Basic Athletic Training
Course Pack B

Conditions of the Upper Extremity

SECTION

V

CHAPTER

17

Shoulder Conditions

STUDENT OUTCOMES

1. Identify the major bony and soft-tissue structures of the shoulder.
2. List the major motions at the shoulder and the muscles that produce them.
3. Describe the phases of the throwing motion and list the common injuries sustained during each phase.
4. Explain the general principles used to prevent injuries to the shoulder.
5. Describe a thorough assessment of the shoulder region.
6. List the common mechanisms of injury that can lead to instability in the sternoclavicular, acromioclavicular,

and glenohumeral joints.

7. Describe the common acute injuries and conditions sustained in the shoulder region by physically active patients.
8. Describe the soft-tissue pathology in the shoulder region that results from overuse.
9. Explain the management strategies for common injuries and conditions of the shoulder.
10. Explain general principles and techniques used in developing a rehabilitation exercise program for the shoulder complex.

INTRODUCTION

The loose structure of the shoulder complex enables extreme mobility but provides little stability. As a result, the shoulder is much more prone to injury compared to the hip. Common shoulder injuries include dislocations, clavicular fractures, muscle and tendon strains, rotator cuff tears, acromioclavicular (AC) sprains, bursitis, bicipital tendonitis, and impingement syndrome. Shoulder injuries commonly occur during activities involving an overhead motion, such as baseball, swimming, tennis, volleyball, and weight lifting.[1] In fact, shoulder pain is the most common musculoskeletal complaint among competitive swimmers and volleyball players, affecting 40% to 70% of swimmers and approximately 60% of volleyball players.[2,3] Dislocations of the shoulder articulations are not uncommon in contact sports, such as wrestling and football.[4,5]

This chapter begins with a review of the anatomy of the shoulder region, followed by a synopsis of the kinematics and kinetics of the shoulder joints. A discussion regarding prevention of injuries is followed by the assessment process. An overview of common injuries to the shoulder complex is presented as well as management of specific injuries. Examples of rehabilitation exercises then conclude the chapter.

ANATOMY OF THE SHOULDER

The arm articulates with the trunk at the shoulder, or pectoral girdle, which comprises the scapula and clavicle (Figs. 17.1 and 17.2). The shoulder region has five separate articulations:

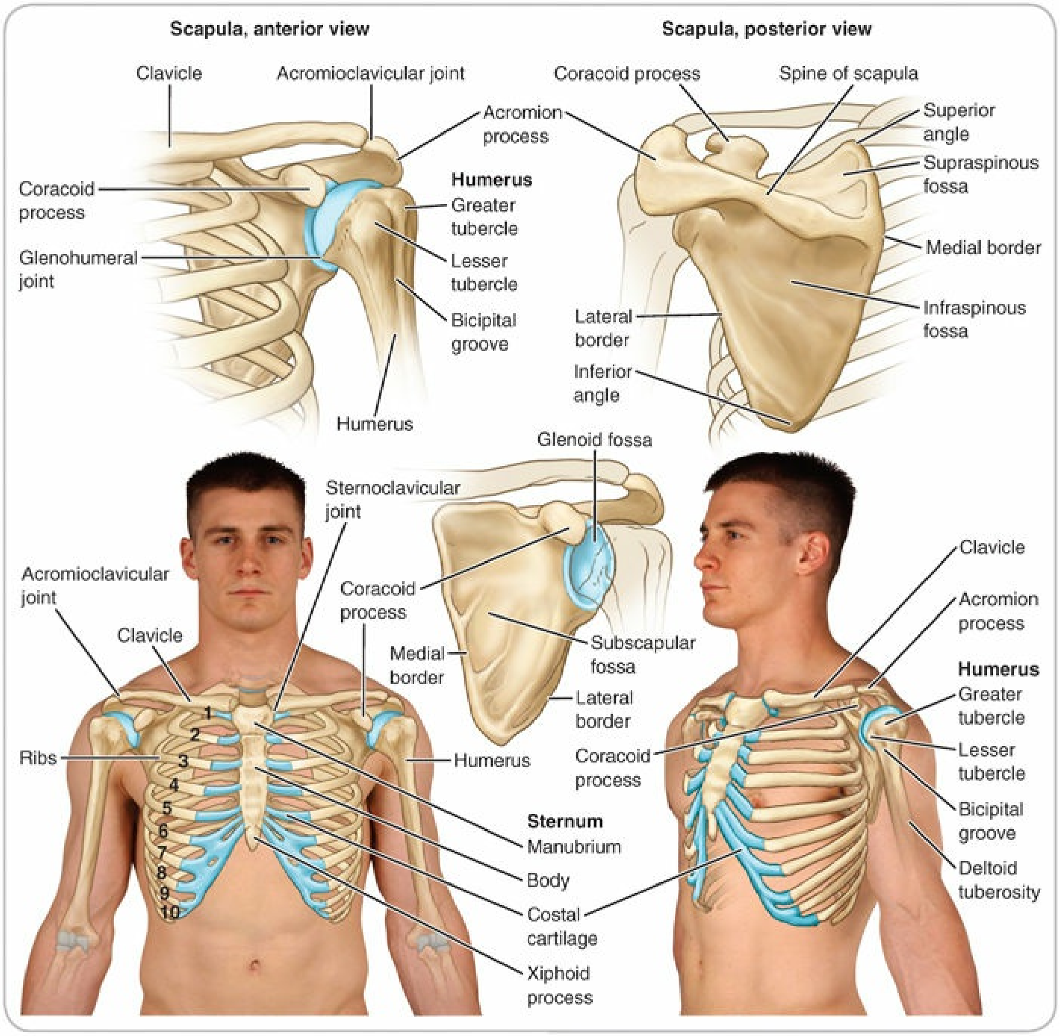

Figure 17.1. Skeletal features of the shoulder and chest.

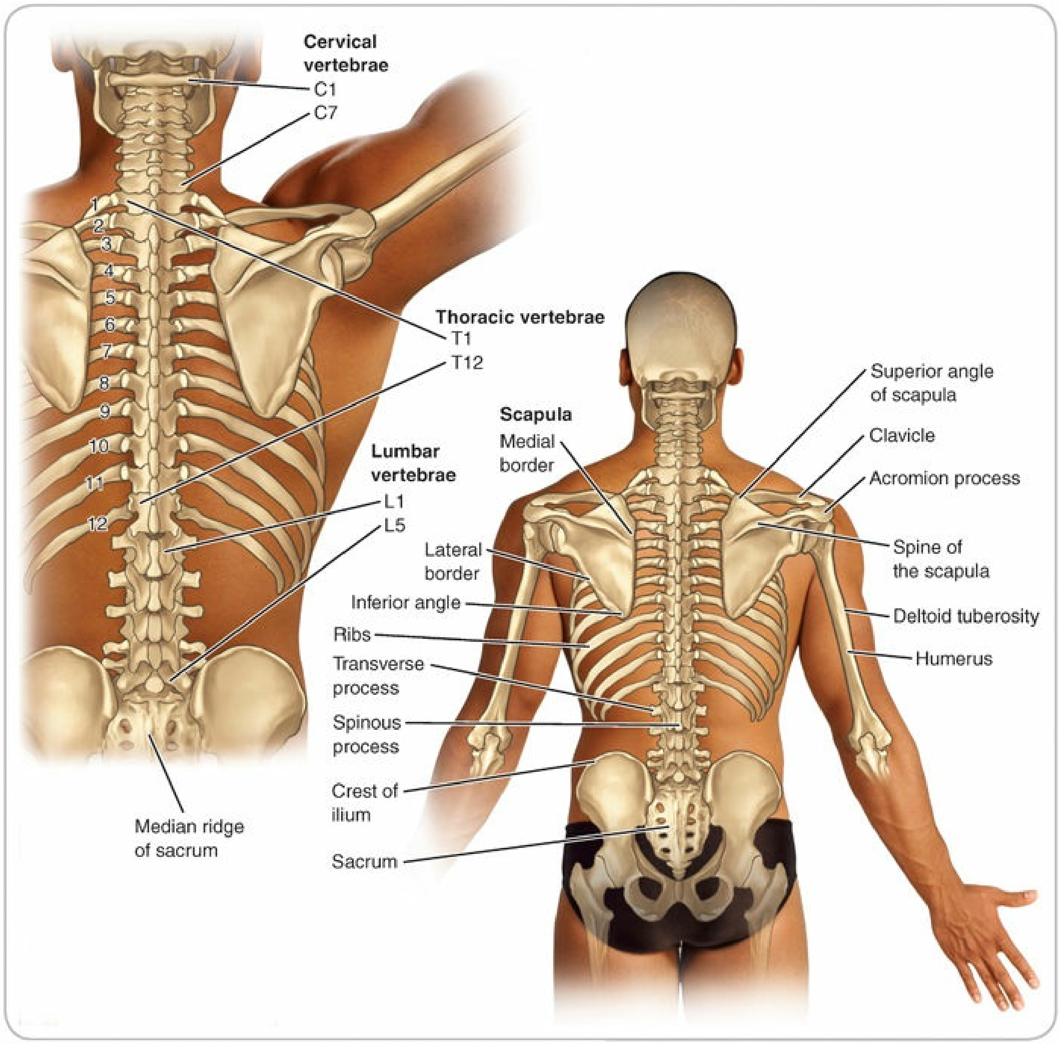

Figure 17.2. Skeletal features of the shoulder and upper back.

1. The sternoclavicular (SC) joint
2. The AC joint
3. The coracoclavicular joint
4. The glenohumeral (GH) joint
5. The scapulothoracic joint

The articulation referred to specifically as the shoulder joint is the GH joint; the remaining articulations are collectively referred to as the shoulder girdle. The SC and AC joints enhance motion of the clavicle and scapula, enabling the GH joint to provide a greater range of motion (ROM).

Sternoclavicular Joint

As the name suggests, the SC joint consists of the articulation of the superior sternum, or manubrium, with the proximal clavicle. The SC joint is surrounded by a joint capsule that is thickened anteriorly and posteriorly by four ligaments, including the interclavicular, costoclavicular, and anterior and posterior SC ligaments (Fig. 17.3). The anterior SC ligament is a broad band supporting the anterior capsule, whereas the posterior SC ligament is smaller and weaker, providing support to the posterior capsule. The costoclavicular ligament runs from the clavicle to the 1st rib and its adjacent cartilage. The interclavicular ligament provides minimal support to the joint, runs between the two SC joints, and attaches to the manubrium. A substantial fibrocartilaginous disk is found between the manubrium and clavicle, which divides the joint almost completely in half. Because of its attachments, the disk adds significant strength to the joint and, in doing so, prevents medial displacement of the clavicle.

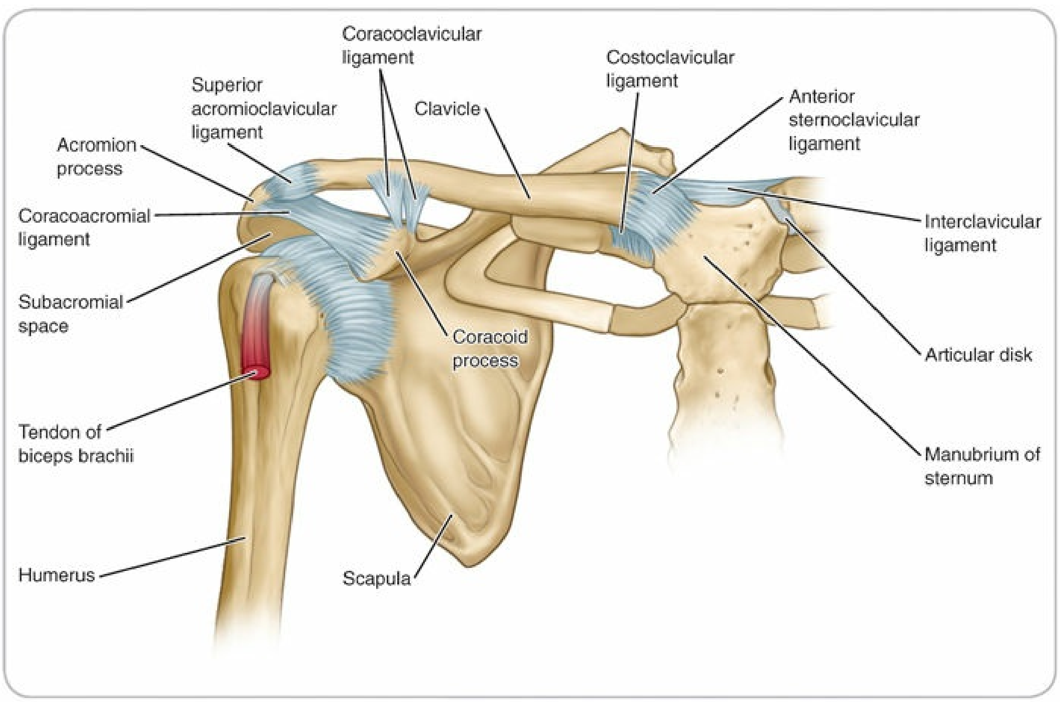

Figure 17.3. Ligaments of the shoulder girdle.

The SC joint enables rotation of the clavicle with respect to the sternum. The joint allows motion of the distal clavicle in superior, inferior, anterior, and posterior directions, along with some forward and backward rotation of the clavicle. As such, rotation occurs at the SC joint during motions such as shrugging the shoulders, reaching above the head, and most throwing-type activities. Because the 1st rib is joined by its cartilage to the manubrium just inferior to the joint, motion of the clavicle in the inferior direction is restricted.

The close-packed position for the SC joint occurs with maximal shoulder elevation. Although SC joint dislocations are uncommon, rapid diagnosis and treatment of posterior SC joint dislocations are important because of the proximity of the displaced medial clavicle to the great vessels.[6]

Acromioclavicular Joint

The AC joint consists of the articulation of the medial facet of the acromion process of the scapula with the distal clavicle (**Fig. 17.3**). As an irregular, diarthrodial joint, limited motion is permitted in all three planes. Highly variable in structure, as many as three different morphological types of AC joint have been identified.[7] The joint is enclosed by a capsule, although the capsule is thinner than that of the SC joint. The strong superior and inferior AC ligaments cross the joint, providing stability. The coracoacromial ligament also attaches to the inferior lip of the AC joint to serve as a buffer between the rotator cuff muscles and the bony acromion process. This ligament is sometimes referred to as the “arch” ligament.

The close-packed position of the AC joint occurs when the humerus is abducted at 90°. Injuries to the AC joint account for nearly half of all athletic shoulder injuries, typically resulting from the force of a fall being absorbed by the shoulder when the arm is in adduction.[8]

Coracoclavicular Joint

The coracoclavicular joint is a syndesmosis in which the coracoid process of the scapula and the inferior surface of the clavicle are joined by the coracoclavicular ligament (**Fig. 17.3**). The coracoclavicular ligament, with its conoid and trapezoid branches, resists independent upward movement of the clavicle, downward movement of the scapula, and anteroposterior movement of the clavicle or scapula. Minimal movement is permitted at this joint. The coracoclavicular ligaments frequently are ruptured during contact sports, such as football, hockey, and rugby.[9]

Glenohumeral Joint

The GH joint is the articulation between the glenoid fossa of the scapula and the head of the humerus. Although the joint enables a greater total ROM than any other joint in the human body, it lacks bony stability. This partially results from the hemispheric head of the humerus, which has three- to fourfold the surface area as compared to the shallow glenoid fossa. Because the glenoid fossa also is less curved than the humeral head, the humerus not only rotates but also moves linearly across the surface of the glenoid fossa when humeral motion occurs. Humeral head translation is limited by muscle tension, which also limits rotation, during active positioning of the arm. The largest translations take place during passive movement of the arm at the extremes of the ROM.

The glenoid fossa is somewhat deepened around its perimeter by the glenoid labrum, a narrow rim of fibrocartilage around the edge of the fossa. The GH joint capsule is joined by the superior, middle, and inferior GH ligaments on the anterior side and by the coracohumeral ligament on the superior side (**Fig. 17.4**). Although joint displacements can occur in anterior, posterior, and inferior directions, the strong coracohumeral ligament protects against superior dislocations. The inferior GH ligament is the thickest of the ligaments and reinforces the inferior capsule. It is the main static stabilizer in the abducted arm.

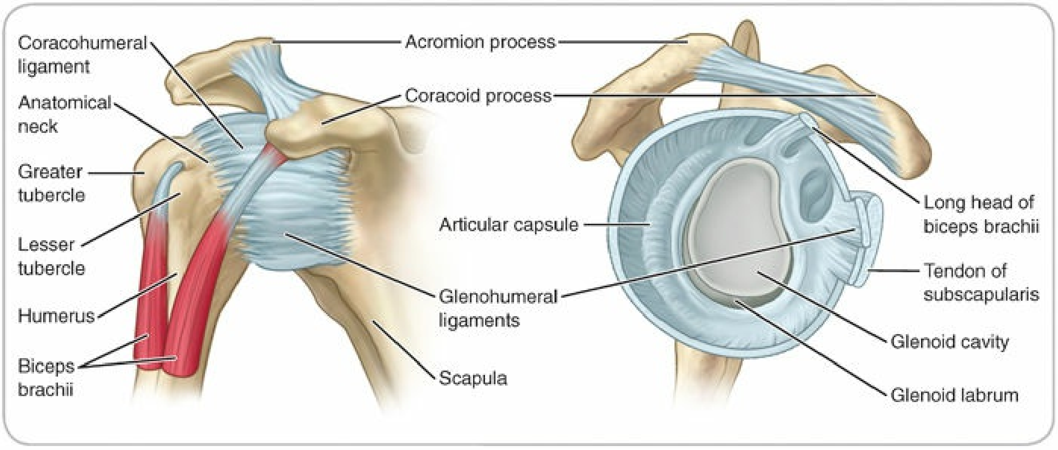

Figure 17.4. Ligaments of the glenohumeral joint.

The tendons of four muscles, including the supraspinatus, infraspinatus, teres minor, and subscapularis, also join the joint capsule. These muscles, which are referred to as the SITS muscles, after the first letter of each muscle's name, also are known as the rotator cuff muscles, both because they act to rotate the humerus and because their tendons merge to form a collagenous cuff around the joint. Tension in the rotator cuff muscles helps to hold the head of the humerus against the glenoid fossa, further contributing to joint stability. The joint is most stable in its close-packed position when the humerus is abducted and laterally rotated.

Scapulothoracic Joint

Because a muscle attaching to the scapula permits its motion with respect to the trunk or thorax, this region sometimes is described as the scapulothoracic joint. Muscles attaching to the scapula include the levator scapula, rhomboids, serratus anterior, pectoralis minor, subclavius, deltoid, subscapularis, supraspinatus, infraspinatus, teres major, teres minor, coracobrachialis, short head of the biceps brachii, long head of the triceps brachii, and the trapezius.

The scapular muscles perform two functions. The first is stabilization of the shoulder region. For example, when a barbell is lifted from the floor, the levator scapula, trapezius, and rhomboids develop tension to support the scapula and, in turn, the entire shoulder through the AC joint. The second is to facilitate movement of the upper extremity through appropriate positioning of the GH joint. For example, during an overhand throw, the rhomboids contract to move the entire shoulder posteriorly as the arm and hand move backward during the preparatory phase. As the arm and hand then move forward to execute the throw, tension in the rhomboids is released to permit forward movement of the shoulder, enabling medial rotation of the humerus. Abduction of the arm at the GH joint is facilitated by rotation of the scapula.

A detailed table providing the **muscles of the shoulder, including each muscle's proximal attachment, distal attachment, primary actions, and nerve innervation**, is available on the companion Web site at thePoint.

Muscles of the Shoulder

A large number of muscles cross the GH joint (Figs. 17.5 and 17.6). Because of the large ROM at the shoulder, however, the action produced by contraction of a given muscle can change with the orientation of the humerus, which complicates the process of identifying the actions of these muscles.

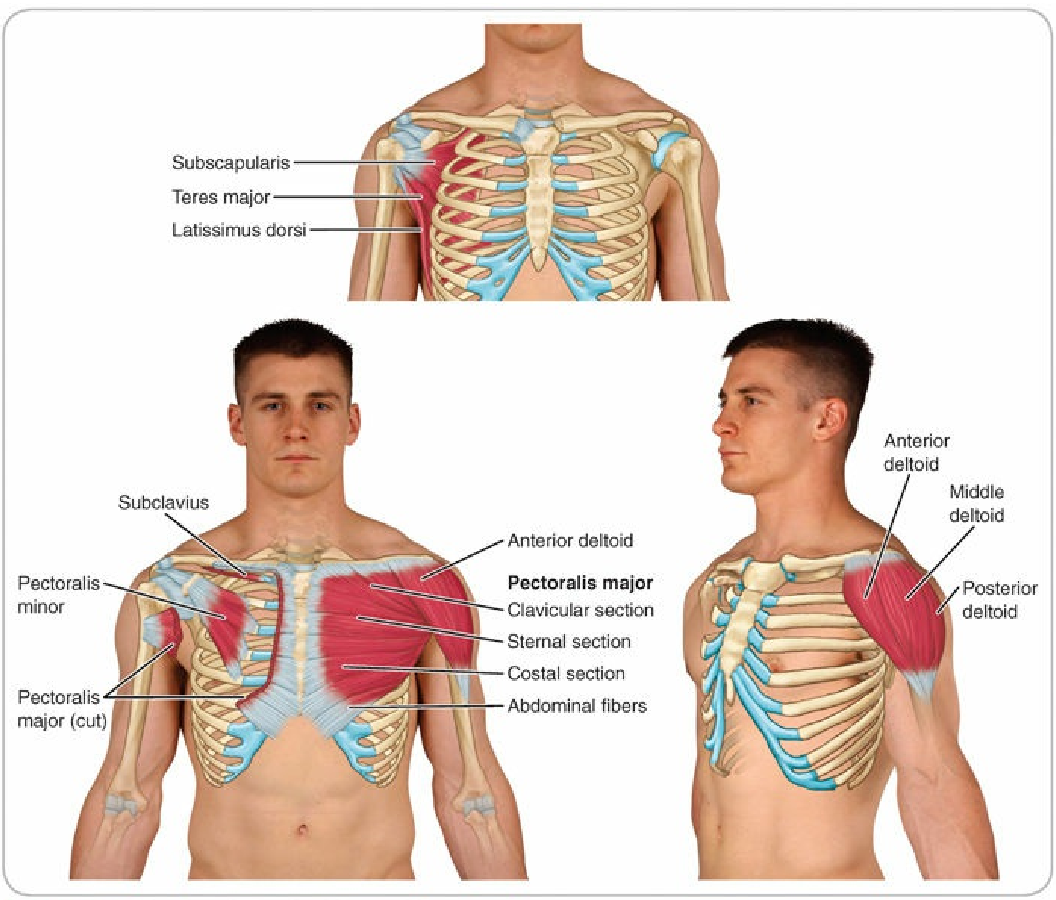

Figure 17.5. Muscles of the shoulder and chest.

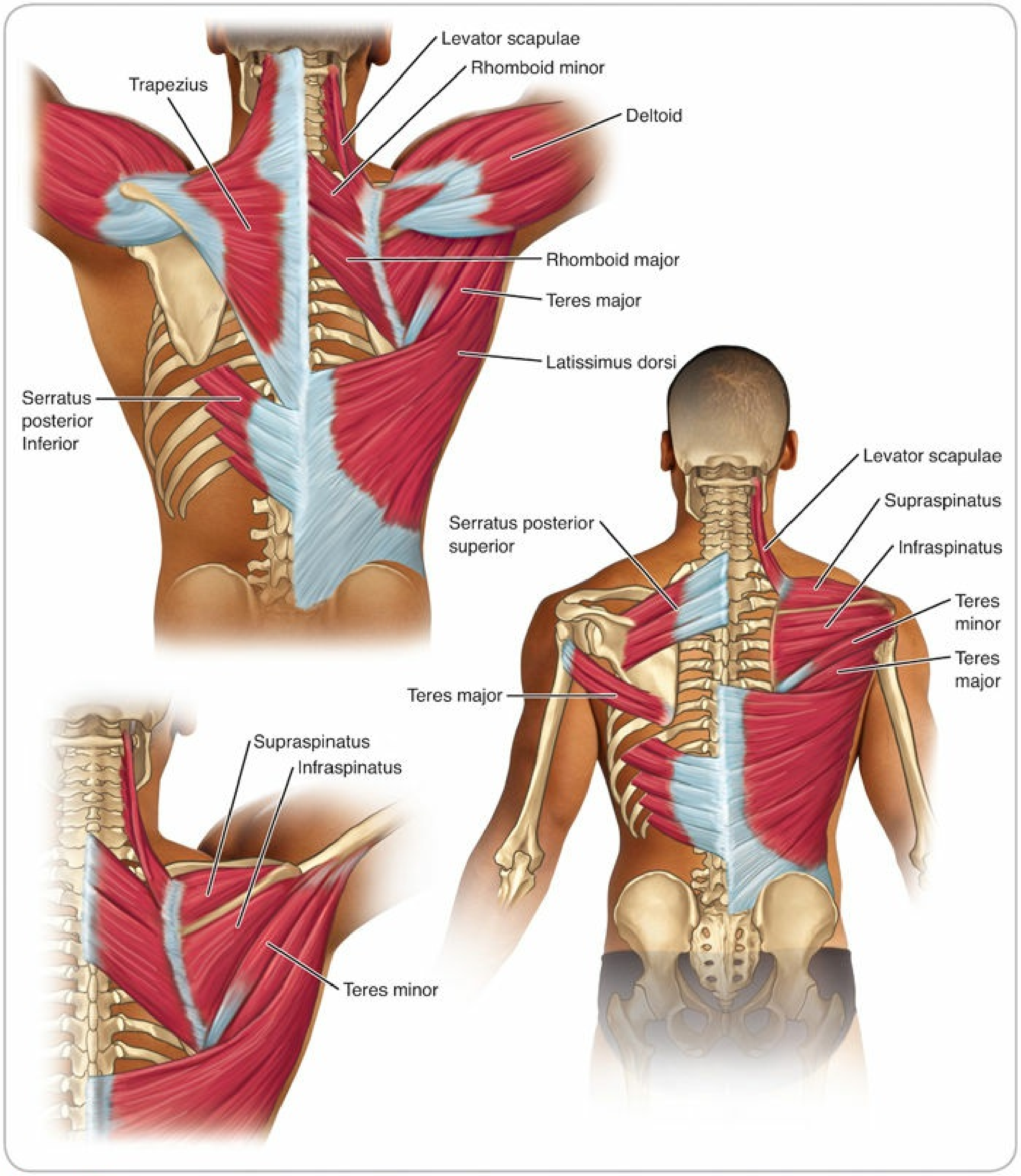

Figure 17.6. Muscles of the shoulder and upper back.

Bursae

The shoulder is surrounded by several bursae, including the subcoracoid, the subscapularis, and the most important, the subacromial. The subacromial bursa lies in the subacromial space, where it is surrounded by the acromion process of the scapula and the coracoacromial ligament above and the GH joint below (Fig. 17.5). The bursa cushions the rotator cuff muscles, particularly the supraspinatus, from the overlying bony acromion, and it provides the major component of the subacromial gliding mechanism. This bursa is supplied with free nerve endings, Ruffini endings, and Pacinian corpuscles and can become irritated when repeatedly compressed during overhead arm action.

Nerves of the Shoulder

Innervation of the upper extremity arises from the brachial plexus, branching primarily from the lower four cervical (C5–C8) and first thoracic (T1) spinal nerves (see **Fig. 21.9**). The brachial plexus is positioned between the anterior scalene and middle scalene muscles in approximately 60% of patients, with the C5 and/or C6 nerves coursing through or lying anterior to the anterior scalene in others. The ventral rami of these nerves divide into upper, middle, and lower trunks, which in turn separate into anterior and posterior divisions and then divide into lateral, medial, and posterior cords (see Chapter 21). This network of nerves passes between the clavicle and 1st rib at a distance approximately one-third of the length of the clavicle proximal to the GH joint. Injuries to the clavicle in this region can damage the brachial plexus. Major nerves arising from the brachial plexus that supply the shoulder region are the axillary (C5, C6), musculocutaneous (C5 through C7), dorsal scapular (C5), subscapular (C5, C6), suprascapular (C5, C6), and pectoral nerves (C5 through T1).

Blood Vessels of the Shoulder

The subclavian artery passes beneath the clavicle to become the axillary artery, which provides the major blood supply to the shoulder (**Fig. 17.7**). Branches of the axillary artery include the thoracoacromial trunk, lateral thoracic artery, subscapular artery, and thoracodorsal artery as well as the anterior and posterior humeral circumflex arteries that supply the head of the humerus.

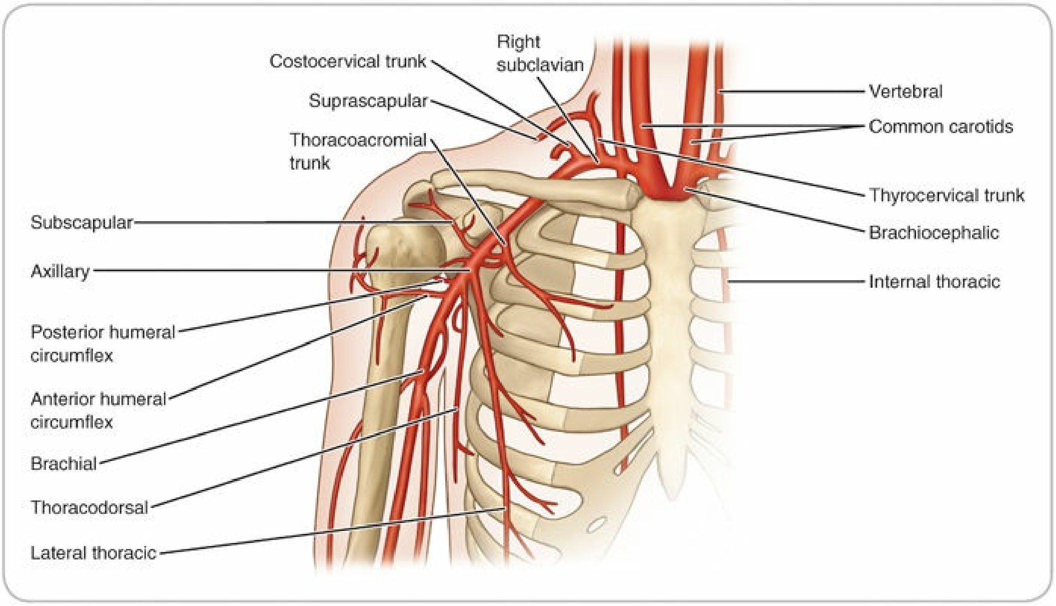

Figure 17.7. **Blood supply to the shoulder.**

KINEMATICS AND MAJOR MUSCLE ACTIONS OF THE SHOULDER COMPLEX

The shoulder is the most freely movable joint in the body, with motion capability in all three planes (Fig. 17.8). Sagittal plane movements at the shoulder include flexion (i.e., elevation of the arm in an anterior direction), extension (i.e., return of the arm from a position of flexion to the side of the body), and hyperextension (i.e., elevation of the arm in a posterior direction). Frontal plane movements include abduction (i.e., elevation of the arm in a lateral direction) and adduction (i.e., return of the arm from a position of abduction to the side of the body). Transverse plane movements include horizontal adduction (i.e., a horizontally extended arm is moved medially) and horizontal abduction (i.e., a horizontally extended arm is moved laterally). The humerus also can rotate medially (i.e., the anterior face of the humerus is moved medially) and laterally (i.e., the anterior face of the humerus is moved laterally). Elevation of the humerus in all planes is facilitated by a coordinated and consistent scapular rotation.[10]

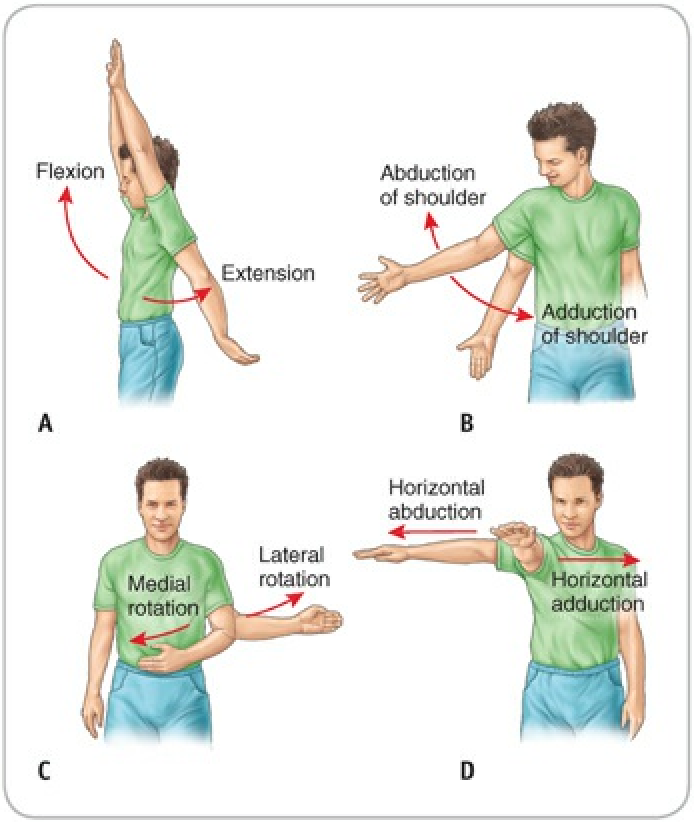

Figure 17.8. Movements of the arm at the shoulder. A, Flexion and extension. **B,** Abduction and adduction. **C,** Internal and external rotation. **D,** Horizontal abduction and adduction.

Throwing

Throwing and related motions can produce a variety of both acute and chronic injuries to the shoulder. Throwing styles vary from patient to patient, even across overarm, sidearm, and underarm styles of the throw. Further complicating matters, some sport skills—casually referred to as throwing—actually involve more of a pushing motion than a throwing motion. An exampleis putting the shot. Nevertheless, overarm throwing can be described in distinct phases (Table 17.1).

TABLE 17.1 Phases and Injuries of the Throwing Motion

PHASE	DESCRIPTION	COMMON INJURIES
Windup phase	From the first movement until the hands separate. The arms begin with a downward swing and then are raised overhead (gathered position). The shoulders and hips rotate as the arms go overhead; the body shifts from facing the target to being perpendicular to the line of throw. Balance is maintained on the "stance leg" as the lead leg or "stride leg" lifts up; the hip and knee flex at about the chest-high level.	—
Stride phase	From hand separation until the lead foot contacts the ground	—
Cocking phase	From foot contact until maximum shoulder external rotation	Anterior GH instability or subluxation Anteroinferior glenoid labral tears AC joint pathology Subacromial bursitis Strain to the medial rotators (i.e., pectoralis major and latissimus dorsi), biceps brachii, and triceps brachii Thoracic outlet syndrome
Acceleration phase	From maximum shoulder external rotation until ball release	Anterior subluxation Rotator cuff tendinitis or partial tears Subacromial bursitis Proximal humeral apophysitis Glenoid labral pathology Strain to the anterior deltoid, pectoralis major, subscapularis, or latissimus dorsi Bicipital tendinitis or biceps tendon subluxation
Deceleration and follow-through phase	From ball release until maximum shoulder internal rotation and balanced position is achieved	Rotator cuff tendinitis or partial tears Triceps tendinitis Biceps tendinitis or rupture Teres minor strain Posterior GH subluxation Posterior capsulitis Glenoid labral pathology AC joint pathology

Although skillful throwing involves the coordinated action of the entire body, this description focuses on the phases in which potential injury to the shoulder girdle and GH joint may occur. In the preparatory or cocking phase, the arm and hand are drawn behind the body through approximately 90° of abduction and 15° of horizontal abduction at the shoulder, accompanied by maximal external rotation of the humerus (170° to 180°), and shoulder distractive forces of 80% to 120% body weight are generated.[11] The combined motion causes heavy eccentric loading of the horizontal adductors and internal rotators of the shoulder. In particular, the subscapularis has its peak eccentric activity during the late cocking phase and serves to protect the anterior joint, which is under extreme tension. The pectoralis major and latissimus dorsi work eccentrically with the subscapularis to further protect the joint. This arm motion is facilitated by the action of the rhomboids contracting concentrically to pull the scapula and GH joint posteriorly, whereas the serratus anterior provides additional scapular stabilization. As the shoulder proceeds into horizontal abduction and external rotation, the humeral head tends to sublux, first posteriorly and then anteriorly, against the anterior capsule; consequently, tendinitis of the anterior muscle tendons is quite common.[12,13] Elbow extension begins just before maximal shoulder external rotation. This is immediately followed by the onset of humeral internal rotation.

During the acceleration or delivery phase, the ball is brought forward and released. Humeral horizontal adduction, elbow extension, and rapid internal rotation of the humerus at velocities that can exceed 7,000 deg/sec are produced by the pectoralis major, latissimus dorsi, and subscapularis and are coupled with relaxation of the rhomboids to enable anterior movement of the GH joint.[13] If the internal rotators are weak, however, the reduced ability to provide forceful arm depression can lead to increased external rotation, superior humeral migration, and impaired scapular rotation, which can cause or aggravate an impingement syndrome. During ball release, the elbow is almost fully extended and positioned slightly anterior to the trunk. Because throwing can involve a whip-like action of the arm, large stresses can be placed on the tendons, ligaments, and epiphyses of the throwing arm during delivery.[12]

Arm deceleration occurs after ball release and continues until maximal shoulder internal rotation occurs, and it consists primarily of a snap-like flexion of the wrist and pronation of the forearm. Large eccentric loads at the elbow and shoulder decelerate the arm. The infraspinatus, supraspinatus, teres major and minor, latissimus dorsi, and posterior deltoid play major roles in resisting shoulder distraction and anterior subluxation forces. If the rotator cuff muscles are weak, fatigued, or injured, the humeral head distracts and translates in an anterior direction, leading to stress on the posterior capsule. The serratus anterior contracts either concentrically or isometrically to decelerate scapular protraction and it is assisted by the middle trapezius and rhomboids. Injuries common to the specific phases of throwing are listed in **Table 17.1**.

Coordination of Shoulder Movements

The extensive ROM afforded by the shoulder results in part from the loose structure of the GH joint and in part from the proximity of the other shoulder articulations and the movement capabilities they provide. Movement at the shoulder typically involves some rotation at the SC, AC, and GH joints. For example, as the arm is elevated past 30° of abduction, or the first 45° to 60° of flexion, the scapula also rotates, contributing approximately one-third of the total rotational movement of the humerus. This important coordination of scapular and humeral movements, known as scapulohumeral rhythm, enables a much greater ROM at the shoulder than would occur if the scapula were fixed (Fig. 17.9). Also contributing to the first 90° of humeral elevation is the elevation of the clavicle through approximately 35° to 45° of motion at the SC joint. The AC joint contributes to overall movement capability as well, with rotation occurring during the first 30° of humeral elevation and then again as the arm is moved past 135°.[14]

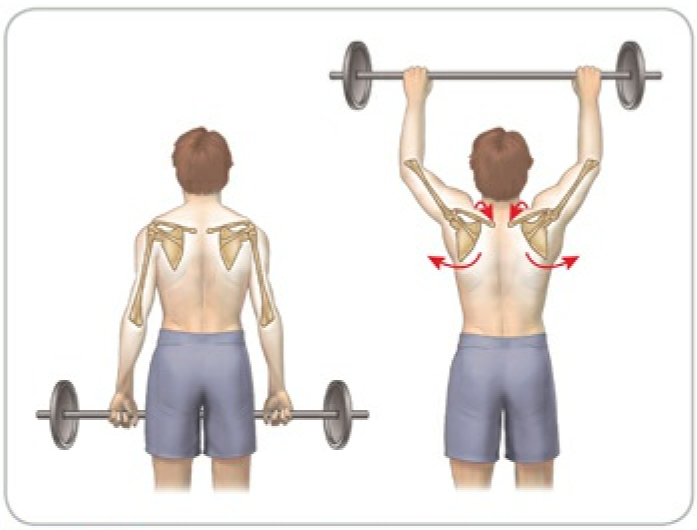

Figure 17.9. Scapulohumeral rhythm. The coordinated movement of the scapula needed to facilitate motion of the humerus is known as scapulohumeral rhythm. The arrows indicate the direction in which the scapulae must rotate to raise the arms.

Glenohumeral Flexion

The muscles that cross the GH joint anteriorly are positioned to contribute to flexion (Figs. 17.5 and 17.6). The anterior deltoid and clavicular pectoralis major are the primary shoulder flexors; the coracobrachialis and short head of the biceps brachii provide assistance. Because the biceps brachii also crosses the elbow joint, it is capable of exerting more force at the shoulder when the elbow is in full extension.

Glenohumeral Extension

When extension is not resisted, the action is caused by gravity. Eccentric contraction of the flexor muscles serves as a controlling or braking mechanism. When resistance to extension is offered, the posterior GH muscles, including the sternocostal pectoralis, latissimus dorsi, and teres major, act with assistance from the posterior deltoid and long head of the triceps brachii (**Figs. 17.5** and **17.6**).

Glenohumeral Abduction

The muscles superior to the GH joint produce abduction and include the middle deltoid and supraspinatus (**Fig. 17.5**). During the contribution of the middle deltoid, from approximately 90° through 180° of abduction, the infraspinatus, subscapularis, and teres minor produce inferiorly directed force to neutralize the superiorly directed, dislocating force produced by the middle deltoid. This action serves an important function in preventing impingement of the supraspinatus and subacromial bursa. The long head of the biceps brachii provides GH stability during abduction.

Glenohumeral Adduction

As with extension, adduction in the absence of resistance results from gravitational force, with the abductors controlling the speed of motion. When resistance is present, adduction is accomplished through the action of the muscles positioned on the inferior side of the GH joint, including the latissimus dorsi, teres major, and sternocostal pectoralis (**Fig. 17.5**). The short head of the biceps and long head of the triceps contribute minor assistance. When the arm is elevated above 90°, the coracobrachialis and subscapularis also assist.

Lateral and Medial Rotation of the Humerus

Lateral rotators of the humerus lie on the posterior aspect of the humerus, including the infraspinatus and teres minor; the posterior deltoid provides assistance. Muscles on the anterior side of the humerus contribute to medial rotation; these include the subscapularis and teres major, with assistance from the pectoralis major, anterior deltoid, latissimus dorsi, and short head of the biceps (Fig. 17.5). Table 17.2 summarizes the primary muscles that act on the arm.

TABLE 17.2 Primary Muscles Producing Movement at the Glenohumeral Joint

FLEXION	EXTENSION	ABDUCTION	ADDUCTION	MEDIAL ROTATION	LATERAL ROTATION
Anterior deltoid	Latissimus dorsi	Middle deltoid	Latissimus dorsi	Subscapularis	Infraspinatus
Pectoralis major (clavicular)	Pectoralis major (sternal)	Supraspinatus	Pectoralis major (sternal)	Teres major	Teres major
	Teres major		Teres major		

KINETICS OF THE SHOULDER

Although the articulations of the shoulder girdle are interconnected, the GH joint sustains much greater loads compared to the other shoulder joints, primarily because the GH joint provides mechanical support for the entire arm. Although the weight of the arm is only approximately 9% of body weight, the length of the horizontally extended arm creates large torques that must be countered by the shoulder muscles. When these muscles contract to support the extended arm, large compression forces are generated inside the joint. The compression force acting on the articulating surfaces of the GH joint when the arm is abducted to 90° has been estimated to reach 50% of body weight.[14] This load is reduced by approximately half when the elbow is maximally flexed, but because of the shortened moment arm, the shoulder is considered to be a major load-bearing joint.

During the throwing motion, two critical instances increase the potential for shoulder injury. The first is during the cocking phase, when the arm has not quite reached maximum lateral rotation and a large internal rotation torque develops at the shoulder, heightening the possibility of a glenoid labral tear.

The second occurs just after ball release, when both a large compression force and a large horizontal abduction torque are generated at the shoulder, creating the potential for rotator cuff tension failure and subacromial impingement.[12]

Muscles that attach to the humerus at small angles with respect to the glenoid fossa contribute more to shear than to compression at the joint. These muscles stabilize the humerus in the fossa when the contractions of the powerful muscles that move the humerus might otherwise dislocate the joint. Maximum shear force has been found to be present at the GH joint when the arm is elevated approximately 60°.[14]

PREVENTION OF SHOULDER CONDITIONS

Acute and chronic injuries to the shoulder complex are common in sport participation. Many contact and collision sports require some protective equipment, but in most cases, flexibility, physical conditioning, and proper technique are the primary factors that can reduce the risk of injury to this vulnerable area.

Protective Equipment

Contact and collision sports, such as football, lacrosse, and ice hockey, require shoulder pads to protect exposed bony protuberances from impact (see Chapter 3). Although shoulder pads do prevent some soft-tissue injuries in this region, they do not protect the GH joint from excessive motion. Several other commercial pads and braces that are used to protect the region are illustrated in Chapter 3.

Physical Conditioning

Lack of flexibility can predispose a patient to joint sprains and muscular strains. Warm-up exercises should focus on general joint flexibility and may be performed either alone or with a partner using proprioceptive neuromuscular facilitation (PNF) stretching techniques. Patients using the throwing motion in their sport should increase ROM in external rotation, because this has been shown to increase the velocity of the throwing arm and to decrease shearing forces on the GH joint. Several flexibility exercises for the shoulder complex are demonstrated in Application Strategy 17.1.

APPLICATION STRATEGY 17.1

Flexibility Exercises for the Shoulder Region

1. **Posterior capsular stretch.** Horizontally adduct the arm across the chest while the opposite hand assists the stretch.

2. **Inferior capsular stretch.** Hold the involved arm over the head with the elbow flexed. Use the opposite hand to assist in the stretching. Add a side stretch.

3. **Anterior and posterior capsular stretch.** Hold on to both sides of a doorway with the hands behind the back. Straighten the arms while leaning forward. Repeat with the hands in front while leaning backward.

4. **Medial and lateral rotators.** Using a towel, bat, or racquet, pull the arm to stretch it into lateral rotation. Repeat in medial rotation.

Strengthening programs should focus on muscles acting on both the GH and scapulothoracic regions. Strength in the infraspinatus, teres minor, and posterior shoulder musculature is necessary to

- Begin the cocking phase of throwing
- Fix the shoulder girdle during the acceleration phase
- Provide adequate muscle tension, with eccentric contractions, for smooth deceleration through the follow-through phase

A weakened supraspinatus is present in many chronic shoulder problems, particularly among throwers. Concentric and eccentric contractions with light resistance during the first 30° of abduction can strengthen this muscle. Strengthening the scapular stabilizers can be accomplished by doing push-ups or moving the arm through a resisted, diagonal pattern of external rotation and horizontal abduction. Other strengthening exercises are demonstrated in Application Strategy 17.2.

APPLICATION STRATEGY 17.2

Strengthening Exercises for the Shoulder Complex

1. Shoulder shrugs. Elevate the shoulders toward the ears and hold. Pull the shoulders back, pinch the shoulder blades together, and hold. Relax and repeat.
2. Scapular abduction (protraction). Lift the weight directly upward while also lifting the posterior shoulder from the table. Relax and repeat.
3. Scapular adduction (retraction). Perform bent-over rowing while flexing the elbows. When the end of the motion is reached, pinch the shoulder blades together and hold.
4. Bench press or incline press. Place the hands shoulder-width apart and push the barbell directly above the shoulder joint. This exercise should be performed with a spotter.
5. Bent arm lateral flies, supine position. Keeping the elbows slightly flexed, lift the dumbbells directly over the shoulders. Lower the

dumbbells until they are parallel to the floor and then repeat. An alternate method is to move the dumbbells in a diagonal pattern. In the prone position, the exercise strengthens the trapezius.

6. Lateral pull-downs. In a seated position, grasp the handle and pull the bar behind the head. An alternate method is to pull the bar in front of the body.
7. Surgical tubing. Secure the tubing and then work in diagonal functional patterns similar to those skills experienced in a specific sport/activity.

Proper Skill Technique

Coordinated muscle contractions are necessary for the smooth execution of the throwing motion. Any disruption in the sequencing of integrated movements can lead to additional stress on the GH joint and surrounding soft-tissue structures. High-speed photography, often used to record the mechanics of the throwing motion, can lead to early detection of improper technique. In addition to proper throwing technique, participants in contact and collision sports should be taught the shoulder-roll method of falling rather than falling on an outstretched arm. This technique reduces direct compression of the articular joints and disperses the force over a wider area.

ASSESSMENT OF SHOULDER CONDITIONS

? A collegiate swimmer reports to the athletic training room with anterior pain in the right shoulder. How should the assessment of this injury progress to determine the extent and severity of injury?

The shoulder complex is a complicated region to assess because of the number of important structures that are located in such a small area. Furthermore, the biomechanical demands on each structure during overhead motion are not fully understood, so identification of all injured structures is difficult. As a result, each joint must be methodically assessed to determine any limitation of function. Improper biomechanical skill techniques are a leading cause of many acute and overuse injuries at the shoulder. Assessment of the patient's activity-specific techniques may determine if improper technique contributed to the injury. By correcting minor mechanical flaws in technique and identifying deficits in flexibility and strength, many shoulder injuries can be prevented. It also is important to remember that pain may be referred to the shoulder from the cervical region, heart, spleen, lungs, and other internal organs.

See **Application Strategy: Shoulder Evaluation**, available on the companion Web site at thePoint.

HISTORY

? The injury assessment of the swimmer should begin with a history. What questions need to be asked to identify the cause and extent of this injury?

Questions about a shoulder injury should focus on the current primary complaint, past injuries to the region, and other factors that may have contributed to the current problem (e.g., referred pain, alterations in posture, change in technique, or overuse). Many conditions may be related to family history, age, improper biomechanical execution of skills, and recent changes in training programs. Because the shoulder and upper arm are common sites for referred pain from orthopedic or visceral origins, a complete examination of the cervical spine, thorax, and abdomen may be indicated, particularly when the patient presents a vague history of injury to the shoulder girdle.

The swimmer should be asked questions that address type of pain, changes in training regimen, strokes that are most painful, previous injuries and their treatment, and any medications being taken for the current injury.

See **Application Strategy: Developing a History of the Injury**, available on the companion Web site at thePoint, for specific questions related to the shoulder region.

OBSERVATION AND INSPECTION

? The history reveals a chronic injury. The swimmer reports a feeling of subluxation during the power phase of the crawl and butterfly strokes. The swimmer also complains of an inability to sleep on the right side of the body. Explain the observation component in the ongoing assessment of the swimmer.

On-site (e.g., field or court) assessment may be somewhat limited, because uniforms and protective equipment may obscure the region from observation and assessment. The clinician may need to reach under the protective pads to palpate the region and determine the presence of a possible fracture or major ligament damage. If necessary, the pads could be cut and gently removed to expose the area more fully. When conducting an assessment of an acute injury, the involved area should be inspected for presence of deformity, muscle guarding, bleeding, swelling, bruising, and dysfunction. The patient should be observed for signs of shock and reaction to pain. Following the initial examination, the patient may need to be removed from the on-site location to complete a more comprehensive assessment in the examination room.

When performing an evaluation of chronic or long-term injury, the patient should also be inspected for symmetry, hypertrophy, muscle atrophy, or previous surgical incisions. The affected limb should always be compared to the unaffected limb. The postural examination is an important component of the overall shoulder examination for patients presenting with long-term pain or dysfunction. The postural examination involves looking for faulty posture or congenital abnormalities that could place additional strain on the anatomical structures should be completed. The patient should be viewed from the anterior, lateral, and posterior views. The entire shoulder and arm should be as exposed as possible during the examination. Postural assessment is presented in Chapter 8 and should be reviewed if needed.

Observation of the swimmer should include a postural assessment of the upper body. In addition, the injury site should be inspected for swelling, discoloration, deformity, muscle hypertrophy or atrophy, and other signs of existing or previous trauma.

See **Application Strategy: Postural Assessment of the Shoulder Region**, available on the companion Web site at thePoint, for specific areas in which to focus for this region.

PALPATION

?

Observation of the swimmer reveals slight kyphosis. Otherwise, the patient has no abnormal findings. Explain the palpation for this injury.

Bilateral palpation can determine temperature, swelling, point tenderness, crepitus, deformity, muscle spasm, and cutaneous sensation. Increased skin temperature could indicate inflammation or infection; decreased skin temperature could indicate a reduction in circulation. Swelling should be differentiated between localized, extra-articular swelling and joint effusion. In the shoulder, intra-articular swelling prevents full adduction of the arm against the body. Crepitus may indicate an inflamed subacromial bursa, bicipital tenosynovitis, or irregular articular surface. Vascular pulses can be taken at the radial and ulnar arteries in the wrist, the brachial artery on the medial arm, or the axillary artery in the armpit.

Fractures can be assessed through palpation of pain at the fracture site, compression of the humeral head against the glenoid fossa, compression along the long axis of the humerus, percussion on a specific bony landmark, or use of a tuning fork. If a fracture or dislocation is suspected, circulatory and neural integrity distal to the site should be assessed immediately.

In general, when palpating the shoulder region, the clinician should stand behind the patient to begin bilateral palpation, which should move from proximal to distal. The areas that are anticipated to be most painful should be palpated last. The following structures should be palpated:

Anterior

1. Sternocleidomastoid muscle
2. SC joint, interclavicular ligament, SC ligament, and sternal end of the clavicle
3. Clavicle and costoclavicular ligament
4. AC joint, acromion process, and AC ligament
5. Coracoid process, pectoralis minor, short head of the biceps brachii, and coracoacromial ligament
6. Pectoralis major and anterior deltoid muscle
7. Greater tuberosity and the distal attachments of the supraspinatus, infraspinatus, and teres minor
8. Biceps brachii muscle and tendon. The bicipital groove should be palpated with the arm in external rotation. The lesser tubercle is medial to the groove where the subscapularis is attached.
9. Subacromial bursa and supraspinatus tendon. The arm should be in a position of extension.

Lateral

1. Middle deltoid muscle and greater tubercle
2. GH capsule

Posterior

1. Posterior deltoid and trapezius muscles
2. Spine of the scapula, medial and lateral borders, and inferior angle

3. Rhomboid muscles, latissimus dorsi, serratus anterior, levator scapulae, and scaleni

Bilateral palpation includes bony and soft-tissue structures of the shoulder for point tenderness, swelling deformity, crepitus, sensation, and other signs of trauma.

PHYSICAL EXAMINATION TESTS

Palpation reveals tenderness along the anterior and posterior GH joint. A click is felt during active shoulder abduction and external rotation. What anatomical structures could be involved with this injury, and what injury should be suspected?

The patient should be placed in a comfortable position for the physical examination. Depending on the history, some tests are compulsory, whereas others may be used to confirm or exclude suspected injury or pathology. Caution should be used while moving through the assessment, and bilateral comparison should always be performed.

Functional Tests

The arm and shoulder may act as an open kinetic chain when the hand is free to move or as a closed kinetic chain when the hand is fixed to a relatively immovable object. Depending on the activity-specific skills performed by the patient and when the pain occurs, the components of the kinetic chain can have different effects on the shoulder. The first movements to be performed are active movements.

Active Movements

Active movements may be performed in a seated or prone position. The movements that are expected to be most painful should be performed last.

Because pain frequently is referred from the cervical region into the shoulder, active ROM should be performed initially at the neck. However, cervical spine involvement should be cleared or ruled out through history, inspection, and palpation prior to initiating active ROM. See Chapter 21 for discussion of cervical spine ROM testing. If pain is elicited on active motion at the neck, a full neck evaluation should be completed.

> If findings are significant, and there is a high degree of suspicion of cervical spine involvement, the neck should be immobilized in a cervical collar, and the emergency action plan, including summoning emergency medical services, should be activated.

If no problems are noted during neck movement, the shoulder evaluation should continue. The patient should perform gross movement patterns at the shoulder, and the arms should be viewed from an anterior and a posterior view. When the clinician is standing behind the patient, it is important to note if the scapula and humerus move together in a freely coordinated motion. The scapula should not move until the humerus is elevated to at least 30°.

To facilitate active movement, Apley scratch test can be used to measure gross movement patterns at the shoulder and arm (**Fig. 17.10**). The advantage of these simple tests is that they quickly assess bilateral symmetry in gross motor movements. Any deficit can be easily seen and investigated in further detail.

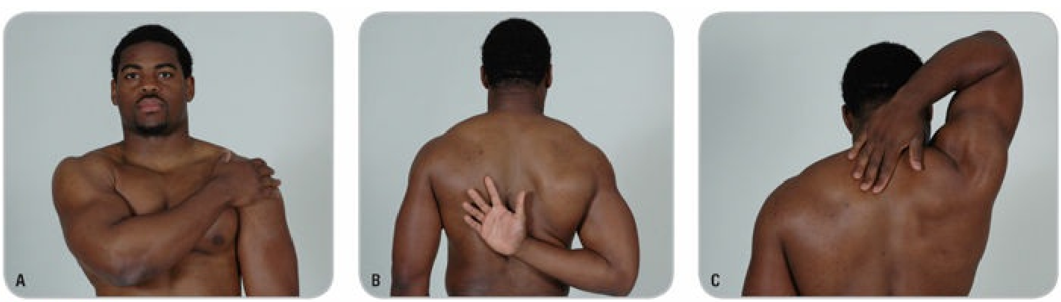

Figure 17.10. **Apley scratch test. A, Medial rotation and adduction.** The patient reaches in front of the head to touch the opposite shoulder. **B, Medial rotation, extension, and adduction.** The patient reaches behind the back to touch the inferior angle of the opposite scapula. **C, Abduction, flexion, and lateral rotation.** The patient reaches behind the head to touch the superior angle of the opposite scapula.

The motions that should be assessed and the normal ROM for each are as follows:

- Shoulder abduction (170° to 180°)

- Shoulder flexion (160° to 180°)
- Shoulder extension (50° to 60°)
- Lateral or external rotation (80° to 90°)
- Medial or internal rotation (60° to 100°)
- Adduction (50° to 70°)
- Horizontal abduction/adduction (130°)
- Upward/downward rotation of the scapula

Goniometry measurements for the GH joint are illustrated in **Figure 17.11**.

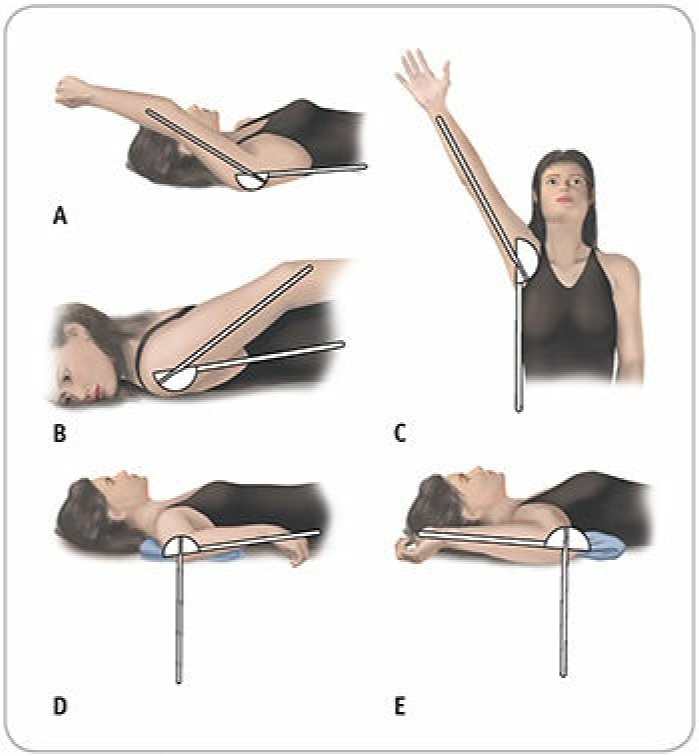

Figure 17.11. Goniometry measurements. A, Shoulder flexion. Align the proximal arm with the midaxillary line of the thorax with the fulcrum close to the acromion process. Align the distal arm along the humerus in line with the lateral epicondyle of the humerus. **B, Shoulder extension.** Use the same landmarks as for shoulder flexion. **C, Shoulder abduction.** The proximal arm is parallel to the midline of the sternum with the fulcrum close to the acromion process. Align the distal arm with the humerus using the medial epicondyle for reference. **D, Lateral rotation.** Flex the elbow at 90° with the fulcrum centered over the olecranon process. The proximal arm is placed perpendicular to the floor, with the distal arm aligned with the olecranon process and ulnar styloid process. **E, Medial rotation.** Use the same landmarks as for lateral rotation.

Passive Range of Motion

If the patient is able to perform full ROM during active movements, gentle pressure should be applied at the extremes of motion to determine end feel. The normal end feels are as follows:

- **Tissue stretch**—shoulder flexion, extension, lateral rotation, medial rotation, abduction, and horizontal abduction
- **Tissue approximation**—shoulder adduction
- **Tissue stretch or approximation**—horizontal adduction of the shoulder

- **Bone-to-bone or tissue stretch**—abduction of the shoulder

Resisted Range of Motion

The hip and trunk should be stabilized during ROM testing to prevent any muscle substitution. This can be achieved through testing the patient in seated, supine, or prone position. The testing begins with the clinician placing the muscle on a stretch. In moving through the various motions, the clinician should apply gentle resistance throughout the full ROM. Motion should be assessed several times to note any weakness or fatigue. A painful arc is a common finding at the shoulder. As such, it is important to assess full ROM and to note if movement through an isolated ROM is particularly painful. Any sudden or jarring motions should be avoided, because this may lead to undue pain. Any lag or muscle weakness should be noted. Muscle actions that may cause extreme pain should be delayed until the final phase of resisted ROM testing. Figure 17.12 demonstrates resisted scapular motions to be tested, and Figure 17.13 demonstrates GH and elbow motions to be tested.

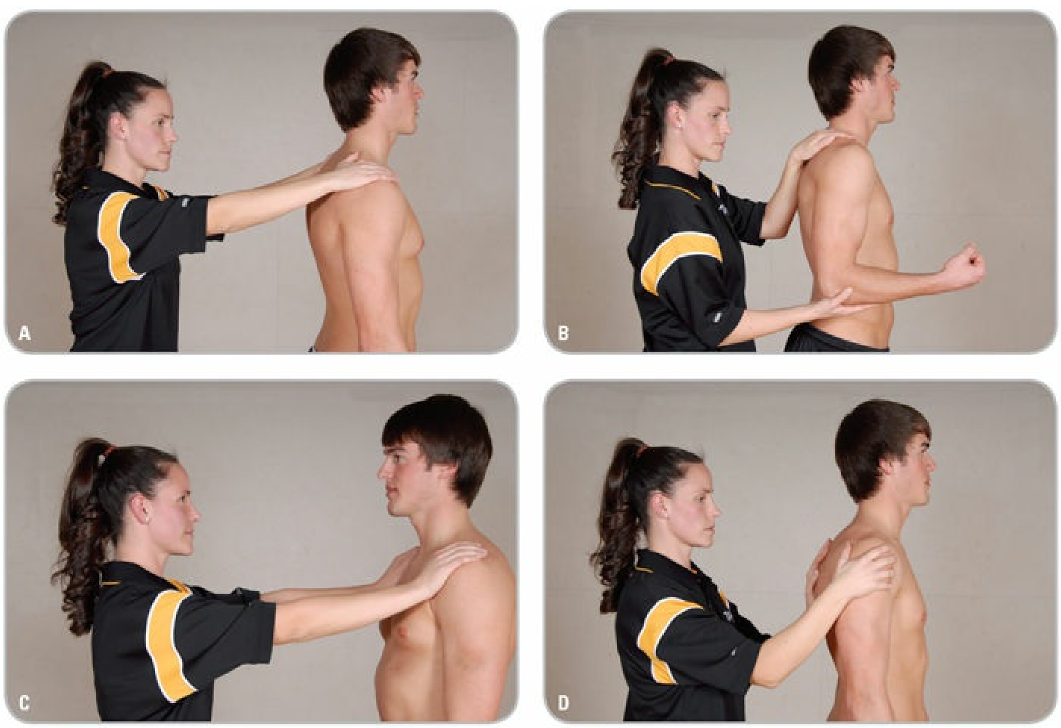

Figure 17.12. **Resisted range of motion testing for the scapula.** Myotomes are listed in parentheses. **A**, Elevation (C4). **B**, Depression. **C**, Protraction. **D**, Retraction.

Figure 17.13. Resisted range of motion testing for the glenohumeral and elbow. Myotomes are listed in parentheses. **A,** Flexion. **B,** Extension. **C,** Abduction (C5). **D,** Adduction. **E,** External or lateral rotation. **F,** Internal or medial rotation. **G,** Elbow flexion (C6). **H,** Elbow extension (C7).

Manual Muscle Testing

If pain or weakness is found during resisted ROM, the clinician may decide to perform a manual muscle test to determine which muscle is damaged. To correctly apply the manual muscle testing techniques to the shoulder complex, the torso must be properly stabilized.[15] See **Table 17.3** for manual muscle testing procedures for the shoulder.

TABLE 17.3 Manual Muscle Testing of Selected Muscles of the Shoulder Complex

MUSCLE	JOINT POSITIONING	APPLY PRESSURE
Coracobrachialis	Patient is seated with forearm supinated, elbow completely flexed, and GH joint laterally rotated.	To the anteromedial surface of the lower one-third of the humerus in the direction of GH extension
Deltoid	Patient is seated with GH abducted to 90° without rotation. Elbow is flexed to 90°.	To the distal end of the humerus on the dorsal surface in the direction of adduction
Anterior deltoid	Patient is seated with GH abducted and slightly flexed with humerus in slight lateral rotation. Elbow is flexed to 90°.	To the anteromedial aspect of humerus in the direction of adduction and slight extension
Posterior deltoid	Patient is seated with GH abducted, in slight extension and slight medial rotation. Elbow is flexed to 90°.	To the posterolateral aspect of the humerus in the direction of adduction and flexion
Upper pectoralis major	Patient is supine, with GH joint in 90° of flexion and slight medial rotation and some adduction. Elbow is fully extended.	To the palmer surface of the forearm in the direction of horizontal abduction
Pectoralis minor	Patient is supine with shoulder protracted.	To the anterior aspect of the humeral head in the direction of retraction or toward the table
Latissimus dorsi	The patient is prone with GH extended and internally rotated so that forearm is in fully pronated. Patient looks away from testing side.	To the forearm in the direction of abduction and flexion
Rhomboid	Patient is prone with GH at 90° of horizontal abduction, elbow fully extended and thumb pointing down. Scapula should be adducted and elevated.	To the ulnar side of the forearm in a downward direction toward the floor
Upper trapezius	Patient is sitting with shoulder elevated and head laterally flexed *toward* testing side but rotated *away* from side being tested.	To the AC joint/top of shoulder in the opposite direction
Supraspinatus	Patient is standing with arm at side and facing away for side being tested.	To the forearm in the direction of adduction as the patient attempts to initiate abduction

For more in depth descriptions and illustrations, see Kendall FP, McCreary EK, Provance PG, et al. *Muscles: Testing and Function with Posture and Pain.* 5th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2005.

Stress Tests

By this point in the assessment, the history, observation, palpation, and functional testing should have established a strong suspicion regarding the structures that may be damaged. In using stress tests, only those tests that are absolutely necessary should be performed (**Table 17.4**). In moving through the various tests, the clinician should begin with gentle stress and apply it several times to note any weakness or instability.