abduction. Cases that were missed initially and manifest as chronic or “locked” posterior dislocations should be discussed with the
orthopedist because they often require semielective open reduction and internal fixation or arthroplasty.\textsuperscript{55,56} Complications. Fractures of the glenoid rim, greater tuberosity, lesser tuberosity, and humeral head account for most associated injuries. The subscapularis muscle rarely may be avulsed from its insertion site on the lesser tuberosity. Neurovascular injuries are uncommon because the anterior location of the neurovascular bundle protects it from injury. Recurrent posterior dislocations occur in 30\% of patients and predispose the joint to degenerative changes.

Inferior Glenohumeral Dislocation (Luxatio Erecta)

Pathophysiology. Luxatio erecta is a rare type of glenohumeral dislocation in which the superior aspect of the humeral head is forced below the inferior rim of the glenoid fossa. Less than 0.5\% of all shoulder dislocations are of this variety, and the mechanism of injury involves either indirect or direct forces.\textsuperscript{56} Most inferior dislocations result from indirect forces that hyperabduct the affected extremity. This causes impingement of the humeral head against the acromion process. Further levering of the humeral shaft against the acromion ruptures the capsule and dislocates the head inferiorly (Fig. 53-36). Application of a direct axial load to an abducted shoulder also can disrupt the weak inferior glenohumeral ligament and drive the humeral head downward.

Clinical Features. Clinically, the patient has the arm locked overhead in 110 to 160 degrees of abduction. The elbow usually is flexed, and the forearm typically rests on top of the head. The shoulder is fixed in this position, and any attempts at movement result in significant pain. The inferiorly displaced humeral head may be palpable along the lateral chest wall. A thorough neurovascular examination is essential to evaluate for associated injuries.

Diagnostic Strategies: Radiology. Many cases of luxatio erecta are mistakenly diagnosed and treated as subglenoid anterior dislocations because the radiographic features of these two clinical entities are remarkably similar. Standard AP radiographs show the superior articular surface inferior to the glenoid fossa (Fig. 53-37). In addition, the humeral shaft characteristically lies parallel to the

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**Figure 53-36.** Luxatio erecta. A, The mechanism by which this injury occurs in hyperabduction. B, This is always accompanied by disruption of the rotator cuff and tear through the inferior capsule. (From Simon RR, Koenigskencht SJ: Emergency Orthopedics: The Extremities, 2nd ed. Norwalk, Conn, Appleton & Lange, 1987.)

**Figure 53-37.** Anteroposterior radiographic view of an inferior glenohumeral dislocation. The humeral shaft lies parallel to the spine of the scapula.
spine of the scapula on the AP view. This radiographic feature is useful in distinguishing luxatio erecta from a subglenoid anterior dislocation: in the latter the humeral shaft lies parallel to the chest wall. Associated fractures of the acromion, coracoid, clavicle, greater tuberosity, humeral head, and glenoid rim are common.

**Management.** Reduction usually can be accomplished by traction-countertraction maneuvers under procedural sedation. The operator applies traction in line with the humeral shaft while an assistant applies countertraction across the shoulder (Fig. 53-38). Gentle abduction usually reduces the dislocation, and the arm is brought down into an adducted position. Multiple attempts may be necessary; occasionally, “buttonholing” of the capsule will prevent closed reduction, necessitating an orthopedic consultation for open reduction. An alternative approach is the two-step closed reduction maneuver, in which the inferior dislocation is first converted into an anterior dislocation before being reduced.\(^\text{57}\) Initially, one hand is placed on the shaft of the dislocated humerus and the other hand on its medial condyle. The hand on the shaft initiates an anteriorly directed force rotating the humeral head from an inferior to an anterior position. The adducted humerus can then be externally rotated to reduce the head into the glenoid fossa. The reported advantages of the two-step maneuver are that it requires a single operator, fewer attempts, minimal force, and only local analgesia or minimal procedural sedation.\(^\text{57}\)

**Complications.** Neurapraxic lesions of the brachial plexus are common, and thrombosis of the axillary artery has also been associated with luxatio erecta.\(^\text{56}\) Other associated injuries include tears of the rotator cuff, damage to the glenoid labrum, and avulsion fractures of the greater tuberosity.

**Scapulothoracic Dislocation**

Scapulothoracic dissociation is a rare and severe injury characterized by complete disruption of the scapulothoracic articulation and may be thought of as a partial or complete internal forequarter amputation.\(^\text{56}\) The mechanism of injury involves a massive blunt force directed over the shoulder or severe traction force applied to the upper extremity. Approximately 50% of the reported cases involve motorcycle accidents, with the injury occurring when the motorcyclist hangs onto the handlebars while the body is forced away.\(^\text{59}\) The diagnosis is based on history, clinical findings, and radiologic studies. The injury often is overlooked at first, because most patients have multiple injuries that distract the treating physician.\(^\text{59}\) Massive local soft tissue swelling of the shoulder, along with more than 1 cm of lateral displacement of the scapula on the AP chest radiograph, is pathognomonic for scapulothoracic dissociation (Fig. 53-39). Associated osseous injuries include acromioclavicular separation, displaced fractures of the clavicle, and dislocations of the SCJ. Vascular lesions have been reported in 88% of patients and severe neurologic injuries in 94%, so a thorough assessment for these injuries is essential.\(^\text{58}\) Acute limb ischemia is rare because of the extensive collateral network in the shoulder. Vascular and neurologic injuries can be confirmed through angiography and MRI. Outcomes generally are poor, with death in 10% of cases and a flail anesthetic upper extremity in complete brachial plexus injuries. Many of these latter cases eventually in upper extremity amputation.\(^\text{58}\)

**Soft Tissue Conditions**

**Impingement Syndromes: Rotator Cuff Tendinitis, Subacromial Bursitis**

**Pathophysiology.** Rotator cuff tendinitis and subacromial bursitis can be considered part of a pathophysiologic continuum whose
Recurrent pain with activity

Conservative, surgical

The spectrum of illness is marked by a progression of symptoms. Neer classified the progressive pathologic processes into three stages (Table 53-2). Patients in stage 1 report a dull ache around the deltoid area after strenuous activity. On examination, tenderness can be elicited over the supraspinatus and anterior acromion. A painful arc of abduction at 60 to 120 degrees is characteristic. The Neer impingement sign (Fig. 53-41) has a sensitivity of 68% for all three stages. Several other tests have been described for the diagnosis of impingement syndrome. The combination of the Hawkins-Kennedy impingement sign (arm placed into 90 degrees of flexion followed by internal rotation), the painful arc sign, and the infraspinatus muscle test (resistance to internal rotation with arm adducted and elbow flexed to 90 degrees) provided the best post-test probability (95%) in one large clinical study.

Stage 2 is characterized by more persistent pain that is particularly severe at night. The inflammatory process within the bursa and tendons leads to the formation of minor adhesions. Disruption of these adhesions is thought to account for the nighttime pain. Physical findings are similar to those in stage 1. In addition, bursal thickening leads to increased soft tissue crepitus within the glenohumeral joint.

The hallmark of stage 3 is significant tendon degeneration after a prolonged history of tendinitis and bursitis. Findings in this stage are discussed in the subsequent section on tears of the rotator cuff. The radiographic appearance usually is normal in stages 1 and 2. Findings in stage 3 are similar to those with complete tears of the rotator cuff.

The differential diagnosis of impingement syndrome is extensive and includes intrinsic and extrinsic causes of shoulder pain. Extrinsic sources include the cervical spine, lung, heart, and diaphragm. Intrinsinc conditions include acromioclavicular arthritis, adhesive capsulitis, calcific tendinitis, and traumatic anterior subluxation. A Neer impingement sign may be present in many of these other conditions. Relief of pain after the subacromial injection of 10 mL of 1% lidocaine (impingement test; see Fig. 53-41) helps localize the condition to the subacromial space.

**Table 53-2** Three Progressive Stages of Impingement Lesions

<table>
<thead>
<tr>
<th>STAGE</th>
<th>PATHOLOGIC FINDINGS</th>
<th>AGE (yr)</th>
<th>COURSE</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Edema, hemorrhage</td>
<td>&lt;25</td>
<td>Reversible</td>
<td>Conservative</td>
</tr>
<tr>
<td>2</td>
<td>Fibrosis, tendinitis</td>
<td>25-40</td>
<td>Recurrent pain with activity</td>
<td>Conservative, surgical</td>
</tr>
<tr>
<td>3</td>
<td>Bone spurs, tendon rupture</td>
<td>&gt;40</td>
<td>Progressive disability</td>
<td>Surgical</td>
</tr>
</tbody>
</table>
Management. Initial treatment in stage 1 impingement syndrome is conservative and consists of rest, nonsteroidal anti-inflammatory drugs (NSAIDs), and modification of activities that produce impingement. In stage 2, emphasis is on maintaining flexibility and range of motion through physiotherapy and rotator cuff strengthening exercises. Patients with stage 1 and 2 disease in the ED with reports of treatment failure with NSAIDs may benefit from a subacromial injection of a local anesthetic (lidocaine or bupivacaine) and corticosteroid preparation (Table 53-3), along with referral to a primary care sports medicine physician. Corticosteroid injections take 3 to 4 days to achieve their full effect and must be injected accurately into the subacromial bursa. Patients with treatment-refractory stage 2 and stage 3 disease may require decompression surgery to control pain. Patients with stage 2 and stage 3 disease may benefit from referral to an orthopedist for more detailed evaluation and treatment.

Rotator Cuff Tears

Pathophysiology. The rotator cuff acts as a dynamic stabilizer of the glenohumeral joint. Its primary function is to hold the humeral head in place throughout the full range of motion (see Fig. 53-5). In addition, it contributes power in all directions and is responsible for specific movements. The infraspinatus and teres minor act as external rotators, whereas the subscapularis is an internal rotator. The supraspinatus is essential for the first 30 degrees of shoulder abduction.

The tenuous blood supply of the rotator cuff, abusive tensile overload, and chronic wear under the coracoacromial arch predispose it to age-related degenerative changes. The advanced stage of this process is characterized by complete rupture of the rotator cuff.

The role of impingement in the development of rotator cuff tears is controversial. Primary impingement (e.g., impingement related to variation in acromion anatomy) is uncommon but when present accelerates the degenerative process. More often, weakening or rupture of the cuff with age allows for superior migration of the humeral head, which results in secondary impingement. This impingement produces secondary changes within the subacromial space and symptoms characteristic of the impingement syndrome.

Rotator cuff tears typically involve the dominant arm and occur in men older than 40 years. The occupational history is significant for strenuous work requiring overhead activity. Most tears occur near the attachment of the supraspinatus and can extend anteriorly into the subscapularis or posteriorly into the infraspinatus. Tears can be classified according to their size, completeness, pattern location, or duration. A clinically useful system is to divide tears into acute or chronic types. Acute tears (10%) usually are associated with a specific traumatic event. Often, no history of previous shoulder problems can be identified. The most common mechanism of injury is forced abduction associated with significant resistance; this usually occurs when the patient attempts to break a fall with an outstretched hand. Alternatively, the tendon
Features. With acute tears, patients typically report a sudden tearing sensation in the shoulder followed by severe pain that radiates into the arm. Pain and secondary muscle spasm limit shoulder motion. Physical findings depend on the completeness, size, and location of the tear. Point tenderness is usually present over the site of rupture (greater tuberosity). A palpable defect also may be present. Subacromial injection of 10 mL of 1% lidocaine eliminates pain and allows for proper evaluation of motor function. The patient with a large tear cannot initiate shoulder abduction. A discrepancy between active and passive range of motion is highly suggestive of a rotator cuff tear.64 The drop-arm test, performed by passively abducting the arm to 90 degrees and asking the patient to hold the arm in this position, is positive with significant tears. Slight pressure on the distal forearm or wrist causes the patient to drop the arm suddenly. The acute pain resulting from hemorrhage and spasm subsides over a few days. Repeat examination at this point confirms the loss of function in significant tears.

Chronic tears account for approximately 90% of all lesions. Chronic tears are attritional and more insidious in their presentation. Early findings include the painful arc sign as a result of secondary impingement. The pain is worse at night and interferes with sleep. Worsening pain is followed by the gradual onset of weakness in the arm. Flexion and abduction are affected first. The patient attempts to initiate abduction with scapulothoracic movement. Internal rotation is weakened by anterior extension of the tear. Posterior extension compromises external rotation. The drop-arm test result is positive with large tears, and atrophy of the supraspinatus and infraspinatus muscles may be seen. In a large clinical study, the combination of the painful arc sign, positive drop-arm test result, and positive infraspinatus muscle test result produced the best post-test probability (91%) for full-thickness rotator cuff tears.62

Diagnostic Strategies: Radiology. Radiographs may be normal in acute and chronic tears, but more often they show evidence of nonspecific degenerative changes within the glenohumeral joint and subacromial space. The greater tuberosity can have a sclerotic or cystic appearance. Osteophytic spurs and sclerosis of the undersurface of the acromion may narrow the subacromial space. The hallmark of a complete tear is superior displacement of the humeral head. This displacement is best seen on an external rotation view. The normal distance from the superior aspect of the humerus to the undersurface of the acromion ranges from 7 to 14 mm. A distance of less than 6 mm is highly suggestive of a complete tear. Outpatient ultrasound examination, MRI, or an arthrogram can confirm the diagnosis. Ultrasound appears to be an excellent initial screening test, and in one study the overall accuracy of ultrasonography in the detection of partial- and full-thickness rotator cuff tears was 87%, with arthroscopy used as the "gold standard" diagnostic modality.65

Management. Acute tears should be immobilized in a sling and the patient referred promptly for orthopedic follow-up care. Early surgical repair (before 3 weeks) is preferred in these instances, especially for a young or active person. The management of chronic tears includes pain control and a shoulder rehabilitation program. Painful arc symptoms may respond to subacromial injection of a corticosteroid (see Table 53-3). Orthopedic follow-up care is essential because patients with persistent pain and weakness may require surgical repair.

Lesions of the Biceps Muscle

The biceps is composed of two heads. The long head originates from the supraglenoid tubercle and glenoid labrum and ascends over the humeral head to enter the arm by way of the bicipital groove. The long head is covered by a synovial sheath and is held in place within the groove by the coracohumeral and transverse humeral ligaments. The short head of the biceps originates from the coracoid process and inserts with the long head onto the tuberosity of the radius. The biceps is responsible for flexion as well as supination at the elbow and serves as a stabilizer for the glenohumeral joint.

Bicipital Tendinitis

Pathophysiology. Anatomically, the long head of the biceps is subject to the same stresses as those incurred by the rotator cuff within the subacromial space. Irritation and microtrauma as a result of repetitive elevation or abduction of the shoulder produce an inflammatory reaction within the synovial sheath. Bicipital tendinitis usually is associated with other acromial arch impingement conditions (e.g., subacromial bursitis, rotator cuff tendinitis).

The typical patient is middle-aged and involved in an occupation or recreational activity that requires overhead movement. The presenting complaint is pain in the anterior part of the shoulder along the bicipital groove that radiates into the upper arm. There is usually no history of trauma. Pain increases with activity and decreases with rest. Abduction and external rotation in particular are painful. Pain is worse at night and may interfere with sleep.

Primary bicipital tendinitis (inflammation without other underlying pathology) is rare (5% of cases) and affects younger individuals.66

Clinical Features. On examination, point tenderness can be elicited over the biceps tendon as it passes through the bicipital groove. This is best shown with the arm in 10 degrees of internal rotation. Active range of motion is limited by pain, but the passive range remains intact. Supination against resistance—the Yergason test—with the arm adducted and the elbow flexed to 90 degrees reproduces the pain in 50% of cases (Fig. 53-42).66 Another provocative test is the biceps resistance test (Speed test), in which forward flexion of the shoulder (elbow extended and forearm supinated) carried out against resistance produces pain in the bicipital groove. The specificity of these tests is limited in the presence of impingement and rotator cuff disease.

Figure 53-42. Yergason’s test. With the elbow flexed, supination of the forearm (arrows) against resistance causes pain in the anterior and inner aspect of the shoulder. (From DePalma AF: Surgery of the Shoulder, 3rd ed. Philadelphia, JB Lippincott, 1983.)
**Diagnostic Strategies: Radiology.** Radiographs are usually normal but may show evidence of subacromial space impingement by associated acromioclavicular arthritis and osteophytic spurs. The preferred imaging modality is MRI.67

**Management.** Emergency treatment consists of rest (immobilization in a sling), application of ice, and an NSAID regimen. Gentle stretching exercises are encouraged as symptoms subside. Refractory or progressive cases should be referred to an orthopedic surgeon. Although the bicipital sheath can be injected with a corticosteroid preparation, the procedure is technically difficult, and inadvertent direct tendon injection can lead to tendon rupture. An alternative option is iontophoresis with a topical steroid over the bicipital groove.67 Surgery may be necessary in patients who fail to respond to conservative therapy.

**Ruptures of the Biceps Tendon**

**Pathophysiology.** Ruptures of the biceps tendon can be classified into proximal and distal types. Distal ruptures are rare and are not discussed here. Proximally, microtears and other age-related attritional changes within the long head predispose it to rupture.66 The rupture can be spontaneous or may follow a traumatic event either forced extension or resisted supination and flexion.

**Clinical Features.** The classic history of an acute rupture is that of a sudden snap or pop, followed by pain and ecchymosis along the arm. The tendon usually ruptures at its weakest point, which is just distal to the exit from the glenohumeral joint cavity. With a complete rupture, distal retraction of the muscle results in a “Popeye” appearance of the arm. A difference in muscle contour (Ludington sign) also may be seen when both arms are placed behind the head and the biceps muscles are contracted. Functionally, forearm supination is weakened, but elbow flexion stays strong because the coracobrachialis and short head of the biceps remain intact. Most bicep tendon ruptures are associated with the impingement syndrome and a rotator cuff tear.

**Diagnostic Strategies: Radiology.** Radiographic findings usually are unremarkable, and the confirmatory test of choice is MRI. Management. The injured arm should be immobilized in a sling with the elbow in 90 degrees of flexion. The local application of ice may provide temporary relief. Analgesia should be provided, and the patient should be referred to an orthopedic surgeon for further evaluation and treatment within 72 hours. Surgical repair is a consideration in young, active persons. In older patients, conservative therapy (range-of-motion and strengthening exercise) is preferred because the cosmetic deformity is minimal and the mild functional loss usually is acceptable.

**Subluxations and Dislocations of the Biceps Tendon.** Subluxations and dislocations of the biceps tendon usually are associated with a congenitally shallow bicipital groove or atraumatic (attritional) tears of the coracohumeral and transverse humeral ligaments. The patient reports a snapping sensation in the upper arm with abduction and external rotation. External and internal rotation of the abducted shoulder shows dislocation and relocation of the tendon. With complete dislocation, the arm may reflexively drop to relocate the tendon. These conditions may require operative repair and should be referred to an orthopedist.

**Calcific Tendinitis**

**Pathophysiology.** Shoulder calcific tendinitis affects up to 10% of the population and is frequently encountered in the ED. The condition affects people aged 30 to 50 years and is painful in 50% of patients.68 Calcific deposits occur primarily in the supraspinatus tendon near its attachment to the greater tuberosity. Deposits also may involve the infraspinatus, teres minor, or subscapularis tendons. Women are more often affected than men, and 10% of the patients have bilateral deposits. In the precalcific stage, the tendon undergoes fibrocartilaginous transformation. The precipitating factors for this change remain unclear and may involve hypoxia- or stress-related degenerative changes within the tendon.66 Calcium hydroxyapatite crystals are deposited and coalesce within the matrix of the tendon. Subsequent invasion of vascular channels into the deposit allows for the influx of neutrophils and macrophages (inflammatory response), which remove the calcification through phagocytosis. Finally, fibroblasts form collagen to create a postcalcification scar.69

**Clinical Features.** The clinical presentation can be divided into silent, subacute, and acute phases based on the physical characteristics of the calcific deposits and the nature of the inflammatory response within the tendon and subacromial bursa. The silent phase consists of a dry, powdery deposit with no surrounding inflammatory reaction. It usually is an incidental diagnosis when shoulder radiographs are obtained for other purposes. The deposits may remain painless and eventually reabsorb.

The painful arc syndrome is a hallmark of the subacute phase of calcific tendinitis. Enlargement and softening of the deposit lead to narrowing of the subacromial space, resulting in impingement under the acromial arch. Pain experienced at 60 to 120 degrees of abduction (see Fig. 53-40) is characteristic. A severe inflammatory reaction within and around the deposit produces the acute phase of calcific tendinitis. The deposit becomes milky and has the appearance of an acute abscess. The patient is in severe pain and holds the arm close to the chest. Active and passive range of motion is severely limited. The shoulder is warm and extremely tender to the touch. Severe pain is related to increased intratendinous pressure, and spontaneous rupture of the deposit into the subacromial bursa can be associated with dramatic relief of symptoms.

**Diagnostic Strategies: Radiology.** Radiographs show calcific deposits in the involved tendon (Fig. 53-43). For the supraspinatus, calcific deposits are best seen on the internal and external rotation AP views. The axillary view is useful for showing calcification within the other tendons of the rotator cuff.

**Management.** Subacute symptoms usually respond to NSAIDs and measures to limit any offending activity. The acute phase should be treated with sling immobilization, NSAIDs, and analgesia. Subacromial injection of a local anesthetic may provide dramatic temporary relief in the ED. Needle lavage (puncturing of the calcific deposits to decrease intratendinous pressure) under ultrasound or fluoroscopy guidance also has been described as an effective treatment during the acute phase.69 The subacromial injection of corticosteroids for impingement symptoms is controversial because these agents may delay the process of calcium resorption, thereby interfering with the natural course of the condition. Patients with chronic symptoms may benefit from surgical removal or extracorporeal shock wave therapy to produce

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*[Image 332x6 to 560x213]*

**Figure 53-43. Rotator cuff calcific tendinitis.**
fragmentation of the calcific deposits. Early shoulder range-of-motion exercises should be encouraged in all patients to minimize the risk of adhesive capsulitis. All symptomatic patients should be referred for orthopedic follow-up care.

Adhesive Capsulitis

Pathophysiology. Adhesive capsulitis (“frozen shoulder”) is a specific diagnostic entity characterized by an idiopathic inflammatory reaction within the capsule and synovium of the glenohumeral joint. The inflammatory reaction results in the formation of adhesions within the capsule and inferior axillary fold, leading to restricted active and passive range of motion. The prevalence rate is 2 to 5%, with a female predominance. Adhesive capsulitis is more common in diabetic patients. Adhesive capsulitis should be differentiated from other, more common causes of the painful stiff shoulder; this distinction is important because any painful condition of the shoulder (e.g., calcific tendinitis, rotator cuff tear, osteoarthritis, or trauma) may be associated with decreased range of motion.

Clinical Features. The typical patient is a diabetic woman 40 to 60 years of age. The nondominant arm usually is affected, and the patient has trouble with the activities of daily living. The pain often is severe at night and localized over the deltoid area. As the condition progresses, there is uniform limitation of all glenohumeral movement, including flexion, abduction, and rotation. On passive testing, a sense of mechanical restriction of joint motion can often be appreciated. Shoulder radiographs usually are normal in appearance if no associated pathologic condition is present.

Management. The best form of therapy is preventive in nature. Prolonged shoulder immobilization is avoided, and early motion is encouraged in all instances (see Fig. 53-14). Treatment of adhesive capsulitis in the ED consists of NSAIDs and referral to an orthopedic surgeon. Initial therapy usually is conservative and consists of a gentle assisted exercise program along with intra-articular steroid injection. Surgical treatment, including manipulation under anesthesia and arthroscopic capsular release, is reserved for patients in whom nonoperative treatment for at least 6 months has failed to produce improvement.

Injection Therapy. The local injection of corticosteroid preparations can be useful in many painful conditions that affect the shoulder, including rotator cuff tendinitis and subacromial bursitis. Evidence-based research that supports or refutes the use of injection corticosteroid therapy is limited and conflicting. Potential explanations for discordant results of randomized controlled studies include differing outcome definitions and the observation that subacromial injections are difficult to give. The accuracy of needle placement for subacromial injections has been reported to be 70%. Although useful for relieving the inflammatory reaction, corticosteroid injections in general do not alter the underlying disease process. Corticosteroids inhibit all phases of the inflammatory response, including leukocyte migration, edema formation, mediator release, vascular permeability, collagen deposition, and fibroblast proliferation. Systemic complications are rare after local injection therapy. Site-specific complications include articular cartilage damage, tendon weakening or rupture, and subcutaneous atrophy. The incidence of local complications correlates with the injection technique, dose used, and frequency of administration. Direct tendon injection is avoided at all times, and the number of steroid injections should be limited to two per shoulder since a high failure rate for rotator cuff repairs has been reported in patients who have received more than three preoperative subacromial injections.

Numerous corticosteroid preparations are available (see Table 53-3). Injection of a long-acting agent or a combination of a short-acting and a long-acting agent is preferred. The dose used depends on the size of the joint or bursa and the response of the individual patient. With concurrent use of a local anesthetic agent for acute pain relief, better diffusion of the steroid preparation may be obtained.

After injection, the shoulder should be immobilized and activity should be limited for several days to protect against further injury. Improvement usually begins within 1 to 7 days and can last weeks to months, depending on the preparation and underlying condition. Local anesthetic injection may result in dramatic temporary relief of symptoms in the ED.

The references for this chapter can be found online by accessing the accompanying Expert Consult website.


