Shoulder Girdle Fractures
And Dislocations

You are working in the ED during football season and receive a call from the local university team physician who is sending you two patients with shoulder-related complaints. One patient is the team’s quarterback who was tackled to the ground and complains of pain over the lateral tip of his shoulder. Your medical student, who is interested in orthopedics, asks if you will request weighted views of the shoulder to evaluate the acromioclavicular joint in this patient.

The second patient is the team’s star wide receiver who complains of difficulty breathing and pain over the inner part of the clavicle after taking a direct helmet blow to the upper chest. The charge nurse wonders if this patient should be moved into the trauma bay due to the mechanism of injury and associated dyspnea.

The shoulder joint has the largest range of motion of any appendicular joint in the body. It allows the upper extremity to rotate up to 180 degrees in three different planes, enabling the arm to perform a versatile range of activities but also predisposing the joint to instability and injury. The shoulder can be injured by trauma (indirect or direct) or by overuse. Traumatic injuries are more common in sports such as swimming, tennis, volleyball, and baseball. Children are vulnerable to the same injuries as adults; however, the presence of epiphyseal centers changes the pattern of injuries. An injury that produces a sprain or dislocation in an adult often causes a fracture through the hypertrophic zone of the growth plate in a child. The shoulder has epiphyseal plates at the acromion process, proximal humeral head, coracoid process, glenoid cavity, and medial end of the clavicle. Fortunately, most shoulder injuries in the pediatric population do well and have a good prognosis for full return of function.2

CME Objectives

Upon completion of this article, you should be able to:
1. Describe the clinical presentations of shoulder girdle fractures and dislocations in the ED and how to assess for any associated complications.
2. Understand which radiographic studies to order and the principles for correct interpretations.
3. Discuss several different techniques for reduction of glenohumeral dislocations.
4. List conditions or circumstances that require orthopedic consultation or referral in patients with shoulder injuries.
5. Appreciate current concepts and controversies in the management of these injuries.

Date of most recent review: August 23, 2007
Date of most recent update: October 1, 2010

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Critical Appraisal Of The Literature

The literature review was launched with an Ovid MEDLINE® search for articles on shoulder injuries published through February 2007. Keywords included shoulder dislocation, clavicle fracture, humerus fracture, scapula fracture, acromioclavicular joint injury, sternoclavicular joint and dislocations, and scapulothoracic dissociation. The search was limited to humans and English language. This produced 1789 articles, over 300 of which were reviewed; 104 are referenced here. In addition to those articles, several key textbooks were also reviewed. It should be noted that the orthopedic and sports medicine literature is largely based on observational studies supplemented by case reports and case series. There are few randomized clinical trials.

Anatomy

The shoulder girdle connects the upper extremity to the axial skeleton and is composed of three bones (clavicle, humerus, and scapula), three joints (acromioclavicular, glenohumeral, and sternoclavicular), and one articulation (scapulothoracic).

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.

The sternoclavicular joint (Figure 1) is the only true articulation between the upper extremity and the axial skeleton. It is the most moved joint in the body.3 Stabilizers of this diarthroidal joint include the anterior and posterior sternoclavicular ligaments, the interclavicular ligament, and the costoclavicular ligament. The costoclavicular ligament opposes the pull of the sternocleidomastoid thus resisting the elevation of the clavicle. It is also the most important stabilizing ligament of the sternoclavicular joint.4

Immediately posterior to the joint is the superior mediastinum with its great vessels, trachea, lung apices, esophagus, brachial plexus, and thoracic duct.

The diarthrodial acromioclavicular joint (Figure 2) has little or no bony stability and is dependent on the associated ligaments and muscles for support. 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. Its thickened borders are the attachment sites for eighteen muscle origins and insertions.5 It’s thick muscle coat and ability to recoil along the chest wall protects the scapula from both direct and indirect trauma.

The glenohumeral articulation is a ball-and-socket type joint. The glenohumeral joint depends largely on associated capsule, muscles, and ligaments for stability. 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 gleno-humeral ligament is the most important restraint to anterior glenohumeral dislocations.6

The proximal humerus articulates with the glenoid fossa and provides for the attachment of a number of 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. Long muscles that cross the articulation are primarily involved in the movements around the glenohumeral joint. Displacements encountered with fractures of the humerus usually reflect the pull of these attached muscle groups. The proximal humerus is primarily composed of trabecular bone with a thin cortical shell. Changes in bone density with age (osteoporosis) greatly increase the risk of fractures in this area.7

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.

Prehospital Care

The prehospital care of the patient with an injured shoulder begins with an assessment and stabilization. Once this has been accomplished, a history of the events leading to the injury should be obtained from the patient as well as witnesses. The patient should be assessed for any associated injuries of the head, neck, thorax, abdomen, spine, pelvis, and lower extremities. Splint the injured shoulder in a position of comfort; a sling is sufficient for most isolated injuries. Perform a neurovascular examination of the affected extremity before and after splinting as well as following any major movement. In isolated injuries, the use of analgesia as permitted by standing orders or through online medical consultation may be appropriate. Choices include morphine sulfate, fentanyl citrate, and nitrous oxide. Benzodiazepines are an excellent choice since they may help achieve or maintain muscle relaxation. Kanowitz et al recently reviewed over 2100 prehospital uses of fentanyl citrate for analgesia and found it to be safe and very effective, with pain scores decreasing from 8.4 to 3.7.8 In some selected circumstances (rural and wilderness settings), it may be appropriate to proceed with reduction procedures if personnel have received appropriate training, although there is no published data on the efficacy or safety of this approach.

ED Evaluation

Initiate full immobilization if there is a concern for an accompanying spinal injury, and activate the trauma team if appropriate. Since pain is a common presenting complaint, the timely determination of severity scores and administration of oral or parenteral analgesia is important during the clinical and radiographic assessment process in the ED. In a recent retrospective review of 2828 patients with isolated closed fractures of the extremities or clavicle, Brown et al reported that pain severity scores were recorded for 59% of cases and in only 47% of children younger than four years of age.9 Furthermore, among patients with documented moderate or severe pain, only 73% were treated with an analgesic with 54% receiving an opioid. Pediatric patients were least likely to receive analgesics, especially an opioid.9

History

The most important factors to determine in patients with shoulder injuries are the time and mechanism of injury along with the location and severity of the pain. Timing is important since injuries (especially dislocations) that have been present for several hours or days can be more challenging to diagnose and treat. It is also important to determine a list of current medications, allergies, past medical history, and time of the last meal in the event that procedural sedation or emergency operative treatment is required.

Physical Examination

In patients with multi-system trauma, examine the shoulder as part of a complete secondary examination. Inspect the shoulder from all directions. Palpate the shoulder systematically, beginning at the sternoclavicular joint and moving laterally along the clavicle to the acromioclavicular joint. This is followed by palpation of the scapula, glenohumeral joint, and proximal humerus. The exam is completed by an assessment of the neurovascular function. A complete sensory and full motor examination of the brachial plexus must be performed. This is best evaluated by assessing the myotomes and dermatomes (Table 1) pertinent to each nerve root within the brachial plexus. The classic presentation of a brachial plexus injury – the “stinger” or “burner” traction injury of the brachial plexus – is the mixed neurological abnormalities one finds on physical examination. The radial pulse should also be checked, although it should be noted that collateral circulation may preserve this in the presence of a vascular injury. The presence of pallor, paresthesias, or an expanding hematoma raises suspicion of a vascular injury. The neurovascular exam must be repeated and findings recorded following any manipulation in the ED.

General Radiographic Principles

The initial assessment of shoulder injuries should ideally include a three-view trauma series of radiographs consisting of a true anteroposterior (45-

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<td>Lateral arm</td>
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<td>C6</td>
<td>Lateral forearm and tip of thumb</td>
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degree lateral), transscapular lateral, and axillary lateral view. The true anteroposterior (AP) view (Figure 3) is essential because it projects the glenohumeral joint en face without any bony overlap.

Orthogonal views include the axillary lateral, transscapular (“Y” view), and apical oblique. The preferred view is the axillary lateral which projects the glenohumeral joint in a cephalocaudal plane (Figure 4A and 4B). This view is useful for defining the relationship of the humeral head with the glenoid fossa and identifying abnormalities of the coracoid process, humeral head, and glenoid rim. This is especially helpful in identifying either a posterior or a questionable anterior glenohumeral dislocation. Difficulty in obtaining the axillary view has led to the popularity of the transscapular “Y” view. 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 (Figure 5). The humeral head is normally superimposed over the glenoid, located at the junction of the three limbs. One must be cautious when interpreting the “Y” view as normal, for a posterior glenohumeral dislocation may present with the humeral head actually situated posterior to the “Y” but projecting as normal on the “Y” view. Another view that can be obtained easily and painlessly is the apical oblique (AO) view, which is obtained by placing the injured shoulder in a 45-

Figure 3. Normal True AP View Of The Shoulder

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Figure 4A. Lateral Axillary View Of The Shoulder


Figure 4B. Diagram Highlighting The Pertinent Anatomy

Figure 5. Normal Transscapular Or “Y” View Of The Shoulder

Courtesy of Dr. Daya.
degree oblique position and angling the central ray 45 degrees caudally. This view (Figure 6) provides a unique coronal view of the glenohumeral joint. In a retrospective review of 511 patients, Kornguth et al reported that the AO view detected 153 (81%) of 190 injuries compared to 168 (88%) for the true AP view. More importantly, 20 of the radiographic abnormalities were only seen with the AO view. Similar findings were also reported by Sloth et al, who recommended that the AO be used routinely in the evaluation of acute shoulder trauma.

In addition to the shoulder trauma radiographs, additional bone and soft tissue details may be obtained using computed tomography (CT) or magnetic resonance imaging (MRI) in selected cases.

Fractures

Clavicle Fractures

Classification And Pathophysiology

The clavicle accounts for 5% of all fractures and is the most commonly fractured bone in children. Clavicle fractures are classified anatomically and mechanistically into three types. 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 (Figure 7) account for 70-80% of all injuries. The usual mechanism of injury involves a direct force applied to the lateral aspect of the shoulder. Fractures of the lateral third (15%) result from a direct blow to the top of the shoulder and can be further classified into three main subtypes:

- Type I fractures are minimally displaced since the coracoclavicular ligament remains intact.
- Type II fractures (Figure 8) are associated with a torn coracoclavicular ligament and have a tendency to displace, since the medial fragment lacks any stabilizing forces.
- Type III injuries occur distal to the coracoclavicular ligaments and enter the acromioclavicular joint.

Clinical

The affected extremity is held close to the body and there is pain over the fracture site. With fractures of the middle third, the shoulder is typically slumped downward, forward, and inward. This is a result of the effect of gravity (weight of the arm) and the pull of the pectoralis major and latissimus dorsi on the distal fragment. The proximal fragment is often displaced upward by the action of the sternocleidomastoid. Associated neurovascular injury is rare. Associated pneumothorax and pulmonary injuries are also rare unless an open fracture exists.

Management and Disposition

Principles of initial management include pain control, immobilization, and appropriate follow-up (Table 2). Immobilize fractures of the clavicle with a supportive device such as a sling. Treatment with a clavicular (figure-of-eight) splint is still recommended in major
orthopedic textbooks, although its use is not evidence-based.3 In a randomized, controlled study of 79 patients comparing a clavicular splint to a sling, those treated with a sling were more satisfied (93% vs. 74%, P = 0.09) and had less local complications.22 These results, while favoring the sling, were not statistically significant. The functional and cosmetic results of the two methods of treatment were identical and alignment of the healed fractures was unchanged from the initial displacement. Stanley et al reported similar findings in 140 patients.23 In summary, the evidence suggests that treatment with a sling is a valid and appropriate alternative to the clavicular splint.

Greenstick fractures of the mid-clavicle are common in the pediatric population. Most of these fractures are non-displaced and will 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 radiographs repeated in 7 to 10 days if symptoms persist. The newborn clavicle fracture suffered during childbirth classically presents as a concerned parent bringing the child in for an uneventful “lump” that represents the area of callus formation.

Immediate orthopedic consultation should be sought for fractures that are open or fractures associated with neurovascular injuries, skin tenting, or interposition of soft tissues. More urgent orthopedic consultation (within 72 hours) is recommended for Type II lateral clavicle fractures, since these fractures have a 30% incidence of nonunion and may benefit from surgical repair.19,24 Severely comminuted or displaced fractures (Figure 10A and 10B) of the middle third (defined as over 20 mm of initial shortening) may also benefit from early orthopedic referral, since these have been associated with a higher incidence of nonunion and long-term functional deficits.18,25,26

Complications
Complications are unusual, the most common ones being delayed union, malunion, or nonunion.16,17,19,25 A recent prospective study of 222 patients reported that sequelae from clavicle fractures with non-operative treatment may be higher than previously reported.27,28 Non-union occurred in 15 patients (7%), and 93 patients (42%) had persistent symptoms, such as pain and shoulder weakness, at six months. Fracture displacement, degree of comminution, and older age were associated with increased risk of persistent symptoms at six months.28 Malunion as well as

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**Table 2: General Management Principles**

- Apply ice intermittently
- Provide appropriate immobilization
- Provide adequate analgesia
- Use passive pendular shoulder exercises to minimize the risk of adhesive capsulitis (Figure 9)
- Refer to orthopedics in selected circumstances

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**Figure 9. Pendular Shoulder Exercises**

![Pendular Shoulder Exercises](http://asansciencere.kr/healthinfo/disease/attach/img/924/20061123162538_3_924.jpg)


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**Figure 10A. Significantly Displaced Mid-Clavicular Fracture**

Courtesy of Dr. Daya.

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**Figure 10B. Same Patient After Open Reduction And Internal Fixation**

Courtesy of Dr. Daya.
exuberant callus formation can also lead to symptoms related to vascular and brachial plexus compression.25 Patients should be advised that articular surface injuries (Type III lateral clavicle fractures) can lead to subsequent osteoarthritis within the acromioclavicular joint.

Since 1990, an uncommon but important association between clavicle fractures and atlantoaxial rotatory displacement (AARD) in children has also been reported in the literature. Recently, Bowen et al reported two new cases and reviewed 11 previously reported cases.29 Most cases occurred in females younger than 10 years of age. The pathophysiology of AARD is not well understood but it is suspected that the clavicle fracture and AARD occur sequentially and may be associated with a lax or disrupted alar ligament.29,30 Sternocleidomastoid muscle spasm may also be a contributing factor.29 Early diagnosis is important since delayed diagnosis can lead to a chronic deformity. The diagnosis should be suspected if the child has a clavicle fracture and holds the head in the classic “cocked-robin” position. In this position, the head is bent toward the fractured side but rotated in the opposite direction. Plain cervical spine radiographs will detect approximately 93% of AARD, although the injury is best demonstrated by dynamic CT. Bowen et al reported that 7 of the 13 cases were recognized within the first three weeks; in these cases, the AARD was reduced with the use of a soft cervical collar or halo traction.29 The remaining six cases were recognized between six weeks and three years following the initial injury. All had developed a fixed deformity requiring surgical correction.

Scapula Fractures

Classification And Pathophysiology
Fractures of the scapula are rare and account for 3-5% of all fractures of the shoulder girdle.31 Considerable force and energy are required to fracture the body and neck of the scapula. Coracoid process fractures are usually secondary to avulsion, and glenoid rim fractures are commonly associated with anterior glenohumeral dislocations. Acromial process fractures result from direct blows applied to the top of the shoulder.

Brown et al retrospectively reviewed 386 patients with 718 associated injuries admitted to two Level I trauma centers. Most patients were male (80%), with a mean age of 38. The mean Injury Severity Score (ISS) was 15, with a mortality rate of 3%. Common mechanisms of injury were motor vehicle accident (42%), pedestrian struck by automobile (33%), fall (11%), and motorcycle accident (10%).32 Fractures of the scapula may be classified according to their anatomic location:33

- Type I fractures involve the acromion process, scapular spine, or coracoid process.
- Type II fractures involve the scapular neck (Figure 11).
- Type III injuries are intra-articular fractures of the glenoid fossa.
- Type IV fractures involve the body of the scapula (Figure 12A and 12B).

The most important clinical aspect of scapular fractures is the high incidence of associated injuries to the ipsilateral lung, chest wall, and shoulder girdle complex.5,33,34 Brown et al reported associated injuries in 99% of patients; of note, however, was that blunt thoracic aortic injury was not more common in patients with a fractured scapula.32

Clinical
In the conscious patient with a scapula injury, the shoulder is adducted and the arm held close to the body. Any attempts at movement result in significant pain. There may be associated tenderness, crepitus, or hematoma over the fracture site. Hemorrhage into the rotator cuff associated with the scapula fracture can result in spasm and a temporary reflex inhibition of function.33 The presence of a scapula fracture requires a careful search for associated injuries.

In many patients, fractures of the scapula are initially overlooked because of the life-threatening nature of associated injuries. In a retrospective review of 100 patients with blunt chest trauma and associated scapular fractures, Harris et al reported that the scapular fracture was initially missed in 31 cases, despite being readily apparent on the initial supine trauma chest radiograph.34 The trauma series of shoulder radiographs will identify most fractures and the axillary lateral view is especially useful in evaluating fractures of the glenoid fossa and the acromion or coracoid processes.5 The os acromiale (unfused acromial process epiphysis) is present in 3% of the population and should not be confused with a fracture of the acromion.7 A comparison film is useful since the abnormality is present bilaterally in 60% of cases.

Figure 11. Type II Scapular Fracture Involving The Neck

Courtesy of Dr. Daya.
Management And Disposition
Most fractures, including those with severe comminution and displacement, heal rapidly with conservative therapy. Initial therapy consists of analgesia and immobilization in a sling to support the ipsilateral upper extremity. Initiate pendular shoulder exercises (Figure 9) followed by active range of motion exercises as soon as discomfort subsides to reduce the risk of adhesive capsulitis. In general, patients require a sling for two to four weeks.

Fractures of the body and spine usually require no further therapy. Undisplaced fractures of the acromion process also respond well to conservative therapy. Displaced acromial fractures that impinge on the glenohumeral joint require surgical management. 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 may do well with conservative therapy, open reduction and internal fixation is needed for more than 2 mm of displacement of the glenoid and is recommended for severely displaced or angulated fractures of the scapular neck. In a recent evidence-based review of 520 scapula fractures from 22 case series, Zlowodzki et al reported that 80% of all fractures with glenoid involvement were treated operatively, while 83% of all neck injuries and 99% of all isolated scapula body fractures were treated nonoperatively.

Complications
Associated injuries of the ipsilateral lung, chest wall, and shoulder girdle account for most of the acute complications after fractures of the scapula. Neurovascular (brachial plexus, axillary artery) injuries have also been reported with fractures of the coracoid process. Delayed complications include adhesive capsulitis and rotator cuff dysfunction.

Proximal Humerus Fractures
Classification And Pathophysiology
Fractures of the proximal humerus are common and account for 4-5% of all fractures. They occur primarily in the elderly, in whom structural changes associated with aging (osteoporosis) weaken the proximal humerus. Although most of these injuries are minimally displaced and do well with conservative therapy, significantly displaced fractures may require operative intervention.

The classic mechanism of injury involves a fall on an outstretched abducted arm. 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 individuals are apt to dislocate.

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 proximal humeral shaft (surgical neck). The Neer classification (Figure 13) is based on the relationship of these fracture fragments. In the Neer system, a segment is considered displaced if it is angled more than 45 degrees or separated more than 1 cm from the neighboring segment. The number of fracture lines is considered irrelevant. This lends to four major categories of fracture:
When present, anterior and posterior dislocations are included within the Neer classification system. Impaction and head-splitting fractures are also classified separately.

Clinical
The affected arm is held close to the body and movement is restricted by pain. Tenderness, hematoma, ecchymoses, deformity, or crepitus may be present over the fracture site. A thorough neurovascular examination is essential to identify associated injuries of the axillary nerve, brachial plexus, or axillary artery. 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 And Disposition
Minimally displaced fractures constitute up to 85% of all cases. No displacement or angulation is present, and the fracture segments are held together by the capsule, periosteum, and surrounding muscles. Good evidence for the management of these fractures is limited. Initial treatment consists of analgesia and immobilization with a sling or sling and swathe device. A recent Cochrane review of 12 randomized trials, eight of which evaluated conservative therapy, concluded that there was very limited evidence that the use of special bandage immobilization affected time to fracture union or functional outcome.39 However, the evidence suggested that the arm sling was more comfortable than a body bandage.39 Have the patient slowly replace initial passive pendular exercises (Figure 9) with more active and resistive exercise. Traditionally, immobilization is recommended until clinical union is achieved (head and shaft move together). The Cochrane review also noted that immediate or earlier commencement of physiotherapy (within one week) resulted in less pain and faster recovery than prolonged immobilization (three weeks), followed by rehabilitation in patients with nondisplaced two-part fractures.39 Most nondisplaced fractures will heal over four to six weeks.

Operative management may be favored for displaced two-, three-, and four-part fractures and orthopedics should be consulted.38 Prospective and retrospective observational studies have failed to show a significant functional difference between operative and non-operative treatment of displaced two-part and three-part fractures in the elderly. Current literature continues to support operative treatment of four-part fractures in the elderly where the procedure of choice is hemiarthroplasty.40

Fracture-dislocation injuries may deserve orthopedic consultation in the ED. Care must be used because closed reductions of these injuries are often unsuccessful and can cause separation of previously undisplaced segments. Closed reduction under fluoroscopy and general anesthesia may be preferable.41

Complications
The most common complication of proximal humeral fractures is adhesive capsulitis (“frozen or stiff shoulder”). This can be prevented by the early initiation of passive shoulder pendular exercises along with a thorough rehabilitation program. One of the most devastating complications is that of avascular necrosis (AVN) of the humeral head. The highest rate of AVN (up to 90%) occurs with four-part fractures.40 It should be anticipated with anatomical neck fractures as well. Neurovascular injuries (axillary nerve, brachial plexus, and axillary artery) may be encountered with displaced surgical neck fractures and fracture-dislocations.

Proximal Humeral Epiphysis Injuries

Pathophysiology
Fractures of the proximal humeral epiphysis are uncommon and account for 10% of all shoulder fractures in children.42 The injury can occur at any age while the epiphysis remains open but is most common in young males aged 11 to 17 years.43 The most common mechanism of injury involves a fall onto the outstretched hand. Injuries can be classified according to their Salter type (Figure 16), stability, and degree of displacement.3,44 This injury should also be suspected in young athletes and is commonly known as little league shoulder.

Clinical
The patient will have the injured arm held tightly against the body by the opposite hand. The area over the proximal humerus will be swollen and tender to palpation. Radiographs obtained at 90 degrees to each other will confirm the diagnosis. Comparison views may be helpful with minimally displaced fractures.43

Management
Fractures of the proximal humeral epiphysis should not be taken lightly because the potential for growth disturbance exists until fusion has taken place between the ages of 20 and 22. The very 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 less than six years of age usually have Salter I epiphyseal injuries and can be treated conservatively with sling and swathe immobilization and analgesia. Children older than six years of age usually have a Salter II epiphyseal injury. Salter II injuries with greater than 20 degrees of angulation should be reduced.45 Closed reduction is accomplished by reversing the mechanism of injury. Imperfect reductions are often 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. Little league shoulder is treated with a sling and activity modification dictated by symptomatology. Fractures of the proximal humeral epiphyses will heal in three to five weeks.45

Complications
Complications include malunion, growth plate disturbances, and injuries to the neurovascular bundle.

Dislocations

Sternoclavicular Dislocations

Pathophysiology And Classification
Sternoclavicular joint (SCJ) dislocations are infrequent, with the most common causes from motor vehicle accidents and contact sports.46 Significant forces are required to disrupt the strong ligamentous stabilizers of this joint. The SCJ can dislocate in an anterior or posterior direction. Anterior dislocations, which result from indirect forces, are far more common (9:1 ratio).4 The usual mechanism of injury involves an anterolateral force to the shoulder, followed by backward rolling which lever the medial clavicle out of its articulation. Posterior dislocations can result from a direct blow to the medial clavicle (30%) or from a posterolateral force to the shoulder, followed by inward rolling (70%).3 Posterior dislocations can be associated with life-threatening injuries within the superior mediastinum. Injuries to the SCJ (Figure 1) can be graded into three types: 4

- 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 while the costoclavicular ligament remains intact.
- A Grade III injury is complete rupture of the sternoclavicular and costoclavicular ligaments that results in dislocation.

It is important to note that in patients under 25 years of age, these actually represent Salter I injuries, since the medial epiphysis of the clavicle has not yet fused.47

Clinical
Patients present with the injured extremity flexed at the elbow and supported across the trunk by the opposite arm.48 There is usually pain in the region of the SCJ which increases with arm motion, although atraumatic cases (attributable to ligamentous laxity in teenagers) may have minimal symptoms.46 The SCJ may be mildly swollen and tender to palpation. With an anterior dislocation, the displaced medial end of the clavicle may be palpable. Posterior dislocations are associated with more severe pain, and the neck is often flexed toward the injured side.48

The clavicular notch of the sternum may be more or less prominent, and there may be complaints of hoarseness, dysphagia, and dyspnea as well as weakness or paresthesias in the upper extremity. Although rare, airway complications secondary to tracheal injury have been reported.49 The presence of cyanosis and venous congestion of the neck and arm is typical of an innominate vein injury.48

Although the diagnosis of sternoclavicular dislocations can be made clinically, it should be confirmed through radiographic studies. Standard AP chest radiographs as well as other recommended (40-degree cephalic tilt) views are often difficult to interpret because of overlapping rib, sternum, and vertebral shadows. These dislocations and associated mediastinal injuries are best visualized by CT (Figure 17).15,48 Ultrasound (Figure 18) may also be a useful adjunct in some circumstances.4,50

Management and Disposition
Treatment of Grade I injuries includes immobilization (simple sling), adequate analgesia, and primary care follow-up. Immobilization is generally maintained (one to two weeks) until full painless motion is restored. Grade II injuries should be immobilized with a sling and referred for orthopedic follow-up. Grade III injuries require a longer course of immobilization (three to six weeks) and are more likely to be associated with persistent pain.3,4

All Grade III injuries should be managed by closed reduction. Anterior dislocations may be reduced in the ED after orthopedic consultation and intravenous analgesia. 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

Figure 17. CT Image Demonstrating A Right Posterior Sternoclavicular Dislocation

Courtesy of Dr. Daya.
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 sling or clavicular splint and referred for orthopedic follow-up. Although major orthopedic textbooks still recommend immobilization with the clavicular splint in grade II and III injuries, there is no published evidence to support this. Many of these reductions remain unstable, and since the deformity is primarily cosmetic and not functional, recurrent anterior dislocations are treated conservatively with benign neglect.

Posterior dislocations are true orthopedic emergencies and should be reduced expeditiously. Closed reduction of retrosternal dislocations is considered the treatment of choice, with open reduction and internal fixation required only in cases where the clavicle cannot be reduced or remains unstable after reduction. Reduction of posterior dislocations can be attempted in the operating room under general anesthesia or in the ED under procedural sedation. A cardiothoracic surgeon should be consulted before reduction of these injuries in the event that a vascular injury requiring thoracotomy becomes apparent during the procedure. 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. With this technique, the skin is sterilely prepped and the clavicle shaft is grasped with a sterile towel clip and pulled out anterolaterally. Once reduced, these injuries are generally stable and can be immobilized with a clavicular splint. Buckerfield and Castle have described an alternate method of reduction for posterior dislocations. In this technique, traction is applied to the abducted arm while both shoulders are simultaneously forced posteriorly using direct pressure. This levers the clavicle into place and requires much less force than the traditional abduction-extension method.

**Complications**

Significant complications are associated with retrosternal dislocations. Ono et al reviewed 102 cases reported in the literature as of 1998 and documented complications in 31 (30%) patients, with three deaths. Complications include compression or laceration of the great vessels, tracheoesophageal fistula, tracheal compression, pneumothorax, thoracic outlet syndrome, and brachial plexus injuries.

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**Acromioclavicular Joint**

**Pathophysiology And Classification**

Injuries of the acromioclavicular joint (ACJ) occur primarily in young men secondary to sporting or motor vehicle accidents. They account for up to 25% of all dislocations of the shoulder girdle. 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 away from the clavicle to produce the injury. The weak acromioclavicular ligaments rupture first. With increasing force, the coracoclavicular ligaments rupture and the attachments of the deltoid and trapezius muscles are torn from the distal clavicle. The ACJ can also be injured after a fall onto the outstretched hand.

Classification is based on the degree of damage sustained by the different joint stabilizers. The most commonly used system is that modified by Rockwood:

- **Type I:** Sprains of the acromioclavicular (AC) ligaments with no separation of the acromion and clavicle.
- **Type II:** Disruption of the AC ligaments. The joint space is widened and the clavicle displaces slightly upward. There are minor tears in the attachments of the deltoid and trapezius muscles, but the coracoclavicular (CC) ligaments remain intact and the coracoclavicular distance is maintained (Figure 19).
- **Type III:** Complete disruption of the AC ligaments, CC ligaments, and muscle attachments. The joint space is widened, and the

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The coracoclavicular distance is increased by 25-100%. The clavicle is displaced upward by the pull of the trapezius, and the shoulder is displaced downward by the effect of gravity (Figure 20).

- Type IV: Complete rupture of the AC and CC ligaments with displacement of clavicle posteriorly through the trapezius.
- Type V: Complete rupture of the AC and CC ligaments with an exaggerated superior displacement of the clavicle. The coracoclavicular distance is increased 100-300%.
- Type VI: Subcoracoid displacement of the clavicle.

**Clinical**

Always examine patients while they are sitting or standing because the supine position can mask ACJ instability. It is helpful to visualize both shoulders simultaneously to assess for symmetry. Type I and II injuries are associated with mild tenderness and swelling over the ACJ margin and minimal deformity. A full range of motion is often possible, although painful. Patients with Type III, IV, V, and VI injuries usually have severe pain and will hold the arm tightly adducted. In Type III injuries, the shoulder hangs downward and the clavicle rides high, producing a visible 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.

The energy settings used for the three-view shoulder trauma series usually overpenetrate the ACJ. Therefore, specific ACJ views that use less intensity should be ordered. The recommended projections include an AP view of both shoulders on a single wide film, an axillary lateral view, and a 15-degree cephalic tilt view. The axillary lateral view is very important for identifying associated fractures and any posterior dislocation of the clavicle. The normal coracoclavicular distance varies between 11 mm and 13 mm. A difference of more than 5 mm between the injured and uninjured sides is diagnostic of complete coracoclavicular disruption. Type I injuries have essentially normal radiographs. Type II injuries (Figure 19) show widening of the joint and a slight upward or posterior displacement of the clavicle but a normal coracoclavicular distance. Type III, IV, and V injuries have a widened joint, an increased coracoclavicular distance, and either superior or posterior displacement of the clavicle. Historically, stress views of the ACJ have been recommended to differentiate between Type II and III injuries. To study this recommendation, Bossart et al presented 83 pairs of radiographs, taken with and without weights, in a blinded manner to a staff radiologist. In only three cases (4%) did weights cause the injured coracoclavicular distance to increase and thereby unmask a grade III injury not evident on plain radiographs. In several cases, the weights actually caused the injured and uninjured CC distance to decrease; the authors concluded that the use of weighted radiographs lacks efficacy for unmasking grade III ACJ injuries and recommended that the routine use of this technique be abandoned in the ED.

**Management And Disposition**

Type I and II injuries should be immobilized in a sling for comfort and to protect against further injury. These patients should be referred for follow-up with their primary care physician. Once pain has subsided (one to three weeks), the patient can begin range-of-motion and strengthening exercises with a return to sports when pain-free function has been achieved. Type IV, V, and VI injuries require immediate orthopedic consultation. The management of Type III injuries has changed dramatically over the last two decades.
Most studies have concluded that conservative treatment provides equal or, in some cases, better functional results than surgical intervention. In addition, surgical patients have longer recovery times and higher complication rates.

**Complications**
The most common complications following ACJ injuries are residual symptomatic instability and tenderness over the joint due to secondary degenerative changes. Acromioclavicular arthritis typically presents as an impingement syndrome with shoulder pain between 120 and 180 degrees of abduction.

**Glenohumeral Dislocations**
The glenohumeral joint (GHJ) is the most commonly dislocated major joint in the body. The lack of intrinsic bony stability in conjunction with its wide range of motion predisposes the joint to dislocations. Anterior dislocations account for 95-97% of all glenohumeral dislocations. Posterior dislocations account for most of the remainder, while inferior and superior dislocations are rare.

**Anterior Dislocations**

**Pathophysiology And Classification**
The most common mechanism of injury of anterior dislocations consists of an indirect force transferred to the anterior capsule from a combination of abduction, extension, and external rotation. In younger individuals, the injury is usually sustained during athletic activities involving rapid movements; a characteristic pathological feature is avulsion of the anteroinferior glenohumeral ligament with capsulolabral detachment (Bankart lesion). In older patients, a fall onto the outstretched arm is the more common mechanism of injury and there is often an accompanying rotator cuff tear.

Anterior dislocations can be classified according to the anatomic position of the dislocated humeral head. After dislocation, the humeral head can assume a subcoracoid, subglenoid, subclavicular, or intrathoracic position. The subcoracoid (Figure 21) is the most common type of anterior dislocation. The head is displaced anteriorly and rests on the scapular neck inferior to the coracoid process. The second most common type is the subglenoid dislocation, in which the head is anterior and inferior to the glenoid fossa. The subcoracoid and subglenoid types account for 99% of all anterior dislocations. Subclavicular and intrathoracic dislocations are extremely rare and involve the addition of impact forces that push the humeral head medially.

**Clinical**
Clinical presentation is that of severe pain with the dislocated arm held in slight abduction and external rotation by the opposite extremity. The lateral edge of the acromion process is prominent, and the normally rounded shoulder assumes a “squared-off” appearance. The coracoid process is indistinct, and the anterior shoulder appears full. The patient cannot adduct or internally rotate without pain. A neurovascular examination must be 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 over 50 years of age. 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 can be tested by having the patient attempt shoulder abduction while the examiner simultaneously feels for muscle contraction. Motor testing is recommended, since sensory testing may be inaccurate due to the presence of overlapping cutaneous nerve root dermatomes.

The trauma series of radiographs will confirm the clinical diagnosis and identify the position of the humeral head. Associated fractures may be present in up to 50% of cases. The most common of these is a compression fracture (Figure 22) of the posterolateral 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, is reported to be present in 11-50% of all anterior dislocations. The actual incidence is probably much higher, since minor compression fractures are difficult to visualize on plain radiographs. 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 10-15% of cases (Figure 23).

**Management And Disposition**
Perform closed reduction of the dislocation.
expeditiously because neurovascular complications increase with time.\textsuperscript{68} It is recommended that radiographic documentation of the type of dislocation and any associated fractures be obtained before attempting reduction. The role of pre-reduction as well as post-reduction radiographs have been the subject of several recent studies aimed at reducing radiograph utilization and shortening the time spent in the ED; see the \textbf{Controversies And Cutting Edge} section.

Good muscle relaxation is often the key to a successful reduction. Reductions can also be accomplished without the use of any analgesia if the time from injury to reduction is short or if the dislocation is a recurrent one. Muscle relaxation and analgesia can be achieved through procedural sedation. The intra-articular injection of a local anesthetic agent can be used as an alternative to sedation analgesia. Enter the joint under sterile technique 2 cm inferior to the lateral edge of the acromion using an 18- or 20-gauge needle. Aspirate any associated hemarthrosis and then inject 20 mL of 1\% lidocaine over 30 seconds. The patient is then allowed to relax for 15 minutes before reduction is attempted. The published studies to date have all used lidocaine, although it would be reasonable to expect similar results with long acting local anesthetic agents such as bupivacaine. A recent systematic literature review revealed six randomized, controlled trials comparing intravenous sedation to intra-articular lidocaine.\textsuperscript{69} Outcomes in these studies included success rates, complications, and time spent in the ED.\textsuperscript{70-75} 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.\textsuperscript{69} Complication rates were quite different, averaging 0.9\% in the intra-articular lidocaine group (septic arthritis, abscess, cellulitis, allergy, or failure of reduction) and 16.4\% in the intravenous sedation group (potential

### Key Points For Shoulder Girdle Fractures And Dislocations

1. A thorough neurovascular exam is essential and must be repeated after any manipulation.
2. The three-view trauma series leads to an accurate radiographic diagnosis of most fractures and dislocations; however, specialized views (e.g., the apical oblique and 15-degree cephalic tilt view) may be useful or necessary in some instances. Think about the presence of unfused epiphyses in adolescents and young adults and consider comparison films on a selective basis.
3. Most fractures can be treated conservatively with good functional outcomes.
4. Early initiation of passive pendular range-of-motion exercises can reduce the risk of adhesive capsulitis when the shoulder is immobilized for any reason.
respiratory depression, cardiac compromise, allergy, or failure of reduction). In two studies, the time spent in the ED was significantly shorter for the intra-articular lidocaine group and there was as much as a 62% cost savings versus the intravenous sedation-analgesia group.71,74

Reduction can be accomplished using various techniques, most of which involve traction, leverage, or scapular manipulation principles.76 Over a dozen techniques have been described for reducing a shoulder dislocation.69 Most of these have only been described in case series or consecutive prospective cohorts. There is only one randomized trial in the literature which compared the Kocher and Milch techniques; it found no statistical differences in the success rates between the two techniques.77 Due to insufficient data at this time, no specific recommendation can be made regarding the optimal reduction technique.69 The ideal method should be simple, quick, effective, require little assistance, and cause no additional injury to the shoulder. It is wise to be familiar with several techniques of reduction, since none is uniformly successful.

**Traction Techniques**

Gentle traction in various directions (forward flexion, abduction, overhead, lateral) is used to overcome the muscle spasm that holds the humeral head in its dislocated position.76 In the Stimson technique, 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 20-30 minutes. Success rates reported with the Stimson method range from 91 to 96%. This is an excellent technique in the busy ED because it saves time and resources.69

In the traction-countertraction method, traction is applied along the abducted arm while an assistant using a folded sheet wrapped across the chest applies counter-traction (Figure 24). The forward elevation maneuver of Cooper and Milch is also simple and safe (Figure 25). The arm is initially elevated 10-20 degrees in forward flexion and slight abduction. Forward flexion is continued until the arm is directly overhead. Abduction is then increased, and outward traction is applied to complete the reduction.78 Reported success rates with this technique range from 70% to 89%.69

Another simple and very effective traction technique with a reported success rate of 97% is the Snowbird technique.79 In this method, the patient is seated in a chair and the affected arm is supported by the patient’s unaffected extremity. A three-foot loop of four-inch cast stockinet is then placed along the proximal forearm of the involved extremity with the elbow at 90 degrees. The patient is then assisted or instructed to sit up and the physician’s foot is placed in the stockinet 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.

**Leverage Techniques**

The most commonly recommended leverage technique is the external rotation method of Liedelmeyer (Figure 26).80 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. Success rates reported with the external rotation method range from 78% to 90%.69

**Scapular Manipulation**

Scapular manipulation accomplishes reduction by...
repositioning the glenoid fossa rather than the humeral head. The patient is placed in the prone position with the affected arm hanging off the table as for the Stimson technique. After the application of downward traction (manual or hanging weights), the scapula is manipulated (Figure 27) by rotating the inferior tip medially while simultaneously stabilizing the superior and medial edges with the opposite hand.³¹ Success rates range from 79% to 96%. McNamara described a seated modification of the scapular method in which traction is applied in the forward horizontal position while an assistant manipulates the scapula.³² Scapular manipulation can be difficult in obese individuals, in whom it is difficult to palpate and grasp the inferior tip of the scapula.

The neurovascular examination must be repeated after any attempt at reduction. It is also generally recommended that radiographs be repeated to confirm reduction and to identify any associated fractures not apparent on pre-reduction films.

Once reduced, immobilize the affected extremity.

**Clinical Pathway: Approach To Clavicle Fractures In The ED**

<table>
<thead>
<tr>
<th>Clavicle fractures</th>
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<tbody>
<tr>
<td>Is there:</td>
</tr>
<tr>
<td>• An open fracture?</td>
</tr>
<tr>
<td>• A fracture with neurovascular injuries?</td>
</tr>
<tr>
<td>• Skin tenting?</td>
</tr>
<tr>
<td>• Interposition of soft tissues?</td>
</tr>
<tr>
<td><strong>NO</strong></td>
</tr>
<tr>
<td><strong>YES</strong></td>
</tr>
<tr>
<td>Immediate orthopedic consultation (Class I)</td>
</tr>
</tbody>
</table>

| Is it a Type II lateral clavicle fracture? |
| **NO** |
| **YES** |
| Pain control and immobilization, then urgent orthopedic consultation (within 72 hours) (Class I) |

| Is it: |
| • Severely comminuted? |
| • A displaced fracture of the middle third (defined as over 20 mm initial shortening)? |
| **NO** |
| **YES** |
| Pain control and immobilization, then early orthopedic referral (Class III) |

| Pain control and immobilization, then primary care physician follow-up (Class II) |
Discharge patients with adequate analgesia and appropriate follow-up. Primary dislocations and complicated cases (associated fracture, rotator cuff tear, axillary nerve injury) should receive prompt orthopedic follow-up. In uncomplicated cases, immobilize the shoulder for three to six weeks in younger patients and one to two weeks in patients older than 40 years of age. If immobilization is used, early initiation of pendular shoulder exercises can help reduce the risk of adhesive capsulitis. This should be followed by a meticulous rehabilitation program aimed at restoring the static and dynamic stabilizers of the glenohumeral joint.

Complications
Complications include the aforementioned fractures and neurovascular injuries. Most axillary nerve injuries are neuropraxic, and the prognosis for recovery of function is good. Rotator cuff tears may be present in 10-15% of cases. Rotator cuff tears are more common in primary dislocations in individuals over the age of 40. In this setting, failure to abduct the arm is often initially misdiagnosed as an axillary nerve injury. Most of these individuals require tendon and capsular repair to restore shoulder stability. Recurrence is also a common complication after anterior dislocation, especially in patients less than 30 years of age.

Posterior Dislocation

Pathophysiology
Posterior dislocations are rare and account for 2% of all glenohumeral dislocations. The 45-degree angulation of the scapula on the thoracic cage positions the glenoid fossa posterior to the humeral head and serves as a partial buttress against posterior dislocation. Unfortunately, over 50% of posterior dislocations are missed on initial evaluation, and many remain unrecognized 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 because the larger and stronger internal rotator muscles (latissimus dorsi, pectoralis major, teres major, subscapularis) overpower the weaker external rotators (teres minor, infraspinatus). A posterior dislocation can also 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. Classification (subacromial, subglenoid, subspinous) is based on the final resting position of the humeral head. The subacromial variety accounts for 98% of all posterior dislocations.

Clinical
Early diagnosis is essential to prevent long-term functional and therapeutic complications. The patient will hold the affected arm across the chest in adduction and internal rotation. The injury can be relatively painless in some cases. The normal shoulder contour is replaced by a flat, squared-off appearance...
and the humeral head may be palpable posteriorly beneath the acromion process. Abduction is severely limited, and external rotation is completely blocked. Failure to diagnose is often due to an over reliance on radiological findings and an under reliance on the clinical examination. The most common misdiagnosis is adhesive capsulitis.84,86

The true or standard AP radiographs can appear deceptively normal with posterior dislocations. The common inability to diagnose posterior dislocation in the frontal plane has led to the description of several characteristic radiographic findings. The humeral head is often profiled in internal rotation and takes on a “light bulb” or “drumstick” appearance (Figure 28). Standard AP films also show loss of the half-moon elliptical overlap of the humeral head and glenoid fossa as well as an increase in the distance between the anterior glenoid rim and the articular surface of the humeral head (“rim sign”). A true AP film will show abnormal overlap of the glenoid fossa with the humeral head (Figure 29). Finally, an impaction fracture (Figure 30) of the anteromedial humeral head (reverse Hill-Sachs deformity) is invariably present. This may produce a curvilinear density on the frontal projection parallel to the articular cortex of the humeral head (“trough sign”). Orthogonal views such as an axillary lateral, transscapular “Y,” or apical oblique (Figure 31) are essential to clinch the diagnosis. These views can identify associated fractures of the humeral head and posterior glenoid rim. CT may be helpful in some instances.87

Management And Disposition
Obtain orthopedic consultation for all patients with posterior dislocations. Closed reduction may be attempted in the ED under procedural sedation. The technique of reduction incorporates axial traction in line with the humerus, gentle pressure on the...
posteriorly displaced head, and slow external rotation. If this fails, reduction with the patient under general anesthesia is indicated. Once reduced, the shoulder is immobilized in external rotation with slight abduction. Cases that were missed initially and present as a chronic or “locked posterior dislocation” should be discussed with the orthopedist since they often require semi-elective open reduction and internal fixation or arthroplasty.

Complications
The most common complications are associated fractures of the glenoid rim, greater tuberosity, lesser tuberosity, and humeral head. The subscapularis muscle 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 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 1% of all shoulder dislocations are of this variety and the mechanism of injury involves either indirect or direct forces. 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, dislocating the head inferiorly. Application of a direct axial load to an abducted shoulder can also disrupt the weak inferior gleno-humeral ligament and drive the humeral head downward.

Clinical
Typically, the patient presents with the arm locked overhead in 110-160 degrees of abduction. The elbow is usually flexed with the forearm resting on top of the head. The inferiorly displaced humeral head may be palpable along the lateral chest wall and any attempted movement is very painful. A completed neurovascular examination is essential to evaluate for associated injuries.

Luxatio erecta cases are often mistakenly diagnosed and treated as subglenoid anterior dislocations, since the radiographic features of these two clinical entities are remarkably similar. Standard AP radiographs demonstrate the superior articular surface inferior to the glenoid fossa. In addition, the humeral shaft characteristically lies parallel to the spine of the scapula on the AP view (Figure 32). This radiographic feature is useful in distinguishing luxatio erecta from a subglenoid anterior dislocation because the humeral shaft lies perpendicular to the spine of the scapula in the latter. Associated fractures of the acromion, coracoid, clavicle, greater tuberosity, humeral head, and glenoid rim are frequently present.

Management And Disposition
When possible, obtain orthopedic consultation before attempting closed reduction in the ED; it should then be performed under procedural sedation using a traction-countertraction maneuver. Apply traction in line with the humeral shaft while an assistant applies countertraction across the shoulder. Gentle abduction usually reduces the dislocation, and the arm can then be brought down into an adducted position. Multiple attempts may be necessary and occasionally button-holing of the capsule will prevent closed reduction, necessitating open reduction. A single operator technique has been described by Nho et al.

Figure 32. Inferior GHJ Dislocation Demonstrating The Scapula Spine Parallel To The Humeral Shaft

Cost- And Time-Effective Strategies

1. The use of intra-articular 1% lidocaine to facilitate analgesia and relief of muscle spasm in anterior glenohumeral joint dislocations results in shorter ED length of stay and substantial cost savings when compared to procedural sedation.
2. The routine use of weighted views to diagnose grade III ACJ injuries lacks efficacy, adds cost, and is unnecessary.
3. Recent studies suggest that post-reduction radiographs may not be necessary following successful reduction of anterior glenohumeral dislocations. In selected cases, pre-reduction radiographs may also be unnecessary.
Complications
Neuropraxic lesions of the brachial plexus are very common. Aneurysm or thrombosis of the axillary artery as well as thrombosis of the axillary vein have also been associated with luxatio erecta.\(^{91,92}\) Given the proximity of the two structures, arteriography should be strongly considered any time a brachial plexus injury is observed. In a 1990 case report and review of the literature, Mallon et al reported that 12% of cases were associated with rotator cuff tears and 37% of cases had a fracture of some type. Greater tuberosity avulsion fractures occur in 31% of cases, and fractures of the glenoid, acromion, surgical neck, humeral head, and scapular body have also been reported.\(^{93}\) Adhesive capsulitis is a common long-term complication of luxatio erecta.

Controversies And Cutting Edge

Cutting Edge

Once an anterior shoulder dislocation is reduced, the standard teaching has been immobilizing the shoulder in internal rotation using a sling (Figure 33A) to allow for the healing of the injured soft tissues. The wisdom of this has recently been questioned by cadaveric studies from Japan and Australia which demonstrated that immobilization in external rotation (Figure 33B) allowed for better approximation of the injured soft tissues (Bankart lesion) to the glenoid rim following an anterior shoulder dislocation.\(^{94,95}\) The potential benefits of immobilization in external rotation have been subsequently confirmed through two clinical studies. In the first study, Itoi et al obtained MRI images in both internal (mean 29 degrees) and external (mean 35 degrees) rotation following reduction of an anterior dislocation in 19 patients (13 recurrent, 6 acute). They noted that separation and displacement of the labrum were both significantly less when the arm was immobilized in external rotation as compared to internal rotation (\(P = 0.0047\) and \(P = 0.0017\), respectively).\(^{96}\) This preliminary study was then followed by a prospective, randomized trial comparing these two methods of immobilization following reduction in 40 patients with first time anterior dislocations.\(^{97}\) The authors reported that three weeks of immobilization in 10 degrees of external rotation was associated with a zero recurrence rate at 13-15 months compared to 30% with sling immobilization in internal rotation.\(^{97}\) A larger confirmatory study with longer follow-up intervals would be helpful, but, for now, it appears that immobilization in external rotation (Figure 33B) may be of more benefit than immobilization in internal rotation in patients with a first anterior shoulder dislocation.\(^{98}\)

Controversies

Most health care practitioners have traditionally been taught that pre-reduction radiographs are necessary in all suspected shoulder dislocations to confirm the clinical diagnosis and to assess for the presence of any associated fractures. Furthermore, it has been recommended that patients receive post-reduction radiographs to confirm reduction and exclude fractures caused by the reduction technique. The need for pre- and post-reduction radiographs in suspected shoulder dislocations has been challenged by several authors in recent years.\(^{99-104}\) Reduction in the number of radiographs should decrease costs and shorten ED throughput times. Hendey et al retrospectively reviewed the radiographic findings in 131 patients with 175 dislocations to determine the utility of post-reduction radiographs.\(^{100}\) They noted that pre-reduction radiographs demonstrated all associated fractures except for 14 new Hills-Sachs deformities which they deemed to be clinically insignificant. In a subsequent prospective study of 104 patients, these same authors reported that physician clinical confidence with regards to a successful reduction (presence of a palpable clunk, decrease in pain, and improvement in the range of motion) was well correlated with findings on the post-reduction radiographs.\(^{101}\) Shuster et al investigated the need for pre-reduction radiographs at a rural community hospital that serves...
an active skier and snowboarder population. In one study, they found that when the emergency physician was clinically confident of the diagnosis (68% of cases), they were 100% accurate. In a follow-up study, they demonstrated that implementation of voluntary guidelines based on physician certainty allowed for the elimination of pre-reduction radiographs in 88.9% of cases.

Decreasing the need for pre- and post-reduction radiographs was recently prospectively evaluated by Hendey and colleagues using a clinical decision algorithm based on mechanism of injury, history of prior dislocations and physician’s certainty of joint position. The algorithm reduced x-ray utilization by 46%. In addition, the mean ED times were significantly shorter for patients managed without radiographs and the reduction in ED utilization was not offset by an increase in follow-up office radiographs. The findings of most of these studies are very subjective and one cannot assume that all doctors will have

### Risk Management Pitfalls

1. **Failure to obtain a CT to evaluate the SCJ joint.** Standard AP, oblique, and specialized (40-degree cephalic tilt) views of the SCJ are often difficult to interpret because of overlapping rib, sternum, and vertebral shadows. These dislocations and associated injuries are best visualized by CT.

2. **Failure to search for associated injuries with retrosternal SCJ dislocations.** Up to 25% of posterior dislocations may be complicated by life-threatening injuries to intrathoracic and superior mediastinal structures.

3. **Failure to diagnose an axillary nerve injury following an anterior glenohumeral dislocation.** The incidence of axillary nerve injuries after anterior glenohumeral dislocation ranges from 5% to 54%. Axillary nerve function can be assessed by testing for sensation over the lateral aspect of the shoulder (the “regimental badge” region) and by testing motor function of the deltoid muscle. Motor testing is more accurate because sensory testing can be misleading due to the presence of overlapping cutaneous nerve root dermatomes.

4. **Failure to refer Type II lateral clavicle fractures as well as severely comminuted or displaced midclavicular fractures to an orthopedic surgeon.** Although most clavicle fractures will heal without surgical intervention, these fractures have a high incidence of non-union and may benefit from surgical repair.

5. **Failure to recognize a posterolateral compression fracture of the humeral head (Hill-Sachs deformity) in conjunction with an anterior glenohumeral dislocation.** Hill-Sachs deformities are very common following anterior dislocations and appear to be a predisposing factor for recurrence.

6. **Failure to initiate passive shoulder exercises early during the immobilization phase for shoulder injuries.** One of the most dreaded complications after any shoulder injury with immobilization is adhesive capsulitis. This can be avoided by minimizing the duration of immobilization when possible and initiating stretching and pendular shoulder exercises early.

7. **Failure to diagnose a posterior glenohumeral dislocation.** Over 50% of posterior dislocations are missed on initial evaluation, and many might go unrecognized ("locked posterior dislocations") for weeks and months. This can be avoided by a careful clinical examination which will show limited abduction and blocked external rotation. Include posterior dislocation in the differential diagnosis of any shoulder injury.

8. **Misdiagnosing luxatio erecta as an anterior subglenoid dislocation.** It is important to evaluate the relationship between the spine of the scapula and the longitudinal axis of the humerus to avoid missing an inferior glenohumeral dislocation. In luxatio erecta, the scapula spine and humerus are parallel to each other whereas they are perpendicular to each other in subglenoid anterior dislocation. Associated tears of the rotator cuff are very common with luxatio erecta.

9. **Failure to refer young individuals to an orthopedic surgeon following a primary traumatic anterior dislocation.** Recurrence is a common complication after anterior dislocation in patients under 30 years of age. Such individuals may benefit from orthopedic follow-up and arthroscopic repair of associated Bankart lesions.

10. **Attempting reduction of two-part proximal humeral fracture dislocations in the ED.** Forced reduction of these injuries can lead to separation of the fracture fragments. It is best to seek orthopedic consultation.
the same clinical acumen. Radiographs of the shoulder are easily available and present little or no risk to the patient. Unfortunately, clinical and diagnostic errors in this area may lead to malpractice claims. For these reasons, imaging of suspected shoulder dislocations remains advisable in most cases, with the possible exception of some patients presenting with a history of recurrent dislocations in the absence of trauma.

**Case Conclusion**

The quarterback was diagnosed with a Type III ACJ injury based on a widening of the acromioclavicular and coracoclavicular distances. He was eventually discharged home with his family with orthopedic follow-up within 72 hours to discuss operative vs. non-operative treatment. You advise your medical student that a study by Bossart and colleagues showed the use of weighted radiographs to lack efficacy for unmasking Type III ACJ injuries and that the routine use of this technique has been abandoned in the ED.

On arrival, the wide receiver was noted by the trauma team to be in severe respiratory distress, and a retrosternal dislocation of the clavicle was clinically suspected. This was confirmed through a CT scan and the patient was transferred by the orthopedic surgeon along with cardiothoracic surgery service to the operating room for a closed reduction.

**Summary**

Shoulder girdle fractures and dislocations are commonly encountered in the ED. Diagnosis and management of these injuries is best accomplished by a thorough clinical assessment supplemented by radiological studies when needed. The evidence supporting many of our current management strategies is limited primarily to prospective and retrospective observational studies. Many researchers have begun to question the traditional diagnostic and treatment approaches to these injuries, such as whether immobilization is necessary following the successful reduction of anterior glenohumeral dislocation and, if so, for how long and in what position. Prospective, randomized trials will hopefully allow us to move away from historical approaches towards more evidence-based treatment approaches.

**References**

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report. To help the reader judge the strength of each reference, pertinent information about the study, such as the type of study and the number of patients in the study, will be included in bold type following the reference, where available. In addition, the most informative references cited in this paper, as determined by the authors, will be noted by an asterisk (*) next to the number of the reference.


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CME Questions

1. Urgent (within 72 hours) orthopedic consultation is recommended for which type of clavicle fracture?
   a. Type III lateral clavicle fracture
   b. Greenstick fracture
   c. Type II lateral clavicle fracture
   d. Minimally displaced mid-clavicular fracture
   e. Type I lateral clavicle fracture

2. Which of the following has been associated with an increased risk of nonunion with a mid-clavicular fracture?
   a. Male gender
   b. Younger age
   c. Less than 10 mm of shortening
   d. Absence of comminution
   e. Greater than 20 mm of shortening

3. The most common mechanism of injury for patients with a scapula fracture is:
   a. Fall
   b. Motor vehicle accident
   c. Motorcycle accident
   d. Pedestrian struck by auto
   e. Assault

4. The risk of avascular necrosis of the humeral head is highest with which type of proximal humerus fracture?
   a. Displaced two-part fracture
   b. Displaced three-part fracture
   c. Minimally displaced two-part fracture
   d. Displaced four-part fracture
   e. Hill-Sachs deformity (anteromedial impression fracture)

5. The trauma series of the shoulder is best described by which of the following three radiographic views?
   a. True AP, scapular Y, apical oblique
   b. True AP, scapular Y, axillary
   c. 40-degree cephalic tilt, true AP, axillary
   d. Internal AP, external AP, scapular Y
   e. 40-degree cephalic tilt, apical oblique, axillary

6. Which of the following is the most appropriate management with regard to dislocations of the sternoclavicular joint?
   a. All Grade II injuries should be managed by closed reduction
   b. All Grade I injuries should be referred to an orthopedist
   c. If traction alone does not reduce a posterior dislocation, concurrent clavicular manipulation may be helpful via sterile skin prep and a sterile towel clip
   d. Posterior dislocations are best managed in the operating room by a thoracic surgeon
   e. Occasionally, posterior dislocations are true orthopedic emergencies

7. The normal coracoclavicular distance in a standing adult is:
   a. 5-7 mm
   b. 11-13 mm
   c. 13-15 mm
   d. 17-19 mm
   e. 20-22 mm

8. How would you classify an ACJ injury that radiographically shows a posteriorly displaced clavicle with a widened coracoclavicular distance?
   a. Type I
   b. Type II
   c. Type III
   d. Type IV
   e. Type V

9. Which of the following is the most common type of anterior glenohumeral dislocation?
   a. Subglenoid
   b. Subcoracoid
   c. Intrathoracic
   d. Subclavicular
   e. Subspinous

10. Which of the following muscles is innervated by the axillary nerve?
   a. Teres major
   b. Subscapularis
   c. Trapezius
   d. Deltoid
   e. Supraspinatus

11. Axillary vein thrombosis has been reported in association with which of the following injuries?
   a. Posterior subacromial dislocation
   b. Anterior subcoracoid dislocation
   c. Posterior subspinous dislocation
   d. Anterior subglenoid dislocation
   e. Inferior glenohumeral dislocation
12. Which of the following is not a complication associated with anterior glenohumeral dislocations?
   a. Compression fracture of the posterolateral aspect of the humeral head (Hill-Sachs deformity)
   b. Avulsion of the anteroinferior glenohumeral ligament with capsulolabral detachment (Bankart lesion)
   c. Avulsion of the subscapularis muscle
   d. Fracture of the anterior glenoid muscle (Bankart’s Fracture)
   e. Axillary nerve neuropraxia

**Class Of Evidence Definitions**

Each action in the clinical pathways section of *Emergency Medicine Practice* receives a score based on the following definitions.

**Class I**
- Always acceptable, safe
- Definitively useful
- Proven in both efficacy and effectiveness

**Level of Evidence**:
- One or more large prospective studies are present (with rare exceptions)
- High-quality meta-analyses
- Study results consistently positive and compelling

**Class II**
- Safe, acceptable
- Probably useful

**Level of Evidence**:
- Generally higher levels of evidence
- Non-randomized or retrospective studies: historic, cohort, or control studies
- Less robust RCTs
- Results consistently positive

**Class III**
- May be acceptable
- Possibly useful
- Considered optional or alternative treatments

**Level of Evidence**:
- Generally lower or intermediate levels of evidence
- Case series, animal studies, consensus panels
- Occasionally positive results

**Indeterminate**
- Continuing area of research
- No recommendations until further research

**Level of Evidence**:
- Evidence not available
- Higher studies in progress
- Results inconsistent, contradictory
- Results not compelling

Significantly modified from the *Emergency Cardiovascular Care Committee of the American Heart Association and representatives from the resuscitation councils of ILCOR: How to Develop Evidence-Based Guidelines for Emergency Cardiac Care: Quality of Evidence and Classes of Recommendations; also: Anonymous. Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. Part IX. Ensuring effectiveness of community-wide emergency cardiac care. JAMA 1992;268(16):2289-2295.*

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