Basic Athletic Training
Course Pack C

TABLE 17.4 Common Stress and Special Tests Performed at the Shoulder	
JOINT	**TEST**
SC joint	SC instability test (SC joint play)
Acromioclavicular joint	AC instability test (AC joint play) AC distraction test (AC traction test) AC compression test (AC shear test)
GH instability, anterior	Apprehension test ("crank test") Relocation test Anterior load and shift test
GH instability, posterior	Posterior load and shift test Posterior apprehension test
GH instability, inferior	Sulcus sign
Labral lesions	Clunk test Compression rotation test
Impingement tests	Neer shoulder impingement test Anterior impingement test (Hawkins-Kennedy test)
Muscle tendon pathology	Serratus anterior weakness test Pectoralis major contracture test Lift-off test for subscapularis Drop arm test Empty can (Centinela) supraspinatus test Transverse humeral ligament test Yergason test Speed's test Ludington test
Thoracic outlet syndrome	Adson test Allen test Costoclavicular syndrome (military brace) test

Test for Sternoclavicular Instability

SC instability can be determined by assessing the amount of joint play at SC. To assess **SC joint play**, the patient should be supine. The clinician gently grasps the midpoint of the clavicle and attempts to move the clavicle downward, upward, anteriorly, and posteriorly to determine any instability or increased pain.[16] Pain that is present in all movements may stem from an SC sprain, damage to the SC joint disk, or complete disruption of the joint capsule, which would indicate a possible dislocation or subluxation of the joint.

Tests for Acromioclavicular Joint Instability

Paxinos Sign

The patient sits with the affected arm by the side of the chest wall. The clinician's hand is placed over the affected shoulder so that the thumb rests under the posterolateral aspect of the acromion and the index and other fingers of the same or contralateral hand are placed superior to the midpart of the ipsilateral clavicle. The clinician then applies pressure to the acromion with the thumb in an anterosuperior direction and inferiorly to the midpart of the clavicular shaft with the index and long fingers. The test is positive if pain is felt or increased in the region of the AC joint. The Paxinos sign has high sensitivity (79).[17]

Acromioclavicular Instability Test

AC instability can be determined by assessing the amount joint play present at the AC. To assess **AC joint play**, the patient should be supine. The clinician gently grasps the midpoint of the clavicle and attempts to move the clavicle downward, upward, anteriorly, and posteriorly to determine any instability or increased pain. An inferior glide will stress the AC ligament while a superior glide stresses the conoid, trapezoid, and AC ligaments. The coracoclavicular ligament and AC ligament are stressed by an anterior glide and a posterior glide stresses the posterior aspect of the AC ligament. The clinician grasps the distal clavicle and applies pressure in all four directions to determine stability and any increase in pain.[16]

Acromioclavicular Distraction

This test is also referred to as the AC traction test and, as the name implies, involves applying a downward (or traction) force to the AC joint. Assessment involves grasping the arm of the involved shoulder in one hand and applying steady downward traction while palpating the joint with the other hand (**Fig. 17.14A**). A positive test produces pain and/or joint movement. If the AC joint is unstable, downward traction on the upper extremity leads to downward movement of the acromion process away from the clavicle.

Figure 17.14. Acromioclavicular testing. A, AC traction. **B,** AC compression.

Acromioclavicular Compression Test

The AC compression test is also known as the AC shear test[18] and has reported sensitivity ranging from 41 to 100 and specificity ranging from 92 to 97.[19,20] To perform the test, the patient should be seated and in a relaxed position. The clinician places the heel of one hand over the clavicle and the heel of the opposite hand over the spine of the scapula and applies a gentle compression (**Fig. 17.14B**). Pain or abnormal motion at the AC joint is positive and implies AC joint instability.[18]

Tests for Glenohumeral Joint Instability

Apprehension Test ("Crank Test") for Anterior Instability

This test involves positioning the patient in a supine position and then slowly abducting and externally rotating the patient's humerus (**Fig. 17.15A**). If the patient does not allow passive movement to the extremes of motion or shows apprehension in his or her facial expression, the test is considered to be positive for chronic anterior subluxation or dislocation of the GH joint. This motion should always be done slowly to prevent recurrence of a dislocation. The apprehension test has moderate sensitivity (58) and strong specificity (78).[16]

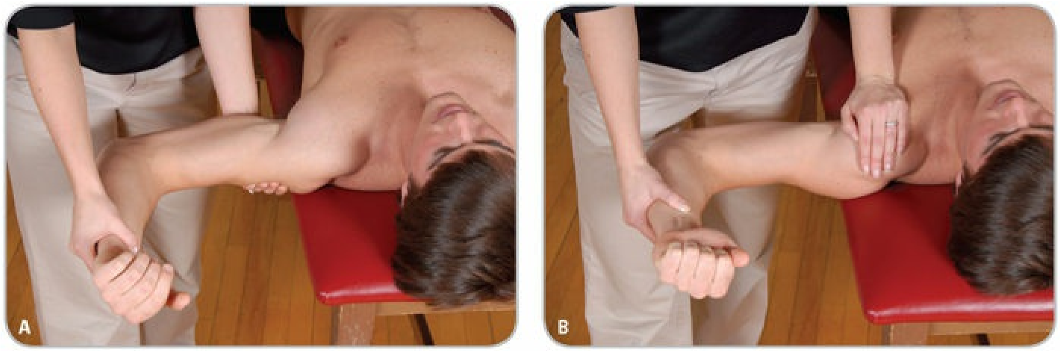

Figure 17.15. **Glenohumeral anterior instability. A, Apprehension or "crank" test.** The clinician should apply gentle pressure in an abducted and laterally rotated position. **B, Relocation test.** The clinician applies abduction and lateral rotation combined with posterior translation of the humerus.

Relocation Test for Anterior Instability

Position for this test is identical to the apprehension test. If the patient demonstrates a positive apprehension test, the clinician slowly applies a posterior stress to the arm (**Fig. 17.15B**). The patient's apprehension and pain should diminish. In addition, further lateral rotation of the GH joint may be possible before the apprehension returns. This test is considered to be positive if pain decreases during the maneuver, even if the patient showed no apprehension. If the arm is released in the newly acquired range, any pain and forward translation of the humeral head indicates a positive sign. The resulting pain from this release procedure may be caused by anterior shoulder instability, labral lesion (i.e., Bankart or superior labrum anteroposterior [SLAP] lesion), or bicipital tendinitis.[16,18] The release should be performed slowly, because it may dislocate the joint, leading to distrust on the part of the patient. Lateral rotation should be released before the posterior stress is released.

Anterior Load and Shift Test

The load and shift test has a strong sensitivity (90) and specificity (85).[21] While the patient is seated and the test arm is resting on the thigh, the clinician stands or sits slightly behind the patient and stabilizes the shoulder with one hand over the clavicle and scapula. The head of the humerus is grasped with the clinician's other hand, placing the thumb over the posterior humeral head and the fingers over the anterior humeral head (**Fig. 17.16**). The clinician then gently pushes the humerus into the glenoid to “seat” it properly in the glenoid fossa. This is the “load” portion of the test, and it is necessary for true translation to occur. If the load is not applied, movement is greater, and the “feel” is altered. While pushing the humeral head anteriorly (i.e., assessing anterior instability) or posteriorly (i.e., assessing posterior instability), the amount of translation should be noted. This is the “shift” portion of the test. Normally, the head translates 0% to 25% of the diameter of the humeral head. The test is considered to be positive if translation is between 25% and 50% and the head feels as if it is riding over the glenoid rim but spontaneously reduces.[18]

Figure 17.16. Load and shift test. The humerus is compressed into the glenoid to load the humeral head. Subsequently, the clinician pushes the humeral head anteriorly or posteriorly, noting the amount of shift or translation.

Posterior Load and Shift Test

In a posterior load and shift test, posterior translation of 50% of the humeral head is considered to be normal. Differences between the normal and injured sides should be bilaterally compared for the amount of translation and the ease with which that translation occurs. This comparison, along with the patient’s symptoms, is considered to be more important than the amount of movement that occurs. If multidirectional instability is present, both anterior and posterior translation may be excessive on the affected side as compared to the normal side. The test also may be done in a supine position.[18]

Posterior Apprehension Test

While the patient is supine, the arm is moved into forward flexion and internal rotation as a steady downward force is applied on the elbow to drive the humeral head posteriorly on the glenoid fossa (Fig. 17.17). While applying the axial load, the clinician horizontally adducts and medially rotates the arm. A positive test is indicated by apprehension, resistance to further motion, or reproduction of symptoms. Reproducing pain is more likely to occur than apprehension. A positive sign indicates a possible posterior dislocation.

Figure 17.17. Posterior apprehension test. The clinician applies a steady downward force on the elbow to displace the humeral head posteriorly on the glenoid fossa.

Sulcus Sign

The clinician applies traction to the humerus to determine the integrity of the supportive structures. If the space widens between the acromion process and humeral head, producing an indentation or "sulcus," the test is considered to be positive for inferior instability. In the sulcus test, only the humerus is distracted away from both the clavicle and scapula. In comparison, the AC distraction test involves distraction of both the humerus and scapula away from the clavicle. The sulcus sign has very low sensitivity (17) but strong specificity (93).[22]

Special Tests

A variety of special tests can be used for detecting shoulder injury or related pathology (e.g., labral lesions, impingement, muscle-tendon trauma, or thoracic outlet syndrome) (Table 17.4). In general, special tests occur across planes and are not graded.

Tests for Labral Lesions

Clunk Test

The clunk test is also referred to as the jerk test. Although the test has strong specificity (94), it is only moderately sensitive (52).[16] While the patient is supine, the clinician places one hand on the posterior aspect of the shoulder under the humeral head. Next, the humerus is grasped above the elbow, and the arm is fully abducted over the patient's head. The hand over the humeral head applies a slow push in an anterior direction while the other hand moves the humerus into lateral rotation (Fig. 17.18A). A positive test results in a clunk or grinding sound, indicating a tear of the labrum. This test also may cause apprehension if anterior instability is present.

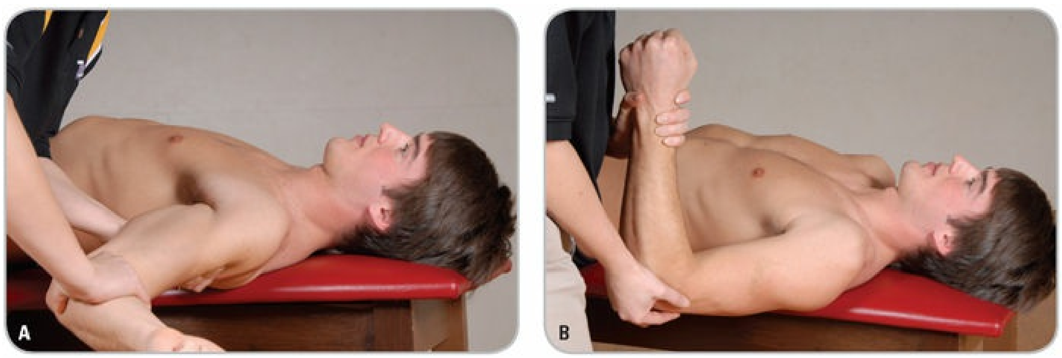

Figure 17.18. **Glenoid labral pathology. A, Clunk test.** Using the hand placed under the humeral head, the clinician applies an anterior force while the other hand rotates the humerus into lateral rotation. **B, Compression rotation test.** With the arm slightly abducted and the elbow flexed, the clinician applies a compression force along the long axis of the humerus while the other hand rotates the humerus medially and laterally.

Compression Rotation Test (Grind Test)

The patient is supine, with the arm positioned at approximately 20° of abduction and the elbow flexed. The humerus is slowly compressed into the glenoid fossa by pushing on the elbow with one hand while the other hand rotates the humerus medially and laterally (Fig. 17.18B). If a snapping or catching sensation is present as the humeral head is felt, the test is considered to be positive for a labral tear (i.e., Bankart or SLAP lesion). The grind test has poor to moderate sensitivity (38) and moderate to strong specificity (78).[16]

Tests for Shoulder Impingement

Neer Shoulder Impingement Test

The patient is seated and the arm is placed in anatomical position. First, the clinician stabilizes the posterior shoulder. Next, the clinician grasps the patient's arm at the elbow joint and passively moves the arm through forward flexion (**Fig. 17.19A**). An easy way to remember the name and action of the test is to passively move the patient's arm *NEAR* the *EAR*. The test is considered to be positive if pain occurs with motion, particularly near the end of the ROM. A positive test indicates impingement of the supraspinatus or the long head of the biceps tendon between the greater tuberosity of the humerus and acromion process or coracoacromial arch. The Neer impingement test has almost equal sensitivity (68) and specificity (68.7) with a positive likelihood ratio of 80.4%.[23]

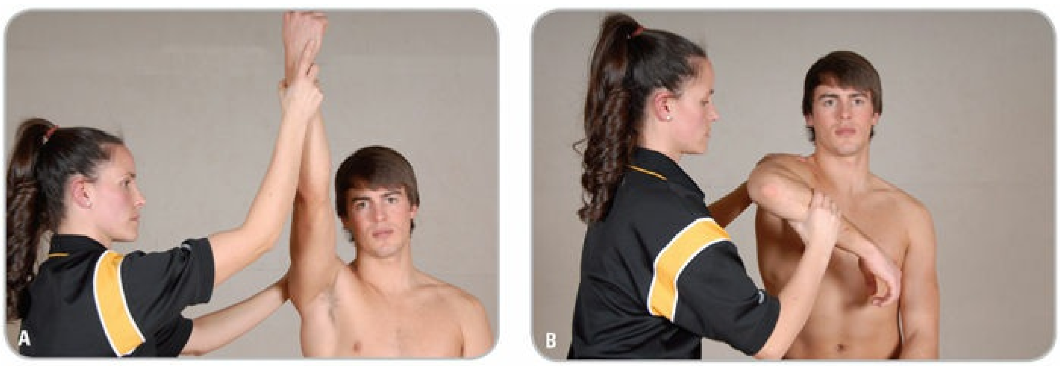

Figure 17.19. **Anterior impingement tests. A, Neer shoulder impingement test.** The arm is internally rotated and forcibly flexed forward to jam the greater tuberosity against the anteroinferior surface of the acromion. **B, Anterior impingement test.** An alternate method is to forcibly, medially rotate the proximal humerus when the arm is forward flexed to 90°. (This also is known as the Hawkins-Kennedy impingement test.)

Anterior Impingement Test (Hawkins-Kennedy Test)

This test involves internally rotating and abducting the humerus through shoulder flexion while depressing the scapula. This action forces the greater tubercle underneath the anteroinferior border of the acromion process. The arm is returned to 90° of abduction (with the elbow flexed at 90°) and then is horizontally adducted across the chest while maintaining internal rotation of the humerus (**Fig. 17.19B**). Pain or apprehension may indicate an overuse injury to the supraspinatus or biceps brachii tendon. This test also is called the

Hawkins-Kennedy impingement test. This test has higher sensitivity (71.5) than specificity (66.3) with relative strong positive predictive value (79.7%).[23]

Painful Arc Sign

The patient is asked to actively abduct the arm through a full ROM if possible and is then asked to indicate if and when pain was experienced while performing the motion. The test is positive if pain was experienced between 60° and 120° of motion (**Fig. 17.20**). This test has a strong positive prediction value (88.2), with strong sensitivity (73.5) and specificity (81.1), indicating that it is a clinically useful test for detecting shoulder impingement.[23]

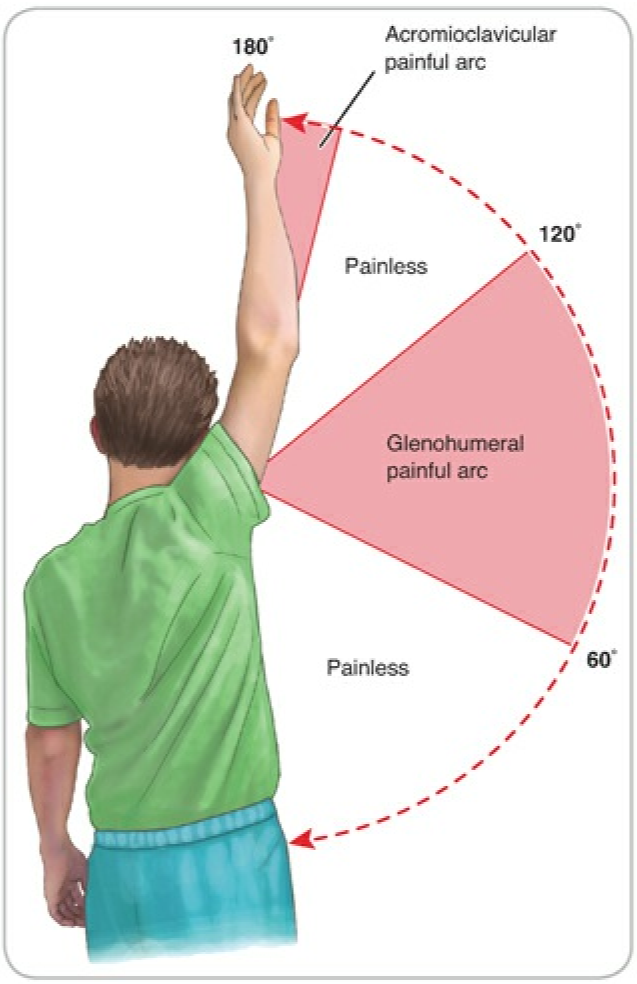

Figure 17.20. Painful arc sign. As the patient actively abducts the shoulder through full ROM, pain occurring between 60° and 120° is positive for impingement syndrome.

Tests for Muscle Tendon Pathology

▪ Serratus Anterior Weakness

Weakness of the serratus anterior, often called winging of the scapula, is determined by having the patient perform a push-up against the wall. If the muscle is weak or the long thoracic nerve is injured, the medial border of the scapula pulls away from the chest wall.

▪ Pectoralis Major Contracture Test

The patient lies supine, with the hands clasped together behind the head. The patient is instructed to lower the arms until the elbows touch the examination table (**Fig. 17.21**). A positive test occurs if the elbows do not reach the table, indicating a tight pectoralis major muscle.

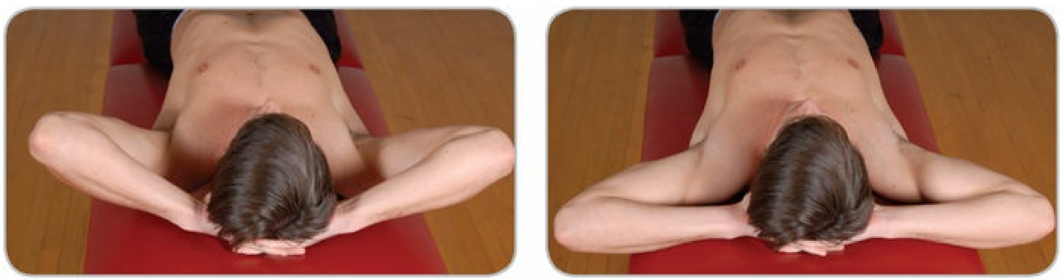

Figure 17.21. Pectoralis major contracture test. The patient begins by clasping both hands behind the head. The elbows are then slowly lowered to the table. A positive test, indicating a tight pectoralis major muscle, occurs if the elbows do not reach the table.

▪ Lift-Off Test for Subscapularis

The patient stands with the dorsum of the hand on the lumbar region of the back. The patient is instructed to lift the hand away from the back (**Fig. 17.22**). An inability to perform this action indicates a lesion of the subscapularis muscle. Abnormal motion of the scapula during the test indicates scapular instability. If the medial border of the scapula wings during the test, the rhomboids also may be affected.

Figure 17.22. Lift-off test. Failure to lift the hand away from the small of the back indicates a weakened subscapularis muscle, scapular instability, or weak rhomboids.

Drop Arm Test

This test assesses the integrity of the supraspinatus muscle and tendon. The patient is positioned with the shoulder abducted to 90° with no humeral rotation. The patient is instructed to slowly lower the arm to the side. The test is positive if the arm does not lower smoothly or increased pain is felt during the motion.

An alternate test is to abduct the arm to 90° with no rotation. The patient is instructed to hold that position while the clinician applies downward resistance to the distal end of the humerus (Fig. 17.23A). A positive test is indicated if the patient is unable to maintain the arm in the abducted position. The drop arm test has poor sensitivity (26.9) and strong specificity (88.4).[23]

Figure 17.23. **Supraspinatus testing. A, Drop arm test.** The clinician instructs the patient to abduct the humerus to 90° and subsequently applies mild, downward pressure on the distal humerus. **B, Empty can test.** The patient horizontally adducts the arm approximately 30° to 60° with the humerus internally rotated. The clinician applies mild, downward pressure on the distal humerus. **C, Full can test.** The patient horizontally adducts the arm approximately 30° to 60° with the humerus in anatomical or neutral position. The clinician applies mild, downward pressure on the distal humerus.

Empty Can (Centinela) Test and Full Can Test for Supraspinatus Pathology

Both arms are positioned at 90° of abduction. The arms are then horizontally adducted approximately 30° to 60°, and the humerus is internally rotated, with the thumbs pointing downward ("empty can position") (**Fig. 17.23B**). The clinician applies a downward pressure proximal to the elbow. Pain and/or weakness should be assessed. The arms should rebound to the 90° abducted position. A positive test indicates a tear to the supraspinatus muscle or tendon. However, because the testing the supraspinatus in the "empty can" position also engages the middle deltoid and subscapularis, the specificity of the test is called into question.[24]

The **full can test**, which is identical to the empty can test except the humerus is externally rotated, as if holding a full can, is recommended (**Fig. 17.23C**).The subscapularis and middle deltoid are less active in this position[24] and is thought to be less pain provoking.[16]

Transverse Humeral Ligament Test

The patient is positioned with the shoulder in 90° of abduction and external rotation and the elbow flexed at 90°. The clinician places the fingers over the bicipital groove. A torn transverse humeral ligament is indicated by an audible and/or palpable snap, which may be accompanied by pain, as the arm is moved into internal rotation (**Fig. 17.24**).

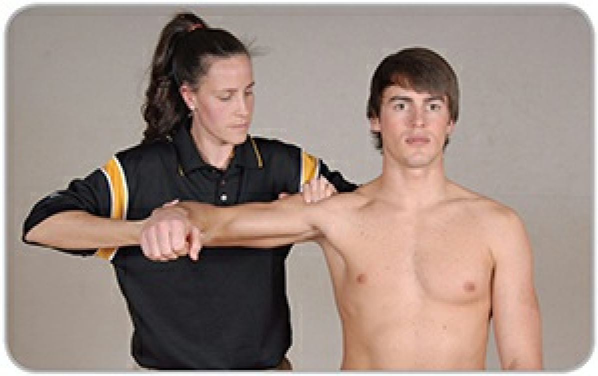

Figure 17.24. Transverse humeral ligament test. The patient is instructed to place the extended arm in 90° of abduction and external rotation. The clinician places one's fingers over the bicipital groove and moves the arm into internal rotation. In a positive test, an audible or palpable snap, which may be accompanied by pain, occurs during internal rotation.

Yergason Test for Bicipital Tendinitis

The patient should be positioned with the arm stabilized against the body, the elbow flexed at 90°, and the forearm pronated. The clinician instructs the patient to supinate the forearm, flex the elbow, and externally rotate the humerus. Simultaneously, the clinician resists the motion with one hand while applying downward traction on the elbow with the other hand (**Fig. 17.25A**). The test is considered to be positive for biceps tendinopathy without the presence of popping.[16,22] If pain and popping or just popping/snapping present over the bicipital groove, the test is positive for tear of the transverse humeral ligament.[16]

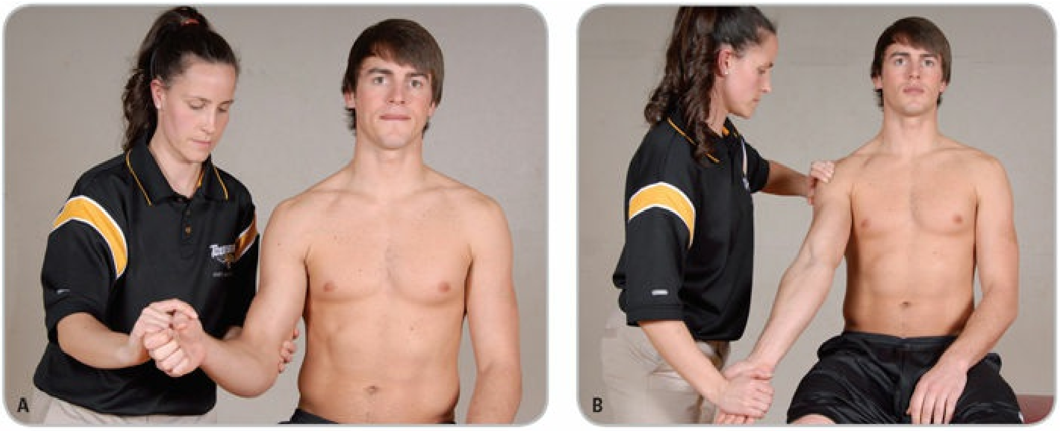

Figure 17.25. **Bicipital tendinitis. A, Yergason test.** The clinician stabilizes the flexed arm against the body, with the forearm pronated. The patient is asked to supinate the forearm, flex the elbow, and externally rotate the humerus. The clinician applies resistance throughout the ROM and, with the other hand, simultaneously applies downward traction on the elbow. **B, Speed's test.** The patient is instructed to supinate the hand, with the elbow fully extended. The clinician places one hand over the bicipital groove and resists forward flexion of the arm.

Speed's Test for Bicipital Tendinitis

In this test, the tendon moves over the bone during movement rather than simply having tension applied to it. As such, it provides a more effective, accurate result than Yergason test.[18] The arm is supinated, with the elbow fully extended. The clinician places one hand over the bicipital groove and resists forward flexion of the arm with the other hand. A positive test results in tenderness over the groove (**Fig. 17.25B**). However, due to this test's low specificity (14) and high sensitivity (90), false positives may be found.[22]

Ludington Test for Biceps Brachii Pathology

The patient may sit or stand during this test. The patient's hands are placed on top of the head with the fingers interlocked. The clinician should stand behind the patient while palpating the long head of the biceps brachii tendon in the bicipital groove. The patient alternately contracts and relaxes the biceps brachii muscles (**Fig. 17.26**). If no contraction or tension is palpated on one side, a rupture of the long head of the biceps brachii likely is present.

Figure 17.26. Ludington test for biceps brachii pathology. The clinician stands behind the patient and palpates the long head of the biceps brachii while the patient contracts the biceps by applying force to the top of the head. The test is positive for rupture of the long head of the biceps brachii tendon if decreased or no tension is felt under the involved tendon.

Tests for Thoracic Outlet Syndrome

Adson Test

This test begins by having the clinician palpate the radial pulse. Next, the patient is instructed to turn the head toward the affected shoulder and extend the head. The clinician then slowly extends and laterally rotates the humerus (Fig. 17.27A). The patient is instructed to take a deep breath and hold it. A diminished or absent pulse indicates a positive test, verifying occlusion of the subclavian artery between the anterior and middle scalene muscles. This test sometimes is referred to as the anterior scalene syndrome test. Differing values for the diagnostic accuracy have been reported for the Adson test. One source reported Adson as having strong sensitivity (79) but poor specificity (7%),[16] whereas a second source reported strong specificity (89 to 100) for the Adson test without posting sensitivity values.[22] It appears that the results of the Adson test should be considered within the context of findings gathered throughout the examination process.

Figure 17.27. Thoracic outlet compression syndrome. A, Adson maneuver. The clinician extends and externally rotates the humerus while the patient extends the head. **B, Allen test.** The clinician abducts the shoulder and flexes the elbow while the patient looks toward the opposite shoulder. An alternate position is to extend the elbow and apply downward traction while the patient hyperextends the neck and rotates the head to the opposite side (Halstead maneuver).

Allen Test

Similar to Adson test, the clinician palpates the radial pulse while the patient abducts the shoulder, flexes the elbow to 90°, and looks toward the opposite shoulder (Fig. 17.27B). Next, the clinician instructs the patient to take a deep breath and hold it. A diminished or absent pulse indicates a positive test, suggesting that the pectoralis minor muscle is compressing the neurovascular bundle. It is important to note, however, that this test often produces false positive results.

An alternate position, called the Halstead maneuver, is performed with the arm extended and the neck hyperextended and rotated to the opposite side. While palpating the radial pulse, the clinician applies a downward traction to the arm. An absent or diminished pulse indicates a positive test for thoracic outlet syndrome.

Costoclavicular Syndrome (Military Brace) Test

The patient stands in a relaxed position. The clinician stands behind the patient and palpates the radial pulse. Next, the patient retracts the shoulders as if coming to military attention. The clinician then extends and abducts the arm to 30° while the patient hyperextends the neck (Fig. 17.28). If the radial pulse diminishes or disappears, it indicates that the subclavian artery is being blocked by the costoclavicular structures of the shoulder.

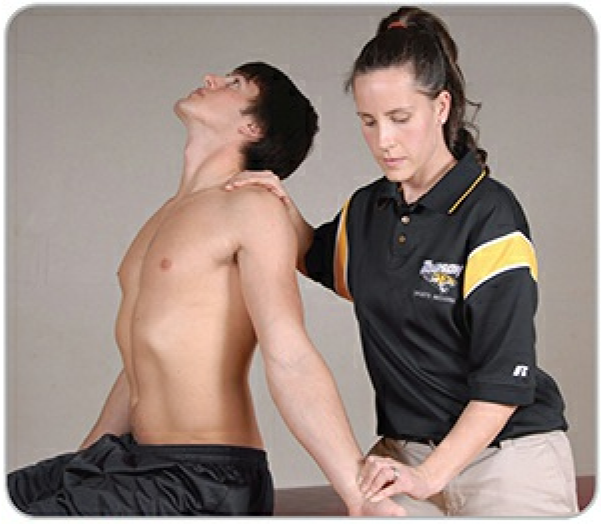

Figure 17.28. Costoclavicular syndrome test. The patient retracts the shoulders as if coming to military attention. The arm is extended and abducted approximately 30° while the head and neck are hyperextended. If the radial pulse disappears, it indicates that the subclavian artery is blocked by the costoclavicular structures in the shoulder.

Neurological Tests

Neurological integrity can be assessed with the use of myotomes, reflexes, and cutaneous patterns that include both the segmental dermatomes and peripheral nerve patterns.

Myotomes

Isometric muscle testing should be performed in the following motions to test specific myotomes in the upper extremity:

- Scapular elevation (C4) (**Fig. 17.12A**)
- Shoulder abduction (C5) (**Fig. 17.13C**)
- Elbow flexion and/or wrist extension (C6) (**Fig. 17.13G**)
- Elbow extension and/or wrist flexion (C7) (**Fig. 17.13H**)
- Thumb extension and/or ulnar deviation (C8)
- Abduction and/or adduction of the hand intrinsics (T1)

Reflexes

Reflexes in the upper extremity include the biceps (C5), brachioradialis (C6), and triceps (C7). The biceps reflex is tested with the patient's arm flexed and supported by the clinician's forearm. The clinician's thumb is placed over the biceps tendon, and the thumb is struck with the reflex hammer using a quick, downward thrust (**Fig. 17.29A**). A normal response is slight elbow flexion. The brachioradialis reflex is tested with the patient's arm flexed, forearm in a neutral position and resting on a support (**Fig. 17.29B**). Strike the tendon of the brachioradialis slightly proximal to the insertion at the base of the styloid process of the radius. A normal response is slight supination. To test the triceps reflex, passively extend the GH joint to 90° and support the limb at the distal humerus, just above the joint. The triceps reflex is tested with the patient's arm abducted and extended with the elbow flexed. The triceps tendon is placed on a slight stretch, and the triceps tendon is then tapped with the reflex hammer (**Fig. 17.29C**). A normal response is slight elbow extension.

Figure 17.29. **Reflex testing. A,** Biceps reflex (C5). **B,** Brachioradialis reflect (C6). **C,** Triceps reflex (C7).

Cutaneous Patterns

The segmental nerve dermatome patterns for the shoulder region are illustrated in **Figure 17.30**. The peripheral nerve cutaneous patterns are illustrated in **Figure 17.31**. Bilateral testing should be performed for altered sensation with sharp and dull touch by running the open hand and fingernails over the neck, shoulder, anterior and posterior chest walls, and both sides of the arms.

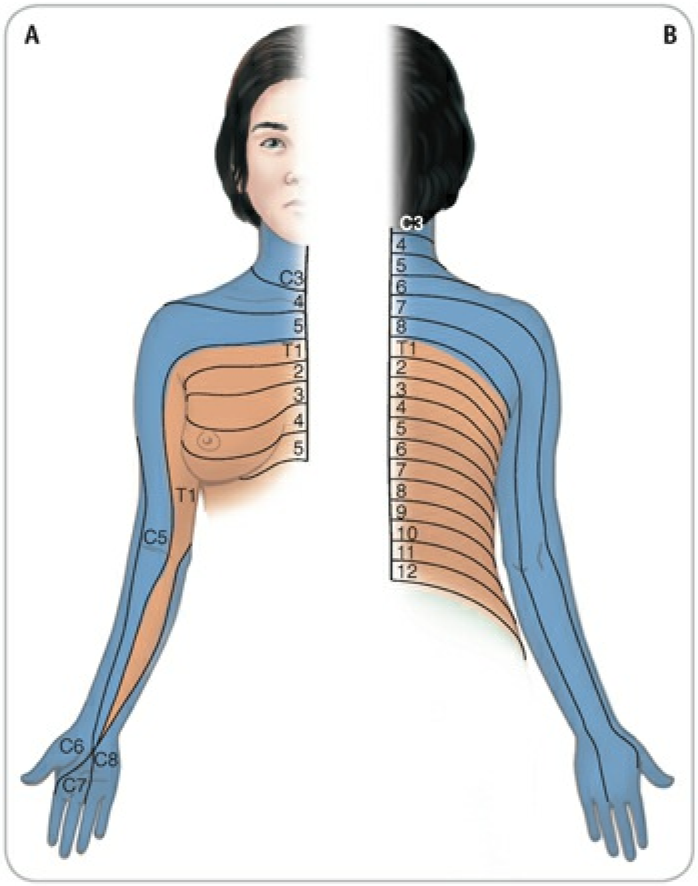

Figure 17.30. Dermatome patterns for the shoulder region.
A, Anterior view. **B,** Posterior view.

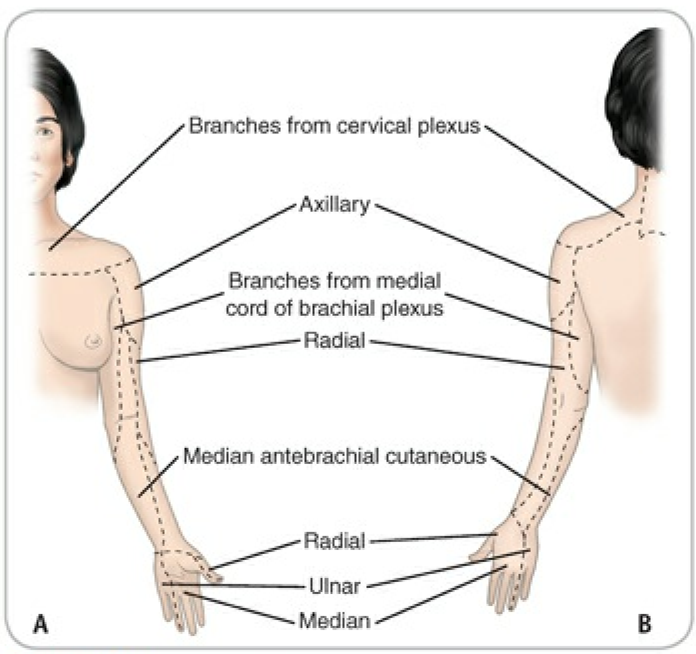

Figure 17.31. Cutaneous patterns for the peripheral nerves.
A, Anterior view. **B,** Posterior view.

Activity-Specific Functional Tests

Occasionally, activity-specific functional movements are the only activities that reproduce signs and symptoms. Throwing a ball, performing a swimming stroke, doing the arm part of jumping jacks, or performing an overhead serve or spike may replicate the painful pattern. The clinician should look for smooth, coupled motion of the scapulothoracic and GH joints. Disharmony constitutes scapulothoracic dyskinesia, which is an inability to perform fluid, voluntary movements. Based on knowledge of the mechanics of the motion, it may be possible to narrow down the few definitive results of the assessment to determine the actual injury. These movements also commonly are used to determine when the patient can return to participation in activity. All functional patterns should be fluid and pain-free.

The assessment of the swimmer suggests that the humerus, glenoid fossa, glenoid labrum, rotator cuff muscles, and anterior GH ligament could be involved with this injury. The swimmer should be suspected of having recurrent GH dislocations or subluxations.

SPRAINS TO THE SHOULDER COMPLEX

A soccer player fell on an outstretched arm. A physician diagnosed a type II AC sprain. What are the signs and symptoms of a type II AC sprain?

Ligamentous injuries to the SC, AC, and GH joints can result from compression, tension, and shearing forces occurring in a single episode or from repetitive overload. A common method of injury is a fall or direct hit on the lateral aspect of the acromion as well as a fall on an outstretched hand (FOSH). The force is transmitted first to the site of impact, then to the AC joint and the clavicle, and finally, to the SC joint. Failure can occur at any one of these sites. Acute sprains are common in hockey, rugby, football, soccer, equestrian sports, and the martial arts.

Sternoclavicular Joint Sprain

Etiology

The SC joint is the main axis of rotation for movements of the clavicle and scapula. The majority of injuries result from compression related to a direct blow, as when another participant lands on a supine patient or, more commonly, by indirect forces transmitted from a blow to the shoulder or a fall on an outstretched arm. The disruption typically drives the proximal clavicle superior, medial, and anterior, disrupting the costoclavicular and SC ligaments and leading to anterior displacement.

Signs and Symptoms

Grade I (first-degree) injuries are characterized by point tenderness and mild pain over the SC joint, with no visible deformity. The SC joint play test will elicit pain and or motion. Grade II (second-degree) injuries involve a joint subluxation that leads to bruising, swelling, and pain. The patient is unable to horizontally adduct the arm without considerable pain and may hold the arm forward and close to the body, supporting it across the chest, which indicates disruption of the stabilizing ligaments. In addition, scapular protraction and retraction can reproduce pain associated with ligamentous or disk damage. Grade III (third-degree) sprains involve a prominent displacement of the sternal end of the clavicle and may involve a fracture. The patient has a complete rupture of the SC and costoclavicular ligaments. Pain is severe when the shoulders are brought together by a lateral force.

Although rare, posterior, or retrosternal displacement is more serious because of the potential injury to the esophagus, trachea, internal thoracic artery and vein, and brachiocephalic and subclavian artery and vein. The most common mechanism of injury is a blow to the posterolateral aspect of the shoulder with the arm adducted and flexed, such as a fall on the shoulder that displaces the distal clavicle anteriorly.[25] This action may occur during a piling-on injury in football; less commonly, the injury may be caused by a direct blow to the anteromedial end of the clavicle. The patient has a palpable depression between the sternal end of the clavicle and manubrium, is unable to perform shoulder protraction, and may have difficulty swallowing and breathing. The patient also may complain of numbness and weakness of the upper extremity secondary to the compression of structures in the thoracic inlet. If the venous vascular vessels are impinged, the patient may have venous congestion or engorgement in the ipsilateral arm and a diminished radial pulse.[25]

Management

Grade I sprains of the SC joint are treated with rest, ice, and anti-inflammatory drugs. The arm may be immobilized with a sling for 1 to 2 weeks, followed by early ROM exercises. Grade II sprains may require longer immobilization (3 to 6 weeks) in a sling or a soft figure eight brace, followed by ROM exercises. Grade III sprains require immediate reduction of the dislocation by a physician. Immobilization usually is maintained by a Velpeau bandage, soft figure eight brace, clavicle strap harness, or bulky pressure pad over the medial clavicle for 4 to 6 weeks. Scar tissue may form, but typically, no function is lost. There remains, however, a high incidence of recurrent SC sprains. When immobilization is discontinued, the arm motion should still be protected for an additional 2 weeks. Elbow exercises and shoulder ROM can be started at 3 weeks.[26] Surgical intervention may be necessary in the treatment of recurrent anterior SC joint or trauma that results in significant cosmetic issues. **Table 17.5** summarizes the signs and symptoms as well as the management of anterior SC sprains.

Posterior displacement can become life-threatening, and the emergency plan, including summoning emergency medical services, should be activated.

TABLE 17.5 Management of a Sternoclavicular Sprain

SIGNS AND SYMPTOMS	FIRST DEGREE	SECOND DEGREE	THIRD DEGREE
Deformity	None	Slight prominence of medial end of the clavicle	Gross prominence of medial end of the clavicle
Swelling	Slight	Moderate	Severe
Palpable pain	Mild	Moderate	Severe
Movement	Usually unlimited but may have discomfort with movement	Unable to abduct the arm or horizontally adduct the arm across the chest without noticeable pain	Limited as in second degree but pain is more severe
Treatment	Ice, rest, and immobilization with sling/swathe	Ice, rest, immobilization with figure eight or clavicular strap with a sling for 3–4 weeks. Initiate strengthening program after 3–4 weeks.	Apply a figure eight immobilizer with scapulas retracted. Immediately refer to a physician. Check radial pulse, respiration, and ability to swallow. If significant findings are present, activate the emergency action plan.

Acromioclavicular Joint Sprain

Etiology

The AC joint is weak and easily injured by a direct blow, fall on the point of the shoulder (called a shoulder pointer), or force transmitted up the long axis of the humerus during a fall with the humerus in an adducted position. In these cases, the acromion is driven away from the clavicle, or vice versa. Although often referred to as a "separated shoulder," ruptures of the AC and/or coracoclavicular ligaments can result in an AC dislocation; therefore, they are more correctly referred to as "sprains."

Classification of Injury

Like other joint injuries, AC sprains may be classified as first degree (i.e., mild), second degree (i.e., moderate), or third degree (i.e., severe). Because of the complexity of the joint, however, AC sprains often are classified as types I to VI based on the extent of ligamentous damage, degree of instability, and direction in which the clavicle displaces relative to the acromion and coracoid process (**Table 17.6**).

TABLE 17.6 Classification of Acromioclavicular Joint Sprains

GRADE	DEGREE	INJURED STRUCTURES
Type I	First	Stretch or partial damage of the AC ligament and capsule
Type II	Second	Rupture of AC ligament and partial strain of coracoclavicular ligament
Type III	Second	Rupture of AC ligament and coracoclavicular ligament
Type IV–VI	Third	Rupture of AC ligament and coracoclavicular ligament and tearing of deltoid and trapezius fascia

Signs and Symptoms

All special tests used to assess AC joint injury will be positive; however, the amount of pain and/or motion elicited will help to determine degree of damage. Type I injuries have no disruption of the AC or coracoclavicular ligaments. Minimal swelling and pain are present over the joint line and increase with abduction past 90°. The injury is inherently stable, and pain is self-limiting.

Type II injuries result from a more severe blow to the shoulder. The AC ligaments are torn, but the coracoclavicular ligament, only minimally sprained, is intact. Vertical stability is maintained, but sagittal plane stability is compromised. The clavicle rides above the level of the acromion, and a minor step or gap is present at the joint line. Pain increases when the distal clavicle is depressed or moved in an anterior-posterior direction and during passive horizontal adduction.

Type III injuries have complete disruption of the AC and coracoclavicular ligaments, resulting in visible prominence of the distal clavicle. The patient will have obvious swelling and bruising and, more significantly, depression or drooping of the shoulder girdle.

Higher grade injuries (types IV to VI) (**Fig. 17.32**) are caused by more violent forces. Extensive mobility and pain in the area may signify tearing of the deltoid and trapezius muscle attachments at the distal clavicle. These rare injuries must be carefully evaluated for associated neurological injuries.

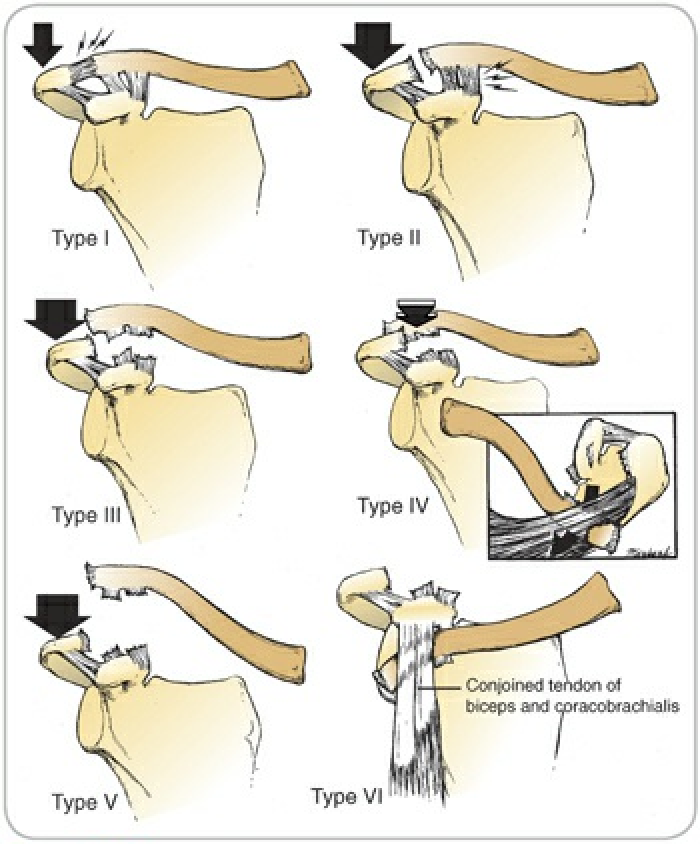

Figure 17.32. Rockwood classification for acromioclavicular joint injury. (From Tornetta P, Court-Brown C, Heckman J, et al. *Rockwood and Green's Fractures in Adults*. 8th ed. Philadelphia, PA: Wolters Kluwer; 2014.)

Management

Type I and II injuries are treated with rest, ice, and nonsteroidal anti-inflammatory drugs (NSAIDs), followed by ROM exercises as tolerated. Immobilization in a sling for 1 to 3 weeks is necessary only if pain is present. The patient may return to activity when pain and strength permit normal use of the extremity, but the area should be padded to protect it from further insult. The majority of type I and II injuries heal without complications. Occasionally, however, persistent limiting pain may necessitate a cortisone injection to diminish inflammation. Rehabilitation involves regaining ROM and, once ROM is bilaterally equal, beginning a progressive resistance exercise program.

The management of type III injuries is controversial, because they are managed both operatively and nonoperatively. Most type III injuries are treated conservatively, with 90% to 100% having satisfactory results. Nonsurgical treatment involves immobilization in a sling for 2 to 4 weeks, followed by pendulum exercises, elbow ROM exercises, isometrics in all planes, and rope-and-pulley exercises for shoulder flexion and abduction as tolerated. If treatment includes surgery, pendulum and isometric exercises in all planes are encouraged during the initial stages of rehabilitation, although abduction and flexion to 90° are limited for approximately 3 to 4 weeks. Rehabilitation should focus on strengthening the rotator cuff and scapula stabilizers and on restoring neuromuscular control and arthrokinematics. Return to activity may take as long as 10 to 12 weeks, depending on the restoration of full, pain-free ROM and the stability of the joint. Participation in contact sports usually is permitted 3 to 5 months after the injury, depending on functional recovery.

In severe cases (types IV to VI) involving total disruption of the supporting ligaments, intra-articular disk damage, or an intra-articular fracture, open or arthroscopic intervention may be necessary. Immobilization may be necessary for as long as 4 to 6 weeks. The patient is permitted to use the arm for most activities of daily living but is restricted from active forward elevation or abduction. Pushing, pulling, or carrying more than 5 lb also is prohibited. In approximately 6 weeks, a progressive ROM and strengthening regimen begins. Complete sport and physical activity participation usually is not permitted until isokinetic testing shows results equal to those of the contralateral side, which occurs approximately 6 months after surgery. **Table 17.7** summarizes the signs and symptoms as well as the management of AC sprains.

TABLE 17.7 Management of an Acromioclavicular Sprain

SIGNS AND SYMPTOMS	TYPE I	TYPE II	TYPE III
Deformity	None; ligaments are still intact.	Slight elevation of lateral clavicle; AC ligaments are disrupted, but coracoclavicular is still intact.	Prominent elevation of clavicle AC ligaments and coracoclavicular ligaments are disrupted.
Swelling	Slight	Moderate	Severe
Palpable pain	Mild over joint line	Moderate with downward pressure on distal clavicle; palpable gap or minor step present; snapping may be felt on horizontal adduction.	Severe on palpation and depression of acromion process; definite palpable step deformity present.
Movement	Usually unlimited but may have some discomfort on abduction greater than 90°	Unable to abduct the arm or horizontally adduct the arm across the chest without noticeable pain	Limited as in type II but pain is more severe
Stability	No instability	Some instability	Demonstrable instability
Treatment	Ice, NSAIDs, regain full ROM and strength; return to activity as tolerated, with protection	Ice, NSAIDs, immobilize with sling; TENS, interferential EMS for pain relief; ultrasound; strengthening and stability exercises; return to activity with protection	Ice, immobilize, and immediately refer to physician; if treated conservatively, deformity remains, but function should be within normal limits.

EMS, electrical muscle stimulation; *TENS*, transcutaneous electrical nerve stimulation.

Glenohumeral Joint Sprain

Etiology

Damage to the GH joint can occur when the arm is forcefully abducted (e.g., when making an arm tackle in football), but such damage more commonly is caused by excessive shoulder external rotation and extension (i.e., arm in the overhead position). When the arm rotates externally, the anterior capsule and GH ligaments are stretched or torn, causing the humeral head to slip out of the glenoid fossa in an anterior-inferior direction (**Fig. 17.33**). A direct blow or forceful movement that pushes the humerus posteriorly also can result in damage to the joint capsule.

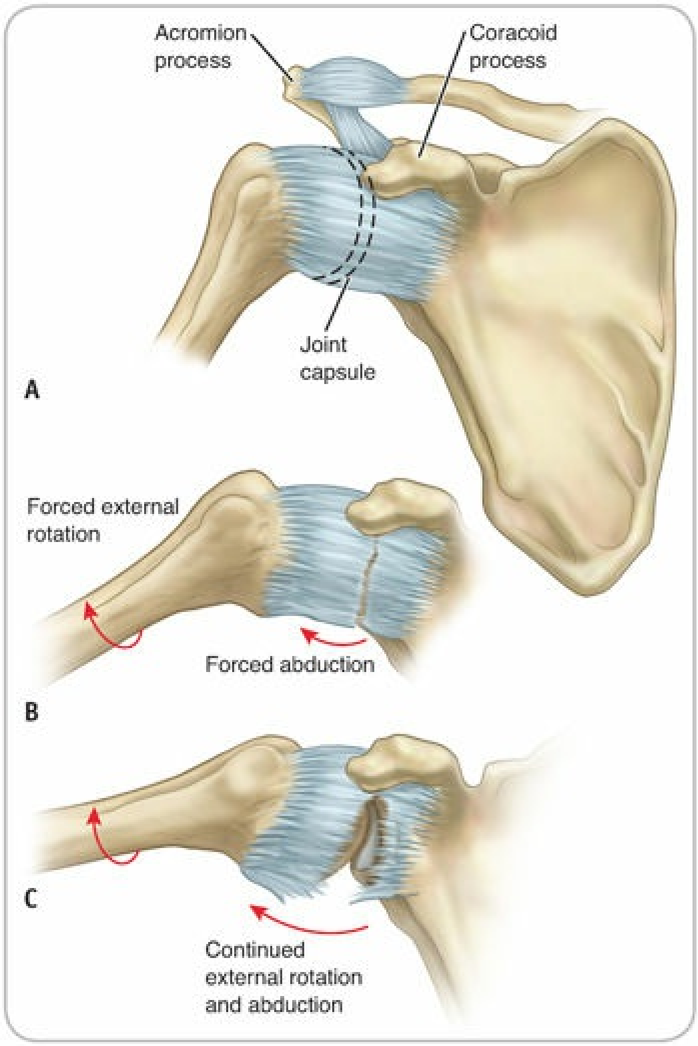

Figure 17.33. Glenohumeral sprains. A, Normal abduction with some stretching of the fibers. **B,** Forced external rotation and abduction with minimal tears to the joint capsule, leading to a moderate or second-degree sprain. **C,** Continuation of the forced movement causes a third-degree sprain or shoulder dislocation.

Signs and Symptoms

In a first-degree injury, the anterior shoulder is particularly painful to palpation and movement, especially when the mechanism of injury is reproduced. Active ROM may be slightly limited, but pain does not occur on adduction or internal rotation, in contrast to a muscular strain. A second-degree sprain produces some joint laxity. In addition, pain, swelling, and bruising usually are significant, and ROM, particularly abduction, is limited.

Management

Treatment includes cryotherapy, rest, and immobilization with a sling during the initial 12 to 24 hours. NSAIDs can be administered after the first 48 hours so as to inhibit the early stages of the healing process. Early emphasis is placed on pain-free ROM exercises, elastic-band strengthening, and PNF exercises. Exercises to regain full external rotation and abduction should be delayed for at least 3 weeks to allow capsular healing. A more extensive resistance program can be started as tolerated.

Glenohumeral Instability

GH instability is based on joint play movements, or the relative displacement of the humeral head in the glenoid fossa, and may be classified as anterior, posterior, inferior, or multidirectional instability. Instability may result from poorly developed musculature; a decrease in the proprioceptive properties of the dynamic stabilizes of the GH joint as well as scapular dyskinesia or prior injury.[27] Instability can range from a vague sense of shoulder dysfunction (atraumatic instability) to noticeable hypermobility with activities of daily living. Although GH instability can occur in any direction, most acute dislocations are anterior, with posterior dislocations being the second most frequent.

Anterior Instability

Etiology

Anterior instability may result from a blow to the posterolateral aspect of the shoulder, but it is more commonly caused by excessive indirect forces that push the arm into abduction, external rotation, and extension.

Signs and Symptoms

Failure of the capsule ligamentous complex, particularly the middle and inferior GH ligaments, allows the head of humerus to slide forward. If excessive, the head of the humerus may dislocate and lodge under the anteroinferior portion of the glenoid fossa adjacent to the coracoid process. As the humerus slides forward, either during a dislocation or due to chronic instability, the inferior GH ligament may be avulsed from the anterior lip of the labrum or in combination with a portion of the labrum. This condition is referred to as a **Bankart lesion**.

A patient with anterior shoulder instability may complain of vague pain within the shoulder, an inability to sleep resting on the shoulder at night, and a sense of abnormal motion within the joint. Tenderness may be elicited when palpating the anterior GH structures. Active ROM may reveal abnormal movement, and the patient may report feeling clicking within the joint if additional structures have been injured.[27] Because deformity is associated with dislocations and not instability, it is appropriate to use clinical test to assess for the presence of instability. In the presence of anterior instability, the shoulder apprehension test, the shoulder relocation test, and the anterior load and shift test may be positive.[27]

Posterior Instability

Etiology

The prevalence of posterior GH instability is becoming more common among young athletes making up about 10% of the instability events.[28] Acutely, the instability will arise when a posterior force is directed along the long axis of the humerus with the humerus flexed and internally rotated. This action often is associated with blocking in football. Although a single traumatic episode may lead to posterior instability, the condition more commonly results from a series of accumulated microtraumatic episodes. Excessive glenoid retroversion and increased internal and external rotation strength are thought to be factors that place a patient at risk for developing posterior instability.[28]

Inferior Instability

Etiology

Inferior instability is rare. The primary restraint against inferior translation is the superior GH ligament. When the arm is abducted 45° in neutral rotation, the anterior portion of the inferior GH ligament is the primary restraint; when the arm is at 90° of abduction, the entire GH ligament, particularly the posterior band, is responsible for restricting inferior displacement. Superior translation is limited by the coracoacromial arch and acromion process.

Multidirectional Instability

Etiology

Multidirectional instability (MDI) of the shoulder occurs when damage takes place in more than one plane. Acutely, most, if not all, anterior and posterior dislocations are associated with some preexisting, inferior laxity or laxity in the opposite direction. If the damage caused by the initial injury is not properly treated with a comprehensive rehabilitation program, the condition may become chronic, leading to further injury and complications.

Signs and Symptoms

Pain and/or instability can occur during simple tasks, such as picking up a box or backpack. The pain may be described as a chronic aching that increases with increased use of the shoulder. It is essential that a shoulder evaluation differentiate between unidirectional and MDI. To assess for the presence of MDI, multiple clinical tests should be used to stress the joint in multiple planes such as anterior and posterior load and shift, posterior drawer, and sulcus sign tests. Failure to identify MDI and, subsequently, provision of treatment only for a unidirectional instability can significantly alter joint mechanics and predispose the patient to continued instability in one or more planes. If the patient presents with or describe clicking within the joint, a labral tear should also be suspected.

Management

Treatment is initially conservative, with 50% to 70% of patients responding favorably to rehabilitation and activity modification. Rehabilitation should focus on restoring muscle function and balance; increasing the proprioceptive properties of the dynamic stabilizes of the GH joint as well as assessing for and treating scapular dyskinesia if present.[27] Surgical repair is indicated for patients who do not respond to conservative measures.

Glenohumeral Dislocation and Subluxation

The GH joint is the most frequently dislocated major joint in the body. A GH dislocation occurs when the humeral head moves out of the glenoid fossa, causing complete disruption to the joint. Ninety percent of shoulder dislocations are anterior; posterior dislocations rank second in occurrence. Inferior dislocations are rare and often are accompanied by neurovascular injury and fracture.[28] A subluxation occurs when the humeral head slides out of the joint, but a portion remains within the joint and can also be described as a partial dislocation. Both dislocations and subluxations can be acute or chronic.

Acute Dislocations

Etiology

The same forces that may cause a sprain of the GH joint capsule may also result in a dislocation. Acute dislocations may have an associated fracture or nerve damage. Therefore, this injury is considered to be serious, and it necessitates immediate transportation to the nearest medical facility for reduction.

Signs and Symptoms

An initial dislocation presents with intense pain. Recurrent dislocations may be less painful. Tingling and numbness may extend down the arm into the hand. In a first-time anterior dislocation, the injured arm often is held in slight abduction (20° to 30°) and external rotation and is stabilized against the body by the opposite hand. Visually, a sharp contour on the affected shoulder, with a prominent acromion process and flattened deltoid can be seen when compared with the smooth deltoid outline on the unaffected shoulder. The humeral head may be palpated in the axilla anterior to the acromion and resting adjacent to the coracoid process. The patient will not allow the arm to be brought across the chest and may assume a guarding posture where the patient cradles his or her arm in slight abduction and external rotation. It is important to assess the axillary nerve and artery, because both structures can be damaged in a dislocation. A pulse may be taken on the medial proximal humerus over the brachial artery, and the axillary nerve can be assessed by stroking the skin on the upper lateral arm to assess sensation. Because the deltoid is not only a key shoulder abductor but also contributes to shoulder flexion and extension, damage to this nerve can be devastating. In the presence of deformity that is either seen or palpated, no special tests are needed to confirm the presence of a dislocation.

Occasionally, posterior dislocations occur from a fall on or a blow to the anterior surface of the shoulder, which drives the head of the humerus posteriorly. If dislocated, the arm is carried tightly against the chest and across the front of the trunk in rigid adduction and internal rotation. The anterior shoulder appears to be flat, the coracoid process is prominent, and a corresponding bulge may be seen posteriorly (if not masked by a heavy deltoid musculature). Any attempt to move the arm into external rotation and abduction produces severe pain. Because the biceps brachii is unable to function in this position, the patient is unable to supinate the forearm with the shoulder flexed.

Management

Muscle spasm sets in very quickly following dislocation and makes reduction more difficult. Management of a first-time dislocation requires immediate referral to a physician. As such, in some settings, it may be necessary to activate the emergency action plan. The injury should be treated as a fracture and the arm immobilized in a comfortable position. To prevent unnecessary movement of the humerus, a rolled towel or thin pillow can be placed between the thoracic wall and humerus before applying a sling. Ice should be applied to control hemorrhage and muscle spasm.

Following reduction, the shoulder is immobilized in a sling and swathe. Traditionally, immobilization for 4 weeks followed by rehabilitation is recommended, but this protocol has not been proved to diminish the risk of recurrent instability, which is about 39%.[29] Men under the age 40 years with hyperlaxity are at the greatest risk for chronic instability following a shoulder dislocation.[29] When the patient is able to tolerate movement, ROM exercises can begin, but it is important to avoid an aggressive flexibility program in extension, abduction, and external rotation. Resisted isometric and stretching exercises can begin immediately after the acute phase has ended. Elastic band exercises below 90° of abduction can be incorporated early during the program to maintain and improve strength. Interferential current stimulation can be used to reduce inflammation, stimulate muscle reeducation, promote deep tissue circulation, and minimize fibrotic infiltration. Strength development of the lateral rotators can reduce strain on the anterior structures of the joint by pulling the humeral head posteriorly during lateral rotation of the shoulder, thus reducing anterior instability. Strong scapula stabilizers (e.g., trapezius, rhomboids, and serratus anterior) also are believed to improve anterior stability by placing the glenoid in the optimal position to perform the skill techniques required. Isokinetic internal rotation and adduction can begin within 3 to 4 weeks and advance as tolerated. More aggressive shoulder rehabilitation exercises are not typically initiated until 5 to 6 weeks after removal of the immobilization device and subsequent to achieving full ROM.

A common finding after an anterior dislocation is a **Hill-Sachs lesion** (**Fig. 17.34**). The lesion is a small defect in the articular cartilage of the humeral head caused by the impact of the humeral head on the glenoid fossa as the humerus dislocates. The lesion usually is located on the posterior aspect of the humeral head, but it may be found on the anterior portion of the humeral head following a posterior dislocation, in which it is called a reverse Hill-Sachs lesion. The lesion is used as a diagnostic tool in determining the severity of the dislocation. In patients reporting that the shoulder dislocated but spontaneously reduced, the lesion may be visible on radiographs. Although the lesion rarely is symptomatic, the condition may lead to early degeneration of the GH joint.

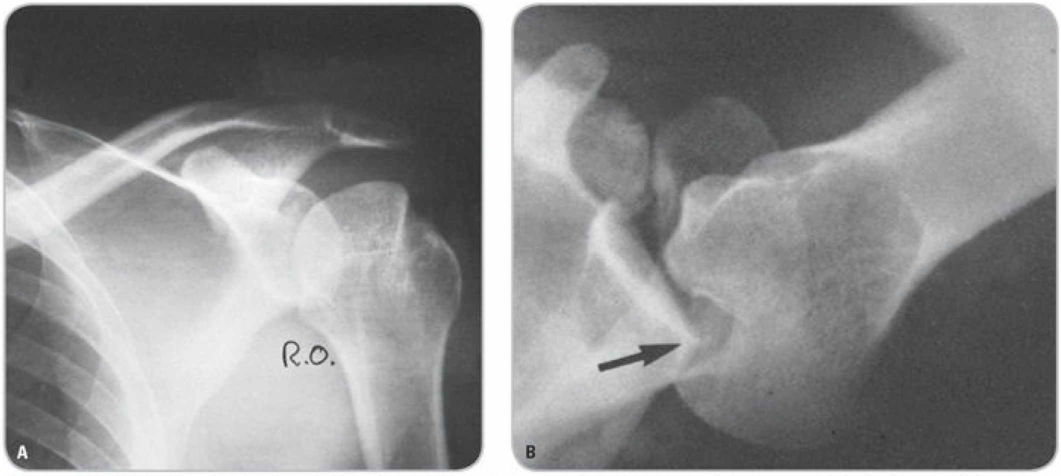

Figure 17.34. **Hill-Sachs lesions. A,** In this radiograph of a reduced anterior dislocation with the humeral head held in internal rotation, a Hill-Sachs compression fracture is evident. Note the posterolateral humeral head defect with a sharp, dense spine of bone running downward from the top of the humeral head toward the center of the humeral head. This line of condensation of bone is the result of an impaction fracture caused by the anterior glenoid rim. **B,** This radiograph demonstrates a subacromial posterior dislocation of the right shoulder with a large, anteromedial compression fracture defect of the humeral head, the so-called reverse Hill-Sachs sign (*arrow*).

Chronic Dislocations

Etiology

Recurrent dislocations, or "trick shoulders," tend to be anterior dislocations that are intracapsular. The mechanism of injury is the same as that for acute dislocations. As the number of occurrences increase, however, the forces that are needed to produce the injury decrease, as do the associated muscle spasm, pain, and swelling. The patient is aware of the shoulder displacing, because the arm gives the sensation of "going dead," which is referred to as the **dead arm syndrome**. Activities in which recurrent posterior subluxations are common include the follow-through of a throwing motion or a racquet swing, the ascent phase of a push-up or a bench press, the recoil following a block in football, and certain swimming strokes.

Signs and Symptoms

Pain is the major complaint, with crepitation and/or clicking after the arm shifts back into the appropriate position. Many patients voluntarily reduce the injury by positioning the arm in flexion, adduction, and internal rotation.

Management

If the injury does not reduce, the patient should be placed in a sling and swathe, or the arm may be stabilized next to the body with an elastic wrap. Ice should be applied to control pain and inflammation. The patient should be referred immediately to a physician for reduction of the injury and further care. Following reduction, conservative treatment involves rest and immobilization, restoration of shoulder motion, and strengthening of the rotator cuff muscles. Surgery may be indicated if persistent instability occurs.

Glenoid Labrum Tears

Etiology

The glenoid labrum is a fibrocartilaginous rim that lines the glenoid fossa to better receive the humeral head. The capsule and inferior GH ligament are contiguous with the labrum at their attachment to the glenoid. Tearing of the labrum and inferior GH ligament is referred to as a Bankart lesion. The lesion is associated with recurrent anterior shoulder instability. Tears of the labrum also may result from degeneration or trauma. In many instances, the tears are asymptomatic and incidental. Longitudinal or flap tears may occur in the anterior or posterior labrum, with or without associated GH instability.

An injury to the superior labrum may begin posteriorly and extend anteriorly, disrupting the attachment of the long head of the biceps tendon to the superior glenoid tubercle (**SLAP lesion**). Figure 17.35 demonstrates both a Bankart lesion and a SLAP lesion.

Figure 17.35. **Glenoid labrum tears. A,** This arthroscopic view demonstrates a detached anterior labrum (i.e., Bankart lesion). **B,** A SLAP lesion is evident at the origin of the long head of the biceps tendon. **C,** Schematic drawing and arthroscopic view of the SLAP lesion.

Signs and Symptoms

The patient may complain of pain, catching, or weakness, usually when the arm is overhead in an abducted and externally rotated position. The pain often is associated with clicking or popping within the joint. If a tear is the result of a dislocation or subluxation, symptoms of instability also may be present. Superior tears may be symptomatic and can be reproduced with ROM and translation testing, particularly with use of the clunk test and compression rotation test. Speed's test and Yergason test may be positive as well. Axial loading of the joint with forced internal and external rotation and the arm elevated 160° in the scapular plane with the elbow flexed (e.g., anterior impingement "crank" test) also may reproduce symptoms.[30]

Management

Treatment is based on the tear pattern and the presence or absence of GH instability. Initial conservative treatment may involve rest, anti-inflammatory drugs, and, if applicable, rehabilitation exercises. For those patients who do not respond well to conservative measures, arthroscopic debridement may be necessary.

> The soccer player with the type II AC sprain experienced the following signs and symptoms: slight elevation of the lateral clavicle; moderate swelling over the joint; moderate, palpable pain with downward pressure on the distal clavicle; palpable gap at the joint; inability to abduct the arm or horizontally adduct the arm across the chest without noticeable pain; and compromised sagittal plane stability.

OVERUSE CONDITIONS

> **?** Why is impingement syndrome a problem for swimmers in particular?

Patients who perform repetitive overhead activities often develop anterior shoulder pain. The GH capsular ligaments are the prime stabilizers of the shoulder, especially the anteroinferior GH ligament. As muscles contract to move the arm, they create compressive and shear forces within the joint. The compression force produced by muscles acting perpendicular to the glenoid fossa stabilizes the humeral head, and the muscles acting more parallel to the glenoid produce a translational shear force. The resultant force derived from the sum of the compressive and shear forces determines the vector direction of the total joint force. A larger superior shear force produces impingement, and a larger compression force centers the humeral head in the glenoid, reducing rotator cuff impingement under the acromion.

During abduction, the strong deltoid and supraspinatus muscles pull the humeral head superiorly relative to the glenoid fossa. The remaining rotator cuff muscles must counteract this migration by producing an inferior shear force to resist the pull from the supraspinatus and deltoid muscles. If the rotator cuff tendons are weak or fatigued, they are incapable of depressing the humeral head in the glenoid fossa during overhead motions. In addition, fatigue of the infraspinatus and teres minor that resist anterior joint translation also may lead to intracapsular impingement and GH instability. The resulting compression can lead to impingement of the supraspinatus tendon and subacromial bursa between the acromion, the coracoacromial ligament, and the greater tubercle of the humerus, resulting in rotator cuff strain, impingement syndrome, bursitis, or bicipital tendinitis.

Rotator Cuff and Impingement Injuries

Etiology

Chronic rotator cuff tears to the SITS muscles result from repetitive microtraumatic episodes that primarily impinge on the supraspinatus tendon just proximal to the greater tubercle of the humerus (**Fig. 17.36**). Partial tears usually are seen in young patients, with total tears typically seen in adults older than 30 years. In older age groups, chronic tears can lead to cuff thinning, degeneration, and total rupture of the supraspinatus tendon.

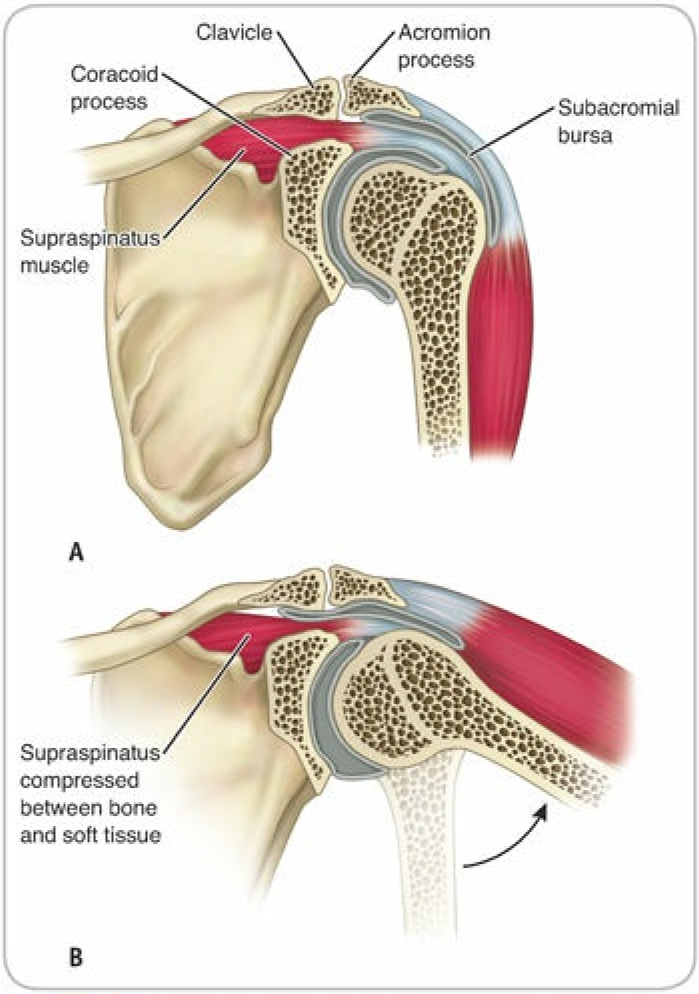

Figure 17.36. Supraspinatus tendon during abduction. A, Normal position. B, Abducted position. Repetitive overhead motions can impinge the muscle or tendon between the acromion process and coracoacromial ligament, resulting in a chronic rotator cuff injury.

Impingement syndrome implies an actual, mechanical abutment of the rotator cuff and the subacromial bursa against the coracoacromial ligament and acromion. This injury is caused from the force overload to the rotator cuff and bursa that occurs during the abduction, forward flexion, and medial rotation cycle of shoulder movements. Along with injury to the supraspinatus tendon and subacromial bursa, the glenoid labrum and long head of the biceps brachii also may be injured. Impingement syndrome sometimes is called "painful arc" syndrome or "swimmer's shoulder." **Box 17.1** lists several factors that can increase the risk for an impingement syndrome.

BOX 17.1 Factors Contributing to Impingement Syndrome

- Excessive amount of overhead movement (i.e., overuse)
- Limited subacromial space under the coracoacromial arch and limited flexibility of the coracoacromial ligament
- Thickness of the supraspinatus and biceps brachii tendon
- Lack of flexibility and strength of the supraspinatus and biceps brachii
- Weakness of the posterior cuff muscles (e.g., infraspinatus or teres minor)
- Tightness of the posterior cuff muscles
- Hypermobility of the shoulder joints
- Imbalance in muscle strength, coordination, and endurance of the scapular muscles (e.g., serratus anterior or rhomboids)
- Shape of the acromion
- Training devices (e.g., use of hand paddles or tubing)

Signs and Symptoms

Initially, pain is described as being deep in the shoulder and present at night. Activity increases the pain but only in the impingement position. As repetitive trauma continues, pain becomes progressively worse, particularly between 70° and 120° (i.e., "painful arc") of active and resisted abduction. Because forced scapular protraction leads to further impingement and pain, the patient may be unable to sleep on the involved side. Pain can be palpated in the subacromial space. If a full-thickness tear has been sustained, atrophy may be apparent in the supraspinatus or infraspinatus fossa. Depending on the extent of the injury (Box 17.2), positive results may be elicited in the drop arm test, empty can test, Neer shoulder impingement test, and anterior impingement test (Hawkins-Kennedy test).

BOX 17.2 Stages of Impingement Syndrome

Stage 1

- Condition typically is seen in individuals younger than 25 years and is reversible.
- Localized hemorrhage and edema are present in the supraspinatus tendon.
- Minimal pain is felt with activity, but no restriction or weakness of motion occurs.
- Atrophy of the rotator cuff muscles may be present.

Stage 2

- Condition typically is seen in individuals between 25 and 40 years of age.
- Marked reactive tendinitis is present, with significant pain felt between 70° and 120° abduction.
- Inflammation may affect the biceps brachii tendon and subacromial bursa, leading to thickening and fibrotic changes in the structures.
- Limited ROM is found in external rotation and abduction.
- Possible clicking sounds are heard on resisted adduction and internal rotation.

Stage 3

- The individual has a history of chronic, long-term shoulder pain with significant weakness.
- Rotator cuff tear usually is less than 1 cm.
- Prominent capsular laxity with MDI is seen.
- Noticeable atrophy of the supraspinatus and infraspinatus muscles occurs.
- Arthroscopy may show a damaged labrum.

Stage 4

- Rotator cuff tear is greater than 1 cm.

Management

Initially, conservative treatment involves restricting motion below 90° of abduction, cryotherapy, NSAIDs, pain-relieving medication, 1 to 2 weeks of rest, activity modification, and occasionally, steroid injection. However, much can be accomplished through the use of therapeutic exercise and modalities. Ultrasound, electrical muscle stimulation, interferential therapy, and heat can supplement treatment and can be used to help with pain management. Overall, NSAIDs and subacromial steroid injections are effective in the short-term treatment of shoulder pain.[31] Concern exists, however, that delaying repair of a supraspinatus tear makes the eventual repair harder or even impossible; initial surgical repair generally has a good outcome.[32]

Mobility should be maintained with mild stretching exercises, particularly in external rotation at 90°, 135°, and 180° of abduction. Pendulum exercises with abduction and forward flexion up to 90°, rope-and-pulley exercises in flexion, and T-bar exercises in flexion and external rotation should be initiated early during the rehabilitation process. In addition, muscles of the rotator cuff as well as muscles that perform scapular retraction, depression, and rotation should be strengthened. In terms of strength about the shoulder, adduction should be the strongest, followed by extension, flexion, abduction, internal rotation, and external rotation. Exercises such as pull-ups or push-ups should be avoided during the early stages of rehabilitation, because they can impinge on the rotator cuff and complicate the condition. **Application Strategy 17.3** outlines the management of an impingement syndrome.

APPLICATION STRATEGY 17.3

Management of an Impingement Injury

- Use cryotherapy initially; later, replace with moist heat therapy twice a day.
- Electrical muscle stimulation, interferential current, and transcutaneous electrical nerve stimulation may be helpful for pain management.
- Use ultrasound and NSAIDs to reduce inflammation.

- Use selective rest. For 4–6 weeks, concentrate on motions that do not cause pain. Avoid abduction above 90°.
- Evaluate skill technique and correct movements that produce shoulder stress.
- Eliminate partner stretching, overhead training, and, for swimmers, use of hand paddles.
- Wand and T-bar exercises can improve sport-specific mobility but should not encourage hypermobility.
- Perform pain-free isometric and elastic band exercises at least two to three times daily to maintain muscle tone. Use low weights and high repetitions.
- Strengthen the lateral rotators (i.e., infraspinatus and teres minor) to control superior displacement of the humeral head.
- After 4–6 weeks, incorporate isokinetic exercises at high speeds and elastic band exercises in diagonal patterns.
- Begin a gradual return to activity, as long as the symptoms do not recur.

Swimmers present a special problem, because many strokes use adduction and internal rotation with excessive propulsion forces. Because of fatigue and lack of coordination in the scapular muscles, this motion may allow subclinical anterior subluxations to occur, resulting in damage to the glenoid labrum. This anterior lesion may be frayed but not detached, resulting in a roughened leading edge that may mechanically catch during overhead motions. As such, swimmers may feel a snapping sensation, clicking, or sense that the shoulder is “going out” when moving through the pull phase of the stroke. Occasionally, a defect or crepitus in the supraspinatus tendon may be palpated just anterior to the acromion process when the arm is extended at the GH joint. Pain also can be palpated anteriorly over the coracoacromial ligament, laterally at the insertion of the supraspinatus, posteriorly at the insertion of the infraspinatus and teres minor, or over the long head of the biceps tendon. Atrophy of the shoulder muscles with subsequent weakness in the supraspinatus and biceps brachii may be present as well. Because rest translates into detraining, other steps may need to be taken to allow continued activity. The intensity and quantity of training need to be reduced and paddle work eliminated. Stroke mechanics should be assessed to determine if changes are needed to reduce shoulder stress.

Bursitis

Etiology

Bursitis is not generally an isolated condition; rather, it is associated with other injuries, such as an impingement syndrome and preexisting degenerative changes in the rotator cuff. The large subacromial bursa is a common site of injury in swimmers and in baseball, softball, and tennis players. Located between the coracoacromial ligament and the underlying supraspinatus muscle, this bursa provides the shoulder with some inherent gliding ability. During an overhead throwing motion, this bursa can become impinged in the subacromial space.

Signs and Symptoms

Frequently, sudden shoulder pain is reported during initiation and acceleration of the throwing motion. Point tenderness can be elicited on the anterior and lateral edges of the acromion process. A painful arc exists between 70° and 120° of passive abduction. Inability to sleep, especially on the affected side, occurs because of forced scapular protraction that leads to further impingement of the bursa. Pain often is referred to the distal deltoid attachment.

Management

Standard acute protocol is followed by referral to a physician. A physician may inject a corticosteroid solution into the subacromial space to relieve the symptoms. In addition, other underlying conditions, such as a rotator cuff tear, impingement syndrome, or bicipital tendinitis, must be ruled out. Treatment is symptomatic and is the same as for a rotator cuff strain or impingement syndrome.

Bicipital Tendinitis

Etiology

Injury to the biceps brachii tendon often occurs from repetitive overuse during rapid overhead movements involving excessive elbow flexion and supination activities, such as those performed by racquet-sport players, shot-putters, baseball/softball pitchers, football quarterbacks, swimmers, and javelin throwers. Irritation of the tendon occurs as it passes back and forth in the intertubercular (bicipital) groove of the humerus. The tendon may partially sublux because of laxity of the traverse humeral ligament, a poorly developed lesser tubercle, or both. A direct blow to the tendon or tendon sheath can lead to bicipital tenosynovitis. Anterior impingement syndrome associated with overhead rotational activity also may damage the tendon.

Signs and Symptoms

Pain and tenderness is present over the bicipital groove when the shoulder is internally and externally rotated. In internal rotation, the pain stays medial; in external rotation, the pain is located in the midline or just lateral to the groove. Pain also may be elicited when the tendon is passively stretched in extreme shoulder extension with the elbow extended and the forearm pronated. Resisted supination of a flexed elbow while externally rotating the shoulder (e.g., Yergason test) increases pain, as does forward shoulder flexion of the extended, supinated elbow (e.g., Speed's test).

Management

Treatment involves restriction of rotational activities that exacerbate symptoms. Because of potential vascular impingement of the biceps tendon when the shoulder is at the side, the arm should be propped or wedged into slight abduction if immobilized in a sling. During the early stages of the condition, cryotherapy, NSAIDs, ultrasound, electrical muscle stimulation, or interferential therapy can control inflammation. Icing before and after activity should be combined with a gradual program of stretching and strengthening as soon as pain subsides. Patients experiencing bicipital tendinitis secondary to impingement should avoid horizontal abduction exercises, which can aggravate symptoms.[33]

Biceps Tendon Rupture

Etiology

Prolonged tendinitis can make the tendon vulnerable to forceful rupture during repetitive overhead motions, as commonly are seen in swimmers, or during forceful flexion activities against excessive resistance, as are seen in weight lifters or gymnasts. The rupture occurs as a result of the avascular portion of the proximal long head of the biceps tendon constantly passing over the head of the humerus during arm motion. This condition often is seen in degenerative tendons in older patients and in patients who have had corticosteroid injections into the tendon.

Signs and Symptoms

The patient often hears and feels a snapping sensation and experiences intense pain. Ecchymosis and a visible, palpable defect can be seen in the muscle belly when the patient flexes the biceps. If the muscle mass moves distally as a result of a proximal long head rupture, a “Popeye” appearance clearly is visible. Partial ruptures may produce only slight muscular deformity but are still associated with pain and weakness in elbow flexion and supination. In this case, Ludington test should help the clinician identify the presence of the rupture. Distal biceps rupture results in marked weakness with flexion and supination of the forearm.

Management

Standard acute care protocol is followed by immediate referral to a physician. Surgical repair usually is not suggested for noncompetitive patients or older patients, because return to normal physical activity can occur after completing an appropriate rehabilitation program. Surgical repair and fixation is indicated, however, for competitive patients to restore elbow flexion and forearm supination strength needed for participation in competitive sports.

Thoracic Outlet Compression Syndrome

Etiology

Thoracic outlet compression syndrome is a condition in which nerves and/or vessels become compressed in the proximal neck or axilla (**Fig. 17.37**). This condition has two clearly defined forms. One is a neurological syndrome, accounting for approximately 90% of all cases, that involves the lower trunk of the brachial plexus and is caused by abnormal nerve stretch or compression. Another is a vascular form that involves the subclavian artery and vein and is more common in men than in women.[34] Thoracic outlet compression syndrome often is aggravated in activities that require overhead rotational stresses while muscles are loaded, such as weight lifting and swimming. Disorders associated with thoracic outlet syndrome include the following:

- Compression of the medial cord of the brachial plexus
- Compression of the subclavian artery and vein
- Cervical rib syndrome
- Scalenus anterior syndrome
- Hyperabduction syndrome
- Costoclavicular space syndrome
- Poor posture with drooping shoulders

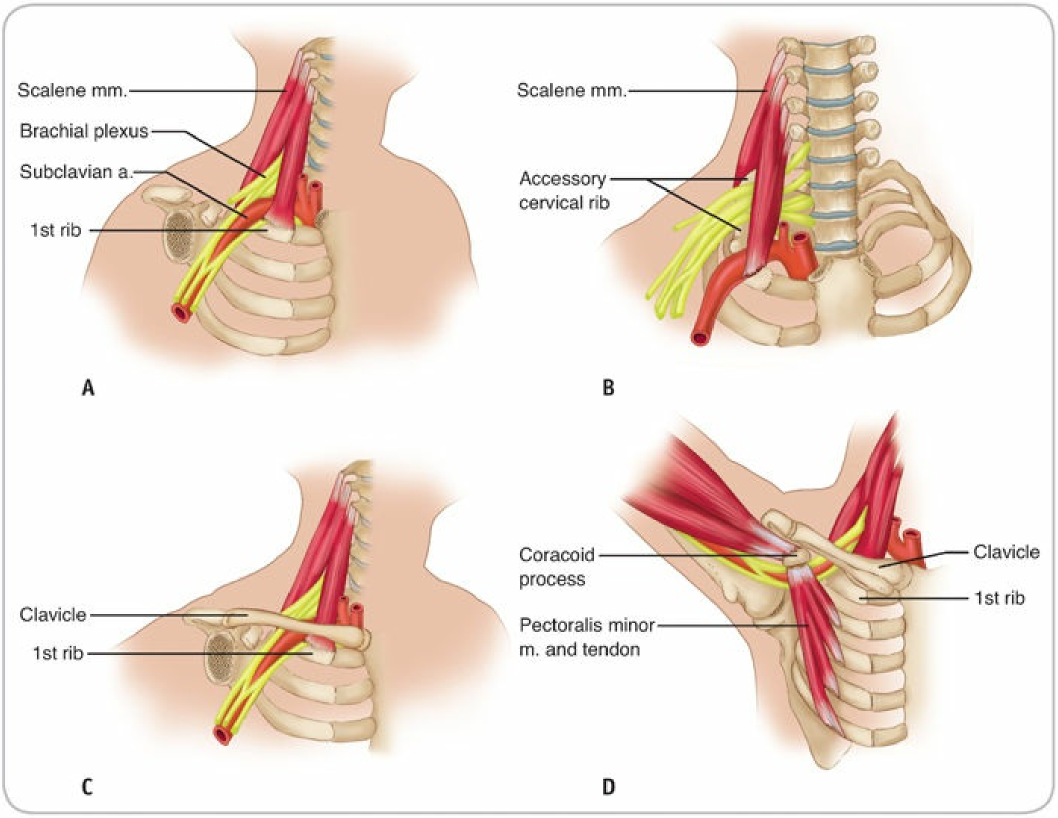

Figure 17.37. Location and etiology of thoracic outlet syndrome. A, Scalenus anterior syndrome. **B,** Cervical rib syndrome. **C,** Costoclavicular space syndrome. **D,** Hyperabduction syndrome.

Signs and Symptoms

If a nerve is compressed, an aching pain, a pins-and-needles sensation, or numbness in the side or back of the neck extends across the shoulder down the medial arm to the ulnar aspect of the hand. If compression is intermittent, due to sleeping position or muscle action, then the symptoms will also occur intermittently. Weakness in grasp and atrophy of the hand muscles also may be present in prolonged cases. If arterial or venous vessels are compressed, signs and symptoms vary depending on the specific structure being obstructed. Blockage of the subclavian vein, for example, produces edema, stiffness (especially in the hand), and venous engorgement of the arm with cyanosis (Fig. 17.38). If untreated, this may result in thrombophlebitis. The patient may present these signs and symptoms several hours after a bout of intense exercise. Occlusion of the subclavian artery results in a rapid onset of coolness, numbness in the entire arm, and fatigue after exertional overhead activity. The radial pulse may be obliterated while performing the Adson test, the Allen test, or the costoclavicular syndrome (military brace) test. A detailed history is needed, and it is essential to evaluate the cervical spine, shoulder, elbow, and hand for evidence of neural compression. Instability of the shoulder also should be ruled out. In addition, a postural assessment should be conducted.

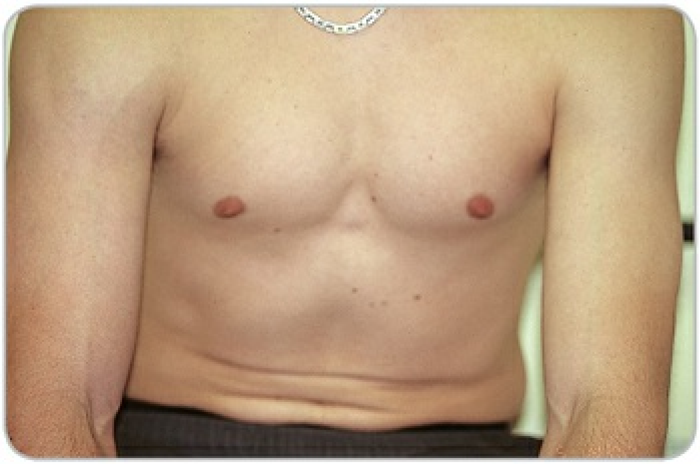

Figure 17.38. Thoracic outlet syndrome. This 20-year-old pitcher presented with "burning" pain, swelling, and erythema of the right arm. His right arm has distended veins, which stemmed from right subclavian vein thrombosis.

Management

Immediate referral to a physician is necessary if patient presents with swelling, erythema, or distended veins for more extensive assessment to rule out serious vascular involvement. Conservative treatment involves assessing muscle strength and posture. Noted deficits should lead to an appropriate retraining program to develop strength and muscle balance in the shoulder girdle and facilitate maintenance of a corrected posture. If the condition was precipitated by a sudden increase in activity, treatment involves anti-inflammatory drugs, activity modification, and reassessment of the training program. Return to full activity may occur after ROM and strength in the shoulder musculature have been regained.

Swimmers present a special problem with regard to impingement, because many strokes use adduction and internal rotation with excessive propulsion forces. Because of fatigue and lack of coordination in the scapular muscles, this motion may allow subclinical anterior subluxations to occur, resulting in damage to the glenoid labrum. This anterior lesion may be frayed but not detached, resulting in a roughened leading edge that may mechanically catch during overhead motions.

FRACTURES

? How can atraumatic osteolysis of the distal clavicle occur?

Most fractures to the shoulder region result from a fall on the point of the shoulder, from rolling over onto the top of the shoulder, or from indirect forces caused by falling on an outstretched arm. Clavicular fractures are more common than fractures to the scapula and proximal humerus, with nearly 80% occurring in the midclavicular region.

Clavicular Fractures

Because of the S-shaped configuration of the clavicle, it is highly susceptible to compression forces caused by a blow or fall on the point of the shoulder, a direct blow to the bone by an opponent or object, or a fall on an outstretched arm. Activities that have a high incidence of clavicular injury include ice hockey, football, the martial arts, lacrosse, gymnastics, weight lifting, wrestling, racquetball, squash, and bicycling.

Osteolysis of the Distal Clavicle

Etiology

Atraumatic osteolysis of the distal clavicle is an overuse injury resulting from repetitive microtrauma. It also has been described as a sequelae following traumatic injury to the distal clavicle or AC joint. The condition is seen most often in weight lifting, but it also has been seen in sports where cross-training is popular and in younger patients who weight train year-round for higher level sports.[35] During repetitive activity, subsequent bone resorption causes cystic and erosive changes, and bone remodeling cannot occur because of the continual stress to the area.

Signs and Symptoms

Patients usually complain of a dull ache over the AC joint, which often is worse at the beginning of an exercise period. Pain and a sense of weakness during abduction and flexion of the arm also are noted. This pain and weakness may occur from weeks to years after the actual injury.[36] Palpable pain, crepitus, and swelling are present over the distal clavicle. Increased pain is experienced with horizontal adduction of the arm; any abduction of the arm greater than 90° is extremely painful. Radiographs tend to show osteopenia and lucency in the distal clavicle.

Management

The treatment of choice is conservative but requires patient compliance. Rest, particularly from weight training, and anti-inflammatory drugs are recommended. Surgical resection of the distal clavicle may be necessary depending on the patient's functional demands and symptoms.[35,36]

Traumatic Clavicular Fractures

Etiology

Nearly 80% of traumatic fractures occur in the middle third of the clavicle.[26] The sternocleidomastoid muscle pulls the proximal bone fragment upward, allowing the distal shoulder to collapse downward and medially from the force of gravity and the pull of the pectoralis major muscle.

Signs and Symptoms

Swelling, ecchymosis, and a deformity may be visible and palpable at the fracture site. Greenstick fractures, which typically are seen in adolescents, also produce a noticeable deformity. Pain occurs with any shoulder motion and may radiate into the trapezius area. In older adults, fractures of the distal clavicle may involve tears of the coracoclavicular ligament, producing an increased deformity. Although rare, complications may arise if bony fragments penetrate local arteries or nerves.

Management

Immediate treatment involves immobilization in a sling and swathe. Following assessment by the physician, a figure eight brace or strapping often is used to pull the shoulder backward and upward for 4 to 6 weeks in young adults and for 6 or more weeks in older adults (Fig. 17.39). Although this immobilization prevents movement in nearly all planes, it does not prevent scapular elevation. As a result, healing may be delayed, and excessive callus formation may occur at the fracture site. This bump tends to remodel, to some degree, over a period of years but may never completely disappear. Following immobilization, gentle isometric and mobilization exercises should begin with gradual return to activity.

Figure 17.39. Figure eight clavicular straps. **A,** Anterior view. **B,** Posterior view.

Scapular Fractures

Etiology

Scapular fractures may involve the body of the scapula, spine of the scapula, acromion process, coracoid process, or GH joint. Avulsion fractures to the coracoid process result from direct trauma or from forceful contraction of the pectoralis minor or short head of the biceps brachii. Fractures to the glenoid area are associated with shoulder subluxations and dislocations. In this case, treatment is dictated by the shoulder dislocation rather than by the fracture and often requires open reduction and internal fixation or shoulder reconstruction.

Signs and Symptoms

Most fractures result in minimal displacement and exhibit localized hemorrhage, pain, and tenderness. The patient is reluctant to move the injured arm and prefers to maintain it in adduction. Arm abduction is painful. It is critical to note any signs or symptoms that would suggest an underlying pulmonary injury (e.g., pneumothorax or hemothorax).

Management

The arm should be immobilized immediately in a sling and swathe, and ice should be applied to minimize hematoma formation. The patient should be referred to a physician. Complications may arise from scarring and adhesions in the muscles overlying the scapula. Subsequently, the muscles in the region must compensate for the limited scapular motion, leading to overuse injuries. The development of adhesions in the area can be reduced with an early program of passive and active stretching exercises, usually within 2 weeks. Early mobilization also is important to avoid loss of ROM, which could lead to a frozen shoulder.

Epiphyseal and Avulsion Fractures

Etiology

Epiphyseal centers around the shoulder region remain unfused for a longer span of time than typically is seen at other epiphyseal sites. For example, the medial clavicular growth plate does not close until approximately 25 years of age, and this situation often is misdiagnosed as an SC subluxation/dislocation. The proximal humeral epiphysis does not close until 18 to 21 years of age. An epiphyseal fracture at this site, called **Little League shoulder**, often is caused by repetitive medial rotation and adduction traction forces placed on the shoulder during pitching (**Fig. 17.40**). Catchers also may sustain this fracture, because they throw the ball as hard and as often as pitchers, but with less of a windup. The injury usually occurs during the deceleration and follow-through phases of throwing or pitching.

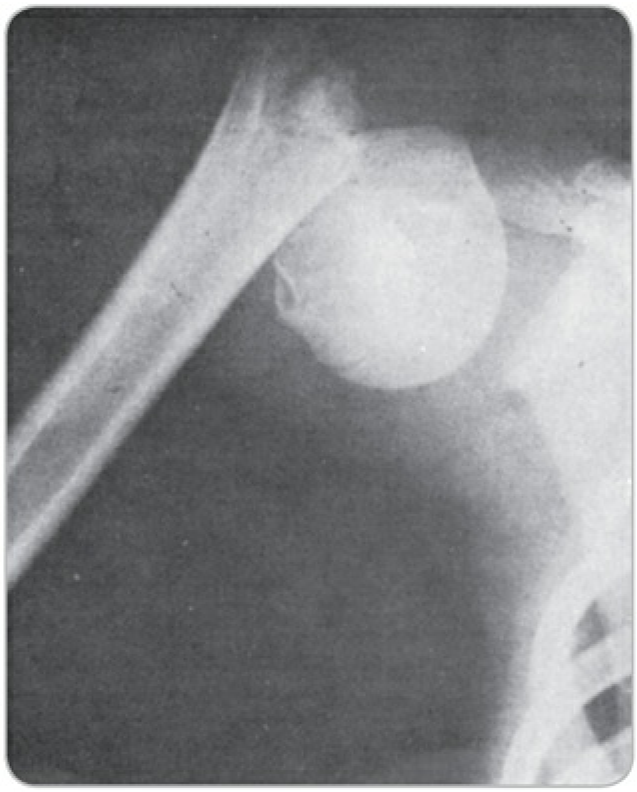

Figure 17.40. Epiphyseal fracture to the proximal humeral growth center.

Avulsion fractures to the coracoid process can be seen in a young patient when forceful, repetitive throwing places too much stress on the growth plate. Fractures of the greater and lesser tubercle often are associated with anterior and posterior GH dislocations, respectively. When the tubercle cannot be maintained in a stable position, open reduction and internal fixation often are required.

Signs and Symptoms

In an epiphyseal fracture, the patient complains of acute shoulder pain when attempting to throw hard, which if ignored may result in an acute displacement of the weakened physis. Pain may be elicited by deep palpation in the axilla. In an avulsion fracture, pain can be elicited by deep palpation over the specific bony landmark.

Management

The arm should be immobilized in a sling and swathe, and ice should be applied to control pain and swelling. Immediate referral to a physician for further care is warranted. Radiographs are necessary to view the widened epiphyseal line and demineralization. Treatment is conservative, with symptoms disappearing after 3 to 4 weeks of rest. The condition may recur if activity is resumed too quickly.

Humeral Fractures

Etiology

Humeral fractures result from violent compression forces from a direct blow, a fall on the upper arm, or a FOSH with the elbow extended. The surgical neck is the most common site for proximal humeral fractures and may display an appearance similar to that of a dislocation (**Fig. 17.41**).

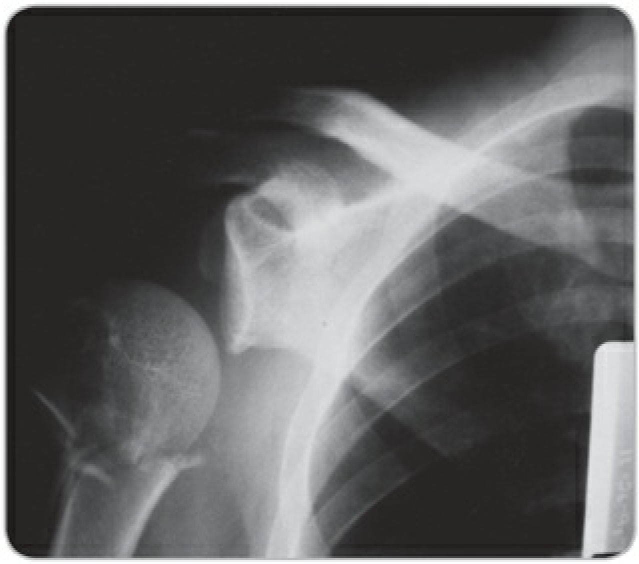

Figure 17.41. Fracture to the surgical neck of the humerus.

Signs and Symptoms

Pain, swelling, hemorrhage, discoloration, inability to move the arm, inability to supinate the forearm, and possible paralysis may be present. The arm often is held splinted against the body.

Management

The arm should be immobilized in a sling and swathe, and ice should be applied to control pain and swelling. Immediate referral to a physician for further care is warranted. In some settings, this injury may warrant activation of the emergency action plan.

Up to 85% of proximal humeral fractures can be treated nonoperatively.[36] For cases in which the fracture is impacted, closed reduction allows early mobilization after 3 to 4 weeks of immobilization. Early complications of a fracture to the proximal humerus include brachial plexus injury and/or vascular injury. Late complications include shoulder stiffness, malunion, nonunion, avascular necrosis, and myositis ossificans.

> A traumatic osteolysis of the distal clavicle is an overuse injury resulting from repetitive microtrauma. It also has been described as a sequelae following traumatic injury to the distal clavicle or AC joint.

During repetitive activity, subsequent bone resorption causes cystic and erosive changes, and bone remodeling cannot occur because of the continual stress imposed on the point.

REHABILITATION

? The swimmer has a painful shoulder as a result of recurrent subluxations. What areas should be the focus of a rehabilitation program for this condition?

A rehabilitation program of the shoulder must address the specific needs of the patient. The program should relieve pain and muscle tension; restore motion and balance; develop strength, endurance, and power; and maintain cardiovascular fitness. Progress within any program is dictated by the type and severity of injury, the amount of immobilization, and the supervising physician's treatment plan.

Restoration of Motion

Gentle ROM exercises, such as Codman circumduction and pendulum swings, often are used immediately after injury. The exercise is performed by making small circles and a pendulum motion in the actions of flexion and extension, and horizontal abduction and adduction. The extent of ROM should increase as pain-free motion is regained. Exercises can progress to active, assistive T-bar exercises in the supine position (Application Strategy 17.4). In throwing activities, the ROM needed to adequately complete the cocking phase exceeds 90° of external rotation when the arm is abducted 90°. Special attention should be focused on regaining this additional ROM but not to the point of hypermobility. A rope-and-pulley system can augment active, assistive GH flexion and abduction. Shoulder shrugs performed in three directions (i.e., superior, anterior, and posterior) can increase scapular ROM.

APPLICATION STRATEGY 17.4

Range of Motion Exercises for the Glenohumeral Joint

Wand and T-bar exercises. Hold the stretch for 5–10 seconds and repeat 10–20 times per session. Initially, ROM exercises can be performed two to three times daily.

1. **Supine shoulder flexion.** Grasp the wand with both hands palm-down at waist height. Raise the wand directly overhead, leading with the uninvolved arm until a stretch is felt in the involved shoulder. If an impingement syndrome is present, this exercise can be performed palm-up.
2. **Shoulder abduction.** Hold the wand with the involved arm palm-up and the uninvolved arm palm-down. With the uninvolved arm, push the wand sideward and upward toward the involved side until a stretch is felt in the involved shoulder.
3. **Shoulder adduction/horizontal adduction.** Reverse the hand positions from exercise 2. Pull the wand toward the uninvolved side until a stretch is felt in the involved shoulder.
4. **Shoulder internal/external rotation.** Keeping both palms down, abduct the shoulders and flex the elbows. Move the wand upward toward the head and then return to waist level.
5. **Shoulder horizontal abduction/adduction.** Keeping both palms down, push the wand across the body with the uninvolved arm and then pull back across the body. Do not allow the trunk to twist.
6. **Supine external rotation.** Abduct the shoulder and flex the elbow to 90°. Grip the T-bar in the hand on the involved arm. Use the opposite arm to push the involved arm into external rotation. Perform external rotation with the arm abducted at 135° and 180°.
7. **Supine internal rotation.** With the arms in the same position as in exercise 6, use the uninvolved arm to push the involved arm into internal rotation.

Restoration of Proprioception and Balance

Closed chain exercises can be performed after acute inflammation has been controlled. Shifting body weight from one hand to the other may be performed on a wall, tabletop, or unstable surface, such as a foam mat or biomechanical ankle platform system (BAPS) board. Push-ups and exercises in a frontal and sagittal plane can be performed on a Pro Fitter or slide board. The dynamic stabilizers can be addressed through using a body blade, dynamic stabilizing exercises, and incorporating PNF training within the program.

Use of free weights can develop balance, coordination, and skill in moving through diagonal patterns; however, it is imperative to include transference of proprioceptive training to the actual motions. For example, pertaining to the throwing motion, this training could involve a slow, deliberate rehearsal of the throwing motion that incorporates visual feedback through the use of mirrors or videotape. As the motion is performed, biomechanical errors are corrected. Once motion has been perfected, speed of movement and distance of throw are gradually increased.

Muscular Strength, Endurance, and Power

Gentle, resisted isometric exercises often can begin immediately after injury or surgery, even while the arm is immobilized. The exercises are initiated with the GH joint in a resting position. This is followed by application of a slow, mild overload in each of the various directions of shoulder movement. A disadvantage of isometric exercise is that strength gains are relatively specific to the joint angle at which the exercise is performed; therefore, isometric contractions must be performed at multiple positions to strengthen the joint. As the patient improves, a more moderate isometric overload is applied. Finally, a higher, rapid, unexpected resistance is provided at various positions, including the end of the ROM.

When ROM approximates normal for the patient, open chain kinetic exercises can be performed in a prone, side-lying, supine, or standing position to add gravity as resistance (**Application Strategy 17.5**). A sandbag or dumbbell can be used for added resistance. The patient should complete 50 to

100 repetitions with a 1-lb weight and should not progress in resistance until 100 repetitions are achieved. Resistance should be limited to 5 lb, because this decreases the chance of rotator cuff inflammation during the strengthening program. Careful attention should be directed to a potential painful arc of motion during concentric and eccentric contractions, because pain can further aggravate the injury. As such, the patient should work within a pain-free arc of motion with light resistance to the point of fatigue.

APPLICATION STRATEGY 17.5

Rehabilitation Exercises for the Shoulder Complex

Progressive exercises should begin when pain subsides. Exercises should be controlled and focus on the line of movement.

Resistance should progress from gravity to light dumbbells or sandbags. The exercises listed in Application Strategy 17.2 should be progressively incorporated as tolerated.

1. **Side-lying medial and lateral rotation.** Maintaining the elbow in a flexed position, perform lateral and medial rotation.

2. **Prone horizontal abduction (90°).** Positioned with the arm hanging over the table and the hand rotated outward, raise the arm and laterally rotate the humerus until it is parallel to the floor.

3. **Prone horizontal abduction (100°).** Positioned with the arm abducted at 100°, raise the arm and laterally rotate the humerus.

4. **Prone flexion and extension.** With the hand rotated outward as far as possible, raise the arm forward into flexion. Repeat, moving the arm into extension.

5. **Prone medial and lateral rotation.** With the shoulder abducted 90° and the elbow flexed, perform lateral and medial rotation. Repeat in the supine position.

6. **Prone rows (scapular adduction).** With the shoulder abducted 90° and the elbow flexed, raise the arm off the table as if pinching the shoulder blades together. Do not raise the chest off the table.

7. **Wall push-ups and press-ups.**

Muscular strength and endurance can be developed through PNF-resisted exercises in diagonal patterns to mimic functional skills or through surgical tubing used through a functional pattern. As strength improves, free-weight or machine-weight exercises for the upper body are incorporated. Many of these exercises are demonstrated in **Application Strategy 17.2**.

Plyometric exercises may involve catching a weighted ball using a quick, eccentric stretch of the muscle to facilitate a concentric contraction in throwing the ball. The exercise can progress through various one- and two-arm chest passes and overhead passes. A minitramp also can be used to do plyometric bounding push-ups.

Cardiovascular Fitness

Cardiovascular conditioning should be maintained throughout the rehabilitation program (see Chapter 13).

> Management of the swimmer's condition likely will involve rest and immobilization. As such, rehabilitation should focus on restoring shoulder motion, but it is important to avoid an aggressive flexibility program in extension, abduction, and external rotation. Strengthening exercises should progress from resisted isometric exercises to elastic band exercises below 90° of abduction. In particular, developing the strength of the lateral rotators can reduce strain on the anterior structures of the joint by pulling the humeral head posteriorly during lateral rotation of the shoulder. Strong scapula stabilizers (e.g., trapezius, rhomboids, and serratus anterior) also are believed to improve anterior stability by placing the glenoid in the optimal position to perform the required skill techniques. Isokinetic internal rotation and adduction should begin as tolerated. More aggressive shoulder rehabilitation exercises eventually should be introduced on a gradual and progressive basis.

SUMMARY

1. The shoulder complex does not function in an isolated fashion; rather, a series of joints work together in a coordinated manner to allow complicated patterns of motion. Subsequently, injury to one structure can affect other structures.
2. The throwing motion occurs in several distinct phases: windup, stride, cocking, acceleration, deceleration, and follow-through.
3. Scapulohumeral rhythm is the combined scapular and GH movement that allows coordinated shoulder motion.
4. Subsequent to the history, observation, and palpation components of an

assessment, the clinician should have established a strong suspicion regarding which structures may be damaged. As such, during the physical examination component, some tests will be compulsory, whereas others will be used to confirm or exclude suspected injury or pathology. Only those tests that are absolutely necessary should be performed.

5. A moderate SC sprain is characterized by pain and swelling over the joint and an inability to horizontally adduct the arm without increased pain. The arm typically is held forward and close to the body.
6. A moderate AC sprain is characterized by an elevated distal clavicle, indicating that the coracoclavicular ligament and the AC ligaments have been torn. The patient typically has a depressed or drooping shoulder.
7. GH instability may be classified as anterior, posterior, inferior, or multidirectional. Anterior instability indicates injury to the middle and inferior GH ligaments and may have an associated Bankart lesion. MDI often is associated with pain and/or clicking during simple tasks.
8. Anterior GH dislocations are more common than posterior dislocations. The injured arm often is stabilized against the body as it is held in slight abduction and external rotation.
9. A Hill-Sachs lesion may occur with an anterior dislocation; a reverse Hill-Sachs lesion may occur with a posterior dislocation. A SLAP lesion is a superior labral tear that may disrupt the attachment of the long head of the biceps tendon and may occur with or without associated GH instability.
10. Impingement syndromes involve an abutment of the supraspinatus tendon and subacromial bursa under the coracoacromial ligament and acromion process. The glenoid labrum and long head of the biceps brachii also may be injured.
11. Thoracic outlet compression syndrome may involve compression of the lower trunk of the brachial plexus or the subclavian artery and vein. If a nerve is compressed, an aching pain or numbness may extend across the

shoulder to the ulnar aspect of the hand. If arterial or venous vessels are compressed, then coolness, numbness in the entire arm, and fatigue occur after exertional, overhead activity.

12. The surgical neck is the most common site for proximal humeral fractures in adults. Adolescents, however, have a high degree of proximal humeral epiphyseal fractures because of repetitive medial rotation and adduction traction forces that are placed on the shoulder during pitching motions.
13. Pain may be referred to the shoulder from other areas of the body, particularly the heart, lungs, visceral organs, and cervical spine region.
14. Injuries that should be immediately referred to a physician include the following:
    - Obvious deformity suggesting a suspected fracture, separation, or dislocation
    - Significant loss of motion or weakness in the myotomes
    - Joint instability
    - Abnormal sensations in either the segmental dermatomes or peripheral cutaneous patterns
    - Absent or weak pulse distal to the injury
    - Any significant, unexplained pain
15. A rehabilitation program should focus on reduction of pain and spasm; restoration of motion and balance; development of strength, endurance, and power; and maintenance of cardiovascular fitness. The patient should have bilateral strength, flexibility, and muscular endurance, as well as an appropriate cardiovascular level, before returning to participation in sport and physical activity. Whenever possible, protective equipment or padding should be used to prevent reinjury.

APPLICATION QUESTIONS

1. A 20-year-old volleyball player reports to the athletic training room complaining of pain in the right arm every time the arm is abducted above 90°. What questions should be asked as part of an injury assessment for this patient? The pain and swelling associated with the condition appear to be confined to the anterior shoulder. In performing the palpation component of the injury assessment, what structures should be palpated and in which order? What specific factors should be noted? Why?
2. A 19-year-old freestyle swimmer reports to the athletic training room with shoulder pain that has been bothersome for the past 2 weeks. Following the history and inspection components of an assessment, you suspect a shoulder impingement injury. What limitations in ROM would be present if the swimmer has a shoulder impingement injury? If the supraspinatus is injured, what special test(s) would confirm the condition?
3. During a match, a high school wrestler falls on an outstretched arm and is in obvious severe pain and discomfort. Your assessment reveals an anterior displacement of the GH joint. How should this condition be managed?
4. A catcher on a high school baseball team complains of sharp shoulder pain when attempting to throw out a runner stealing second base. Palpation elicits pain in the axilla region and mild discomfort in the anterior shoulder region. What injury should be suspected? How might this injury be managed?
5. A 16-year-old gymnast lost her balance on a dismount from the beam and fell on the point of her right shoulder. Observation reveals that the involved shoulder is sagging downward and forward. The gymnast is holding the arm close to her side with the other arm's hand. There is a visible lump in the midclavicular region. What injury should be suspected? How should this injury be managed?
6. A 26-year-old male patient reports to the orthopedic clinic complaining of shoulder pain. He has been playing recreational softball for the past 2 months and his right shoulder feels loose. Pain increases during the

deceleration phase of the throwing motion. As a college football player, he sustained two right shoulder anterior dislocations. The patient has GH instability in addition to a labral tear. How would you differentiate between a Bankart lesion and a SLAP lesion?

7. A soccer player fell on an outstretched arm and is now complaining of pain on the top of the shoulder. It appears that the distal clavicle is somewhat elevated. There is increased pain over the AC joint with horizontal adduction of the arm across the chest and with shoulder flexion. What structures may be involved in this injury? How might you manage this injury?
8. A 20-year-old volleyball player reports to the athletic training room complaining of pain in the right arm every time the arm is abducted above 90°. What questions should be asked to develop a history of the injury? The pain and swelling associated with the condition appear to be confined to the anterior shoulder. In performing the palpation component of the injury assessment, what structures should be palpated and in which order? What specific factors should be noted? Why?
9. A 58-year-old female has participated in badminton competitions in conjunction with the Senior Olympics. A physician diagnosed her with a painful shoulder subsequent to impingement syndrome. The physician has directed you to develop a rehabilitation program for this patient. What priorities will you establish in rehabilitating this injury and returning the patient to full functional status?

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