Chapter 271: Shoulder and Humerus Injuries

Lars Petter Bjoernsen; Alexander Ebinger

STERNOCLAVICULAR SPRAINS AND DISLOCATIONS

ANATOMY

The sternoclavicular joint contains an intra-articular fibrocartilaginous disc and has the least amount of bony stability of any major joint because less than half of the medial end of the clavicle articulates with the upper sternum. However, it is remarkably stable, due to the strong surrounding ligaments, and as a result, most injuries are simple sprains, while dislocations and fractures are uncommon.\(^1\),\(^2\),\(^3\)

The medial clavicular epiphysis is the last epiphysis of the body to appear radiographically (age 18 years old) and the last to close (age 22 to 25 years old). An apparent sternoclavicular joint dislocation in children and young adults is typically a Salter-Harris type I or II fracture, with either anterior or posterior displacement of the clavicular metaphysis that requires orthopedic consultation and follow-up for optimal healing and remodeling.\(^1\),\(^4\)

CLINICAL FEATURES

A posterior dislocation results from a direct blow or from an indirect force to the shoulder, causing the shoulder to roll forward at the time of impact. An anterior dislocation may result from a similar indirect force if the shoulder is rolled backward at the moment of impact.

The major symptom is severe pain, exacerbated by arm motion and lying supine. The shoulder may appear shortened and rolled forward. On examination, anterior dislocations have a prominent medial clavicle end that is visible and palpable anterior to the sternum, although swelling and tenderness may impede diagnosis. In posterior dislocations, the medial clavicle end is less visible and often not palpable, and the patient may have signs and symptoms of impingement of the superior mediastinal contents, such as stridor, dysphagia, and shortness of breath (Figure 271-1).\(^3\)

Minor trauma, on the other hand, may result in a sprain to the sternoclavicular joint with only pain and swelling localized to the joint.

FIGURE 271-1.
Posterior sternoclavicular joint dislocation impinging on the mediastinal structures.
DIAGNOSIS

Routine radiographs have a low sensitivity for the detection of dislocation, but immediate chest x-ray is needed to exclude a pneumothorax, pneumomediastinum, and hemopneumothorax. Special views and comparison with the other clavicle may be helpful.\(^1\) CT is the imaging procedure of choice (Figure 271-2) and is recommended in any posterior dislocation with concern for injury to the mediastinal structures. IV contrast may be administered to further delineate injury. US can identify sternoclavicular joint effusions.
FIGURE 271-2.
CT scan of right posterior sternoclavicular dislocation. Arrow indicates disrupted sternoclavicular joint with posterior displacement of clavicle and compression of adjacent lung.

STERNOClavicular SPRain

Sprains of the sternoclavicular joint are treated with ice, sling, and analgesics. In a nontrauma patient, pain at the sternoclavicular joint should raise suspicion for septic arthritis, especially in injection drug users. US can detect effusion and aid in joint aspiration.

ANTERIOR STERNOClavicular DISLOCATIONS

Patients with uncomplicated anterior dislocations may be discharged without an attempted reduction, because this injury has little or no impact on function. Clavicular splinting, ice, analgesics, sling, and orthopedic referral are required.

For closed reduction, which can be performed within 10 days of the injury, the patient is placed supine with a towel roll or similar between the scapulae. The arm is abducted to 90 degrees, longitudinal traction is applied with slight extension by moving the arm toward the ground, and pressure is placed over the medial end of the clavicle. Even with reduction, the joint is usually unstable and redislocates (50%) when pressure is released.

POSTERIOR STERNOClavicular DISLOCATIONS

Posterior dislocations may be associated with life-threatening injuries to adjacent structures, including pneumothorax or compression or laceration of surrounding great vessels, trachea, or esophagus. Orthopedic consultation is necessary for closed or open reduction. Open reduction should be performed in the operating room with trauma or vascular surgery available.

CLAVICLE FRACTURES

ANATOMY
The clavicle provides support and mobility for upper extremity tasks by functioning as a strut that connects the shoulder girdle to the trunk. It articulates with the sternum proximally and the acromion distally. In addition, the clavicle protects the adjacent lung, brachial plexus, and subclavian and brachial blood vessels. The clavicle is S-shaped, and the mid-portion of the clavicle is the thinnest, having no accompanying ligamentous or muscular attachments. Fracture results from a direct blow to the shoulder, buckling the clavicle.

**CLINICAL FEATURES**

Clinical signs are swelling, deformity, and tenderness overlying the clavicle. The arm is slumped inward and downward, and range of motion is limited. The fracture can often be palpated, and crepitus may be present.

**DIAGNOSIS**

Most clavicle fractures can be diagnosed on standard shoulder and clavicle x-rays. Occasionally, routine clavicle radiographs may miss some fractures, particularly at either end of the bone, due to overlap of surrounding structures. If a fracture is clinically suspected but not initially diagnosed with standard radiographs, a 45-degree cephalad tilt view may be used for further assessment. Definitive diagnosis may require CT.

Obtain emergent orthopedic consultation for open fractures, fractures with neurovascular injuries, and fractures with persistent skin tenting.

**MIDDLE THIRD CLAVICLE FRACTURES**

Fractures of the middle third of the clavicle are most common. Although midclavicular fractures are often managed nonoperatively, operative fixation may result in improved functional outcome and a lower rate of malunion and nonunion.\(^6\)\(^,\)\(^7\)\(^,\)\(^8\) Some fractures (Table 271-1), including severely comminuted or displaced fractures, benefit from referral and possible operative intervention.\(^9\)\(^,\)\(^10\) Additional considerations for orthopedic referral include athletes, professional impact, and cosmetic concerns. Referral to an orthopedist within a few days of injury should be considered in the above instances. In cases where the patient does not want surgery or is a poor surgical candidate, conservative treatment is an appropriate strategy. Initial treatment of midclavicle fractures includes immobilization with either a sling or figure-of-eight brace. The length of immobilization is typically 4 to 8 weeks, until the fracture is no longer painful. Initial primary care or orthopedic follow-up should be in 1 to 2 weeks after injury in conservative treatment. The patient may use the arm as pain permits but should avoid repeat injury from direct contact. Encourage daily range of motion of the elbow immediately and of the shoulder as soon as pain allows (3 to 5 days).
TABLE 271-1
Middle Clavicle Fracture Nonunion Risk Factors

| Initial shortening >2 cm       |
| Comminuted fracture           |
| Displaced fracture >100%      |
| Significant trauma            |
| Female                        |
| Elderly                       |

DISTAL CLAVICLE FRACTURES

Distal clavicle fractures are divided into three subtypes. In type I fractures, the fracture is distal to the coracoclavicular ligaments, with the ligaments remaining intact. In type II fractures, the location of the fracture is the same as in type I; however, the coracoclavicular ligaments are disrupted (Figure 271-3). This results in an upward displacement of the proximal aspect of the clavicle. Type II distal clavicle fractures may require operative intervention to avoid nonunion. Type III fractures are intra-articular fractures through the acromioclavicular (AC) joint. Type I and III fractures can be managed conservatively with sling immobilization and primary care follow-up in 1 to 2 weeks.

FIGURE 271-3.
Classification of distal clavicular fractures. A-P = anteroposterior.
PROXIMAL THIRD CLAVICLE FRACTURES

Proximal third clavicle fractures are often high-mechanism injuries and can be associated with intrathoracic trauma. CT can diagnose the fracture and identify additional injuries. Emergent referral is required when posteriorly displaced fragments compromise mediastinal structures. Refer all other proximal third fractures to orthopedics within 1 to 2 weeks. Initial management includes sling immobilization.
SCAPULA FRACTURES

ANATOMY

The scapula is a triangularly shaped, flat bone that links the axial skeleton to the upper extremity and stabilizes motion of the arm. It serves as the site of origin of the rotator cuff and muscles about the shoulder. The mechanism of injury usually is from high-energy trauma to the shoulder area or from a fall on an outstretched hand. Scapular fractures are classified by their anatomic location (Figure 271-4), with fractures of the body (Figure 271-5) and glenoid neck being most common.

**Figure 271-4.**

**Figure 271-5.**
Scapular Y view demonstrating scapular body fracture. [Photo used with permission of Alexander Ebinger, MD.]
Patients with isolated scapular fractures typically present with localized tenderness over the scapula and the arm held in adduction. Arm movement exacerbates pain. Due to the high energy typically required to fracture this protected bone, there is a high association of injuries to the ipsilateral lung, thoracic cage, and shoulder girdle, with fractures of the ribs being most common. Carefully determine the mechanism of injury to assist in diagnosis and raise suspicion for concurrent injuries. Assess the spine and pelvis, because scapular injuries often occur with high-impact trauma.\textsuperscript{13,14} The indirect axial load transmitted by a fall on an outstretched arm may result in a scapular neck fracture or \textit{glenoid fracture} through shoulder impaction or dislocation.

**DIAGNOSIS**

Overlying structures may obscure a scapular fracture on a single trauma anteroposterior chest radiograph. A dedicated scapular series, including anteroposterior, lateral, and axillary scapular views, will identify most fractures and will guide the need for a CT scan (Figure 271-4). Scapular fractures are often associated with other significant injuries, and hence, diagnosis may be delayed or initially missed entirely. CT scan of the chest can identify both scapular and associated pathology, and a dedicated CT of the scapula can also be obtained.

Most scapular fractures are treated nonsurgically, with sling, ice, analgesics, and early range-of-motion exercises. Surgery may be necessary for significant or displaced articular fractures of the glenoid, angulated glenoid neck fractures, acromial fractures associated with a rotator cuff tear, and some coracoid fractures.\textsuperscript{13,15} Disability is more likely to be associated with fractures of the glenoid, acromion, or coracoid. Isolated scapular fractures should be referred to an orthopedic surgeon.
SCAPULOTHORACIC DISSOCIATION

Traumatic dislocation of the scapula from the thoracic wall results from severe massive traction force applied to the ipsilateral upper extremity and shoulder girdle. Associated disruption of the subclavian or axillary arteries and brachial plexus makes proper identification and treatment critical.\textsuperscript{16,17}

Chest x-ray demonstrates significant lateral displacement of the scapula.\textsuperscript{16,17} Associated radiographic abnormalities include distracted clavicle fracture, AC separation, and sternoclavicular dislocation. Perform a CT scan to identify intrathoracic injuries.

ACROMIOCLAVICULAR (AC) JOINT INJURIES

ANATOMY

The AC joint is a diarthrodial joint that, together with the sternoclavicular joint, connects the upper extremity to the axial skeleton (Figure 271-6).

\textbf{FIGURE 271-6.} Anatomy of the acromioclavicular joint.

www.accessmedicine.com
Copyright © McGraw-Hill Education. All rights reserved.

Support of the AC joint is through the AC and coracoclavicular ligaments and the attachment of the trapezius and deltoid muscles. Surrounding the AC joint is a thin capsule, which is reinforced by the AC ligaments. The AC ligaments provide horizontal stability to the joint. The strong coracoclavicular ligaments consist of two parts, the more lateral trapezoid and the medial conoid, and attach the distal inferior clavicle to the coracoid process of the scapula. The coracoclavicular ligament is the major suspensory ligament of the upper extremity and provides vertical stability to the AC joint.
AC joint injuries range from mild sprain to complete disruption of the ligaments that link the scapula and clavicle. The mechanism of injury is usually direct trauma to the joint from a fall with the arm adducted. The result is that the scapula and shoulder girdle are driven inferiorly while the clavicle remains in its normal position. An indirect mechanism is a fall on the outstretched hand with transmission of force to the AC joint.

**CLINICAL FEATURES**

The diagnosis of AC joint injuries is clinical. The mechanism of injury and tenderness and deformity at the AC joint, especially when compared with the contralateral AC joint, are confirmatory. Range of motion may be limited, depending on the severity of injury. Cross-arm abduction testing is often painful.

**DIAGNOSIS**

Radiographs are useful for identifying other fractures and determining the severity of injury. AC radiographs should specifically be ordered because they require only one-third to one-half of the penetration of standard shoulder films. Shoulder radiographs may overpenetrate the AC joint, and small fractures can be missed. Although standard AC radiographs are generally sufficient, an axillary view is required to identify posterior clavicular dislocation (type IV). Stress radiographs are no longer routinely obtained.¹⁸

Obtain emergency orthopedic consultation for open fractures, fractures with neurovascular injuries, and fractures with persistent skin tenting. Table 271-2 describes specific AC joint injuries. Treatment of type I and II injuries consists of rest, ice, analgesics, and immobilization, followed by early range-of-motion exercises (7 to 14 days).¹⁹
### TABLE 271-2

**Classification and Physical Findings in Acromioclavicular Joint Injuries**

<table>
<thead>
<tr>
<th>Type</th>
<th>Injury</th>
<th>Mechanism</th>
<th>Radiograph/Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Sprained acromioclavicular ligaments</td>
<td>Type I</td>
<td>Radiograph: Normal&lt;br&gt;Exam: Tenderness over acromioclavicular joint</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Acromioclavicular ligaments ruptured;</td>
<td>Type II</td>
<td>Radiograph: Slight widening of acromioclavicular joint; clavicle elevated 25%–50% above acromion; may be slight widening of the coracoclavicular interspace&lt;br&gt;Exam: Tenderness and mild step-off deformity of acromioclavicular joint</td>
</tr>
<tr>
<td></td>
<td>coracoclavicular ligaments sprained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Injury</td>
<td>Mechanism</td>
<td>Radiograph/Exam</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>-----------</td>
<td>----------------</td>
</tr>
<tr>
<td>III</td>
<td>Acromioclavicular ligaments ruptured; coracoclavicular ligaments ruptured; deltoid and trapezius muscles detached</td>
<td><img src="image" alt="Type III" /></td>
<td>Clavicle elevated 100% above acromion; coracoclavicular interspace widened 25%–100% Exam: Distal end of clavicle prominent; shoulder droops</td>
</tr>
<tr>
<td>IV</td>
<td>Rupture of all supporting structures; clavicle displaced posteriorly in or through the trapezius</td>
<td><img src="image" alt="Type IV" /></td>
<td>Radiograph: May appear similar to type II and III; axillary radiograph required to visualize posterior dislocation Exam: Possible posterior displacement of clavicle</td>
</tr>
<tr>
<td>V</td>
<td>Rupture of all supporting structures (more severe form of type III injury)</td>
<td><img src="image" alt="Type V" /></td>
<td>Radiograph: Acromioclavicular joint dislocated; generally 200%–300% disparity of coracoclavicular interspace compared to normal shoulder Exam: More pain; gross deformity of clavicle</td>
</tr>
</tbody>
</table>
### Table: Types of Acromioclavicular (AC) Joint Injuries

<table>
<thead>
<tr>
<th>Type</th>
<th>Injury</th>
<th>Mechanism</th>
<th>Radiograph/Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>VI</td>
<td>Acromioclavicular ligaments disrupted; coracoclavicular ligaments may be disrupted; deltoid and trapezius muscles disrupted</td>
<td><img src="image" alt="Type VI illustration" /></td>
<td>Radiograph: Acromioclavicular joint dislocated; clavicle displaced inferiorly Exam: Severe swelling; multiple associated injuries</td>
</tr>
</tbody>
</table>

A simple sling is the most convenient and effective initial treatment. Prognosis for type I and II injuries is excellent, with only a small percentage of patients developing late symptoms requiring excision of the distal clavicle.

Treatment of **type III injuries** varies, with most orthopedists recommending a trial of conservative treatment with sling immobilization. Surgical strategies have yielded good results in selected patients, with the specific management being operator dependent. Treatment decisions are based on such factors as age, occupation, and activity level. **Types IV, V, and VI are severe injuries**, and most experts recommend surgical repair. Because other injuries are associated with these more severe forms of AC joint injuries (especially type VI), a careful clinical and radiographic examination must be performed.

### GLENOHUMERAL JOINT DISLOCATION

#### ANATOMY

The glenohumeral joint is a ball-and-socket joint, with the articulation between the glenoid fossa of the scapula and the articular surface of the humeral head. The socket of the shoulder is shallow. The glenoid labrum deepens the socket and helps provide joint stability. The capsule and tendinous attachments about the joint also provide stability. Anterior dislocations of the glenohumeral joint are the most common; posterior dislocations account for <1%. Other dislocations include inferior (luxatio erecta) and superior (very rare).

#### CLINICAL FEATURES

In an anterior dislocation, the associated arm is usually in slight abduction and external rotation. The shoulder is "squared off," lacking the normal rounded contour. The patient resists adduction and internal rotation and often cannot touch the contralateral shoulder with the hand of the affected extremity. The humeral head can often be palpated anteriorly. Perform a careful neurovascular examination. The axillary nerve is most commonly injured. This nerve may be tested by pinprick sensation over the skin of the deltoid muscle.

#### DIAGNOSIS

Obtain anteroposterior and scapular lateral or "Y" radiographs before reduction is attempted to confirm the anatomic type of dislocation and identify any associated fractures. Although the anteroposterior radiograph will reveal the
dislocation, the scapular Y radiograph will indicate whether the dislocation is anterior or posterior.\textsuperscript{23}

**ANTERIOR GLENOHUMERAL DISLOCATIONS**

The combination of abduction, extension, and external rotation with sufficient force will cause an anterior dislocation. There are multiple types of anterior glenohumeral dislocations (Figure 271-7). These include subcoracoid, which is the most common; subglenoid; subclavicular; and the very rare intrathoracic dislocation.

**FIGURE 271-7.**
Types of anterior shoulder dislocations.

Prereduction radiographs are advisable when there has been significant trauma, unless time is crucial because circulation is threatened. Radiographs are needed because dislocations and fracture-dislocations may have a similar appearance on physical examination, but the techniques used to treat them may be very different. Shoulder dislocations or subluxations combined with proximal humerus fractures generally require orthopedic consultation and may need operative repair. Shoulder dislocations with associated proximal humerus fracture increase with age. Through the third decade, fracture-dislocations occurred less than 1% of the time. This percentage rises with each decade of life.\textsuperscript{24} Postreduction radiographs are valuable for confirming the success of joint reduction, as well as for providing documentation, in the event the joint redislocates after the patient is discharged from the ED.

There is an expenditure of time, money, and radiation associated with pre- and postreduction films; however, there is currently no validated clinician decision rule that allows safe elimination of prereduction films after injury.\textsuperscript{25} In clinical
practice, films are sometimes omitted in patients with a history of multiple recurrent dislocations of the shoulder who present with history, signs, and symptoms typical of another recurrence in the absence of significant trauma.\textsuperscript{23,25}

**REDUCTION TECHNIQUES**

The three main categories of reduction techniques are traction, leverage, and scapular manipulation.\textsuperscript{26,27,28,29} Success rates are between 70\% and 96\% regardless of technique. It is essential to provide appropriate systemic narcotic analgesia. The use of procedural sedation is highly recommended, but any reduction technique may be attempted without medication when performed slowly and atraumatically. It is best to be comfortable with two or three techniques in case of a failed first attempt. Considerations in selection of a technique include ease of performance, effectiveness, requirement for sedation, number of assistants, and duration. The most common techniques are described below.

Intra-articular injection of 10 to 20 mL of 1\% lidocaine (10 mL provides a total dose of 100 milligrams of lidocaine) reduces the pain associated with reduction and can complement procedural sedation.\textsuperscript{30,31} After sterile skin preparation, introduce the needle at the hollow created by the displaced humeral head, just inferior to the acromion. US can facilitate intra-articular injection. Perform neurovascular examination before and after reduction.

**Complications**

Complications associated with anterior glenohumeral dislocations include recurrence, rotator cuff tears, humeral head bony defects (Hill-Sachs deformity), glenoid labral defects (Bankart lesions), and rarely, neurovascular injuries.\textsuperscript{32} The most common complication is recurrent dislocation, and children and young adults may have a recurrence rate of more than 90\%.\textsuperscript{32,33} Early surgical repair may decrease the recurrence rate, so patients with first-time shoulder dislocations should be referred for orthopedic evaluation.\textsuperscript{34,35,36}

The rotator cuff weakens with advancing age, and in older patients, anterior dislocation is usually associated with rotator cuff tears. Rotator cuff tears can be difficult to identify on ED examination after dislocation reduction, but can be suspected with weakness upon external rotation.\textsuperscript{32} Any patient with pain persisting for greater than 2 weeks should follow up with orthopedics. For further discussion, see chapter 280, "Shoulder Pain."

Bony injuries are common and include fractures of the humeral head (Hill-sachs lesions) and glenoid (bony Bankart lesion) (\textbf{Figures 271-8} and \textbf{271-9}) and tears of the anterior glenoid labrum (soft Bankart lesion) and greater tuberosity. Such fractures are often evident only on postreduction films,\textsuperscript{23} and there is no specific ED treatment other than follow-up with orthopedics.

\textbf{Figure 271-8.}  
CT right shoulder showing a frontal view with fracture tear of the anterior-inferior glenoid bony cavity (Bankart lesion). [Photo used with permission of Erik Magnus Berntsen, MD, PhD, Department of Radiology, St. Olav University Hospital, Trondheim, Norway.]
FIGURE 271-9. CT right shoulder, oblique coronal view, demonstrating both the bony Bankart lesion and the Hill-Sachs fracture of the humeral head. [Photo used with permission of Erik Magnus Berntsen, MD, PhD, Department of Radiology, St. Olavs University Hospital, Trondheim, Norway.]
Vascular injuries are rare, but when they occur, they tend to involve the axillary artery in elderly patients. Clinical findings of vascular injury include absent radial pulse, axillary hematoma, bruising of the lateral chest wall, and an axillary bruit.

Nerve injuries, which occur in 10% to 25% of acute dislocations, are the result of traction neurapraxia. Most involve the axillary nerve, resulting in loss of sensation over the skin of the upper arm. This injury is temporary and resolves spontaneously. The motor portion of the axillary nerve supplies the teres minor and the deltoid, and injury can result in weakness of shoulder abduction and external rotation. Other nerves that may be injured are the radial, ulnar, median, musculocutaneous, and brachial plexus.\(^\text{32}\)

**Disposition**

After reduction, place the arm in a shoulder immobilizer or sling that maintains the shoulder in adduction and internal rotation (Figure 271-10). Provide instructions for orthopedic follow-up in 1 week for uncomplicated dislocations and within 1 to 2 days for dislocations complicated by bony or soft tissue injury.\(^\text{37}\)

**Figure 271-10.**

Arm sling.


www.accessmedicine.com

Copyright © McGraw-Hill Education. All rights reserved.

**Figure 271-11.**

Modified Hippocratic technique.
TRACTION-COUNTERTRACTION TECHNIQUE (MODIFIED HIPPOCRATIC)

A modification of the Hippocratic method uses traction-countertraction (Figure 271-11). The patient is supine with the arm abducted and elbow flexed at 90 degrees. A sheet is tied and placed across the thorax of the patient and then around the waist of the assistant. Another sheet is tied and placed around the forearm of the patient at the elbow and the waist of the physician. Gradually apply traction to the proximal forearm as the assistant provides countertraction. Gentle internal and external rotation or outward pressure on the proximal humerus may aid reduction.

SNOWBIRD TECHNIQUE

Another version of the traction-countertraction technique is the Snowbird technique. The patient should sit upright in a chair or bed with the elbow flexed to 90 degrees. Place a belt or strap across the patient’s proximal forearm, so the bottom of the belt can be used to apply downward pressure with the foot. Use an assistant to place a sheet across the patient’s thorax to provide countertraction. Keep the patient’s elbow at 90 degrees and apply traction to the extremity by stepping on the belt with the foot (Figure 271-12). Gentle external rotation will facilitate reduction.
STIMSON TECHNIQUE

Place the patient prone with the dislocated extremity hanging over the side of the stretcher and a 10-lb weight attached to the wrist. Inject intra-articular lidocaine. Complete muscle relaxation is required. Reduction occurs in 20 to 30 minutes. Although the time to reduction can be a drawback, this technique is safe, effective, and easy to learn.

SCAPULAR MANIPULATION TECHNIQUE

The patient is positioned with weights in the same manner as the Stimson technique (Figure 271-13). After adequate sedation, the physician pushes the tip of the scapula medially using the thumbs, while stabilizing the superior aspect with the cephalad hand. This technique reports a 96% success rate.
EXTERNAL ROTATION TECHNIQUE (KOCHER’S TECHNIQUE)

Place the patient supine with the affected arm adducted to the patient’s side. With the elbow at 90 degrees of flexion, slowly externally rotate the arm (Figure 271-14). No longitudinal traction is applied. Perform the movement slowly to allow time for spasm and pain to resolve. Reduction is usually complete before reaching the coronal plane and is often not noted either by the patient or physician. If needed, the elbow may be brought anteriorly and internally rotated to the opposite shoulder.38

FIGURE 271-14.
MILCH TECHNIQUE

The maneuvers for the Milch technique are external rotation, arm abduction to 180 degrees with simultaneous pressure on the humeral head, and in-line longitudinal traction with continued pressure on the humeral head (Figure 271-15).

FIGURE 271-15.
Milch technique. [Reproduced with permission from Reichman EF: Emergency Medicine Procedures, 2nd ed. Chapter 81. Shoulder Joint Dislocation Reduction. McGraw-Hill, Inc., 2013. Figure 81-7A-C.]
The Cunningham technique is based on the combination of humerus and scapular positioning and specific massage of a spasming biceps muscle (Figure 271-16). Seat the patient comfortably, as upright as possible, with shoulders relaxed. Supporting the affected arm, slowly and gently move the humerus into full adduction with the elbow in flexion. Have the hand of the affected extremity resting against the physician’s shoulder. Gently massage the trapezius and deltoids, which helps to relax the patient. Then, gently massage the biceps at the mid-humeral level. Ask the
patient to elevate and shrug or retract the shoulders (attempting to touch the scapulae together) and continue the biceps massage. The goal is to wait for the patient to relax fully and have the humeral head slip back into place.

**FIGURE 271-16.**
Cunningham technique.

**POSTERIOR GLENOHUMERAL DISLOCATIONS**

Posterior dislocation may occur with the humeral head in the subacromial, subglenoid, or subspinous position, but most often, it occurs with the humeral head posterior to the glenoid and inferior to the acromion ([Figure 271-17](#)). The subglenoid and subspinous positions are rare. The usual mechanism is an indirect force that produces forceful internal rotation and adduction or a direct blow to the anterior shoulder. On examination, there is a prominence of the posterior shoulder and anterior flattening of the normal shoulder contour on the affected side, especially when compared to the nonaffected side. The patient will be unable to externally rotate or abduct the affected arm.

**FIGURE 271-17.**
Posterior shoulder dislocations.
The scapular Y radiograph is diagnostic (Figure 271-18).

**FIGURE 271-18.**
Scapular Y view of posterior dislocation, with the humeral head posterior. [Photo used with permission of Alexander Ebinger, MD.]
Reduction of a posterior dislocation is performed with the patient supine. Because severe pain and muscle spasms are common, muscle relaxation and analgesia are needed. Apply traction to the adducted arm in the long axis of the humerus. Have an assistant gently push the humeral head anteriorly into the glenoid fossa. Fractures of the posterior glenoid rim, humeral head (reversed Hill-Sachs deformity), humeral shaft, or lesser tuberosity are common complications. Neurovascular and rotator cuff tears are less common than in anterior dislocations. Obtain postreduction radiographs to confirm successful reduction. Immobilize the shoulder with an arm sling, with follow-up with an orthopedist.

**INFERIOR DISLOCATIONS (LUXATIO ERECTA)**

Inferior dislocation is associated with significant soft tissue trauma or fracture. The mechanism of injury is a hyperabduction force, which levers the neck of the humerus against the acromion. As the force continues, the inferior capsule tears, and the humeral head is forced out inferiorly. The patient presents with the humerus fully abducted, the elbow flexed, and the patient’s hand on or behind the head. The humeral head can be palpated on the lateral chest wall.

Reduction consists of traction in an upward and outward direction in line with the humerus (Figure 271-19). Have the assistant apply countertraction. Reduction is signaled by a "clunk." The arm is then brought to the patient's side and immobilized in a shoulder immobilizer.

**FIGURE 271-19.**
Reduction of luxatio erecta.
Complications include severe soft tissue injuries and fractures of the proximal humerus. The rotator cuff, which usually becomes detached, requires orthopedic follow-up. Neurovascular compression injuries are usually found but almost always resolve after reduction. When the humeral head is buttonholed through the inferior capsule, the dislocation is irreducible, and operative reduction is required.

**HUMERUS FRACTURES**

**ANATOMY**

The proximal humerus is composed of the articular segment and anatomic neck, the greater and lesser tuberosities, and the proximal shaft (Figure 271-20). The supraspinatus, infraspinatus, and teres minor insert on the greater tuberosity, whereas the subscapularis inserts on the lesser tuberosity. The biceps tendon passes through the bicipital groove. The anterior and posterior humeral circumflex arteries branch off the axillary artery and course around the surgical neck.

**FIGURE 271-20.**
Patients with fractures typically present with pain, swelling, and tenderness about the shoulder. Range of motion is often significantly limited, and the arm is held in adduction. Crepitus and ecchymosis may be present. Carefully perform the neurovascular examination. The most commonly injured nerve is the axillary nerve, and sensation overlying the deltoid muscle should be tested. The second most commonly injured nerve is the suprascapular nerve, which innervates the supraspinatus and infraspinatus. Range of motion may be limited, but assessment of shoulder abduction should be performed. Vascular injuries may occur with even trivial trauma in atherosclerotic elderly patients. The most common vascular injury is to the axillary artery and may be suggested by weak distal pulses compared to the uninjured side, paresthesias, pallor, pulselessness, or an expanding hematoma. Neurovascular injuries can occur in nondisplaced and displaced fractures but are much higher (>50%) in displaced fractures.

**DIAGNOSIS**

Radiographs consisting of anteroposterior, lateral shoulder, and axillary views will diagnose most proximal humerus fractures and evaluate for accompanying glenohumeral dislocation.

**Specific Injuries**

The most common fractures of the proximal humerus include the surgical neck and greater tuberosity. To guide treatment, the Neer system classifies fracture displacement into "parts." The proximal humerus is divided into four segments based on epiphyseal lines where fractures primarily occur: the articular surface of the humeral head; the greater tuberosity; the lesser tuberosity; and the shaft of the humerus (Figure 271-21). The displacement of a fracture fragment from the proximal humerus is called a "part." Parts are therefore not based on the number of fracture lines or segments. Rather, a "one-part" fracture is one in which the fragment is not displaced at all, is displaced <1 cm, or is not angulated >45 degrees. There can be multiple fragments, but if none of the fragments is displaced >1 cm or is angulated >45 degrees, the proximal humerus fracture is termed a "one-part" fracture. Approximately 50% of all proximal humerus fractures are one-part fractures. Treatment of a one-part proximal humerus fracture generally consists of immobilization (such as sling and swathe), ice, analgesics, and orthopedic referral. Early mobilization is important to avoid subsequent adhesive capsulitis and can be started when pain allows. The prognosis is generally
good. All other proximal humerus fractures and fracture-dislocations require orthopedic consultation in the ED because they are more frequently associated with complications and are often difficult to manage. Closed reduction, operative treatment, or a combination of the two may be necessary.

**FIGURE 271-21.**
The four segments of the humerus according to the Neer classification: 1, articular surface of the humeral head; 2, greater tubercle; 3, lesser tubercle; 4, diaphysis or shaft of humerus. A one-part fracture is defined as a fracture fragment displaced by <1 cm or <45 degrees; two-, three-, and four-part fractures have more displacement and angulation.

Any fracture involving the anatomic neck or the articular surface may result in compromise of the blood supply to the articular segment of the humeral head. If ischemic necrosis of the articular segment occurs, insertion of a humeral head prosthesis may be required. Significantly angulated surgical neck fractures are a risk for neurovascular damage (axillary neurovascular structures as well as the brachial plexus) and should be immobilized and radiographed in the position of presentation.

Significant displacement of a greater tuberosity fracture implies a concomitant rotator cuff tear, with surgical repair often necessary for the active patient. Fracture of the lesser tuberosity should alert the examiner to a potential posterior shoulder dislocation.

Children may have significant displacement or separation of the proximal humeral epiphysis and need early orthopedic consultation for anatomic reduction if near skeletal maturity. Salter II injuries are most common after age 6 years old and will require closed reduction if >20 degrees of angulation is present. A shoulder spica is often used after
reduction for unstable injuries, with sling and swathe immobilization for other injuries. If there is a question about the acceptability of angulation, consult the orthopedist.

**HUMERAL SHAFT FRACTURES**

**ANATOMY**

The humerus serves as the attachment site for the rotator cuff muscles, deltoid, pectoralis major, and coracobrachialis. Additionally, it is the site of origin of the biceps, triceps, and brachioradialis. The radial nerve courses along the spiral groove on the posterior aspect of the humerus.

Fractures of the humeral shaft occur in a bimodal age distribution, with peaks in the third and seventh decades of life, representing active young men and osteoporotic elderly women, respectively. Humeral shaft fractures may be caused by a direct blow that produces a bending force resulting in a transverse fracture. They may also be caused by an indirect mechanism, such as a fall on an outstretched hand that produces a torsion force, resulting in a spiral fracture. A combination of bending and torsion forces results in an oblique fracture, sometimes with comminution, producing the "butterfly" fragment. The humerus is also a common site of pathologic fractures, especially from metastatic breast cancer. Fractures in young children should raise suspicion of abuse.

**CLINICAL FEATURES**

Clinical examination reveals localized tenderness, swelling, pain, and abnormal mobility or crepitus on palpation. Displaced fractures are associated with shortening of the upper extremity. Attention must be given to the initial neurovascular status. Complications may include injury to the brachial artery and vein, or the radial, ulnar, or median nerves. A radial nerve injury, which is the most common, may be manifested by weak wrist extension, wrist drop, or altered sensation at the dorsal thumb index web space. Fractures of the distal third are particularly prone to entrapment of the radial nerve, either as a result of the initial injury or after closed reduction. Neurovascular injuries require emergency orthopedic consultation.

**DIAGNOSIS**

Radiographs should include two views of the humerus. Images of the shoulder and elbow should be obtained if additional injuries cannot be excluded.

**FRACTURES OF THE MIDDLE THIRD OF THE HUMERUS**

The most common site of fracture is the middle third of the humerus. Displacement of fracture fragments is the result of the insertions and actions of the various muscles (deltoid, biceps, triceps, supraspinatus, and pectoralis major) that act on the upper arm (Figure 271-22). Most closed fractures of the shaft of the humerus are managed nonoperatively, although treatment options vary. A 2012 Cochrane Review did not find any evidence to suggest outcome differences from surgery versus nonsurgical management. Fractures with less than 20 degrees of angulation in the sagittal plane and less than 30 degrees of varus or valgus angulation and are shortened less than 2 to 3 cm often can be managed nonoperatively. The treatment of uncomplicated fractures includes immobilization, ice, analgesia, and referral. Closed treatment options include the coaptation splint (sugar tong), hanging cast, and functional bracing. A simple sling and swathe are adequate for the emergency management of most such patients.
Humeral fractures anterior view. The actions of the muscles inserting on the humeral shaft determine fracture angulation and displacement. **A.** Angulation of fragments with fracture line distal to rotator cuff insertion. **B.** Angulation of fragments with fracture line distal to pectoralis major insertion. **C.** Angulation of fragments with fracture line distal to deltoid insertion.

**DISTAL HUMERUS FRACTURES**

Distal humerus fractures require emergency orthopedic consultation. These fractures are complex given the anatomical relationship of the bony and neurovascular structures. Clinical examination should include evaluation of the radial, median, ulnar, and anterior and posterior interosseous nerves. See chapter 270 for a discussion of supracondylar fractures.

**BRACHIAL PLEXUS INJURIES**

**ANATOMY**

The brachial plexus (Figure 271-23) and its peripheral nerve branches are infraclavicular and lay anteromedial to the glenohumeral joint. Anatomically, the brachial plexus stems from the C4-T1 cervical roots and ultimately from the lateral, posterior, and medial cords. At the lateral border of the pectoralis minor, these cords ultimately form the five major peripheral nerves of the arm (musculocutaneous nerve, axillary nerve, radial nerve, median nerve, and ulnar nerve).47 Traumatic brachial plexus lesions are the most common form of plexus injuries and can occur from penetrating, compression, or closed traction injuries. Injuries can be divided into supraclavicular (roots and trunks) or infraclavicular (cords and terminal nerves) injuries.

**Figure 271-23.** Brachial plexus.
CLINICAL FEATURES

High-speed motor vehicle or motorcycle crashes result in traction injuries as nerves are stretched longitudinally, with simultaneous traction of the arm and opposite distraction of the head. Penetrating trauma and surgical interventions can also lead to a disruption of the nerves. The initial identification of brachial plexus injuries is often overshadowed by the presence of other severe injuries to, for example, the head, chest, and vasculature. In addition to neurologic impairment, neuropathic pain in the arm is frequently present. Significant swelling and soft tissue injury to the neck and shoulder girdle suggest traumatic forces sufficient to injure the brachial plexus. The accumulation of cerebrospinal fluid from avulsed spinal roots may cause swelling in the posterior triangle. Horner’s syndrome (ipsilateral ptosis, miosis, and anhidrosis of the face) may be present due to adjacent ganglion damage. However, brachial plexus injury may not be clinically apparent until a responsive patient can indicate the extent of motor and sensory deficits, days to weeks after initial stabilization and treatment. Arm pain that is constant and burning in character is common. The pain is usually worst in the distal parts of the arm and hand, typically in a nondermatomal distribution.

DIAGNOSIS

Upper limb and shoulder girdle motor and sensory deficits define the extent of damage to the brachial plexus. Adduction and internal rotation of the shoulder indicate weakness of the deltoid and infraspinatus muscles (C5), whereas elbow extension is due to weakness of the biceps (C6), and flexion of the digits and wrists is due to weakness
of the extensors (C7). The sensory distributions of the cervical roots and the peripheral nerves are shown in Figure 271-24.

FIGURE 271-24.
Sensory distribution of the brachial plexus.

MRI and CT myelography are common radiographic imaging procedures. Electromyographic and nerve conduction velocity studies may aid in diagnosis, and surgical exploration of the area may be necessary. The delineation of pre- and postganglionic injury may not be possible until Wallerian degeneration is completed 2 weeks after injury. Treatment and prognosis will depend on the location and extent of nerve damage.

REFERENCES


   [PubMed: 20806751]

   [PubMed: 23174321]

   [PubMed: 19307670]

   [PubMed: 17251175]

   [PubMed: 24382728]

   [PubMed: 23369483]

   [PubMed: 20687087]

   [PubMed: 17692769]

   [PubMed: 20825841]

   [PubMed: 21524370]

   [PubMed: 16302939]

   [PubMed: 10452444]


