chapter 4

Functional Anatomy of the Shoulder

A comprehensive knowledge of the functional anatomy of the shoulder girdle and all of its component parts is mandatory in understanding arm-shoulder function. The basic function of the shoulder is to place the arm and especially the hand into a functional position that permits manipulative activities (Figure 4.1).

There is a complex neuromuscular pattern involved in the trajectory aspect of placing the hand and fingers where and how they function to accomplish the desired activity. This complex pattern involves numerous muscles for both the static and the kinetic aspects of shoulder function (Figure 4.2).

There are numerous joints in the shoulder complex that must be included in any functional activity of the upper extremity. All joints must be anatomically adequate, well controlled by muscular action, and have adequate sensory feedback (Figure 4.3).

SCAPULOCOSTAL JOINT

The shoulder blade, or the scapula, is the basic structure that supports the arm against the thoracic wall. The scapula is a flattened yet concave bone that articulates against the convex rib cage. It supports the upper extremity, involving the proximal articulation, the glenohumeral joint, which clinically implies the "shoulder joint."

In the dependent-arm position, the scapula is mechanically supported by ligamentous structures between the scapula and the clavicle (Figure 4.4). As the clavicle elevates when the arm is elevated, it would allow the scapula to rotate and elevate the glenoid fossa by only 30 degrees. However, by virtue of the clavicle being in a crank formation and because there is rotation of the clavicle at the sternal joint, the scapula elevates 60 degrees (Figures 4.5, 4.6).

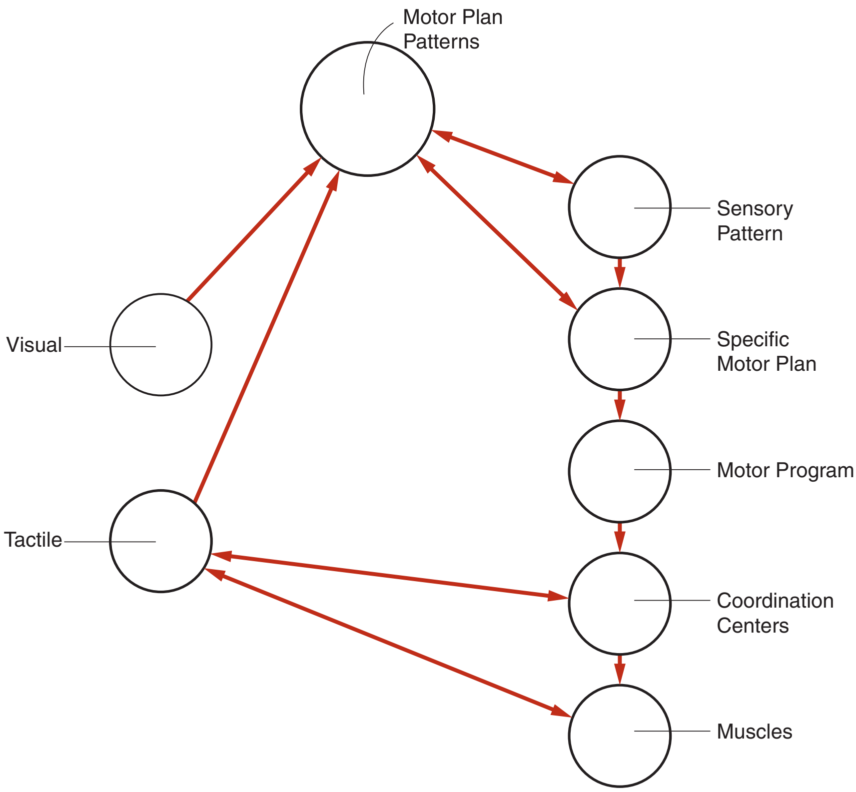

FIGURE 4.1

Functional Model of Hand Motor System General motor plan patterns in cerebral cortex and midbrain, especially cerebellum, initiates specific hand-finger pattern. Motor patterns exist in cortex and cerebellum along with sensory pattern. Motor patterns occur from hand muscles, which are coordinated by central and peripheral coordination centers, including visual and proprioceptive (tactile) responses.

The clavicle centrally rotates about the manubrium sterni, forming the sternoclavicular joint, where it has support on the first rib (Figures 4.7, 4.8).

The acromioclavicular joint at birth (0 to 2 years) is a fibrocartilaginous joint that gradually develops an intra-articular disk that permits motion of rotation, elevation, and descent (Figure 4.9).

Muscles Acting on the Scapula

There are numerous muscles attaching to and from the scapula that are involved in all arm and hand functions. Each merits discussion in interpreting total arm function (Figure 4.10).

The scapula is "held" against the chest wall with isometric muscular contraction supporting the arm. The major support muscles are the trapezius and the anterior serratus, which are also scapular rotators (Figure 4.11). The rhomboid muscles also rotate the scapula as well as act as supporters (Figure 4.12).

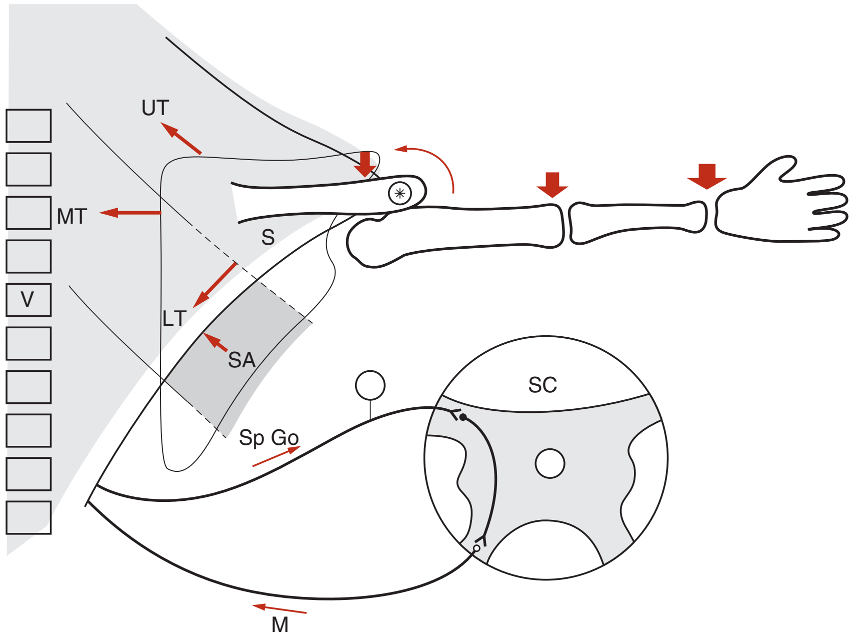

FIGURE 4.2

Complex Neuromuscular Trajectory of Upper Extremity In trajectory phase of upper extremity, when one places hand and fingers in their functional position, scapular muscles—upper trapezius (UT), middle trapezius (MT), lower trapezius (LT), and anterior serratus (SA)—sustain scapula (S) with isometric contraction to support upper extremity (large arrows). Weight depends on distance of object from scapula. All neuromuscular aspects are determined by spindle system (Sp) and Golgi (Go) apparatus "reporting" to spinal cord (SC), with resultant afferent impulses causing appropriate muscular (M) contraction. V indicates vertebra.

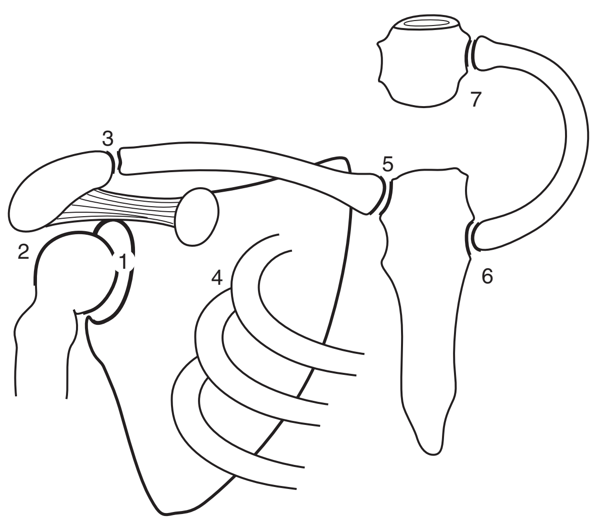

FIGURE 4.3

Joints of Shoulder Girdle Joints comprising shoulder girdle include glenohumeral (1), suprahumeral (2), acromioclavicular (3), scapulocostal (4), sternoclavicular (5), sternocostal (6), and costovertebral (7).

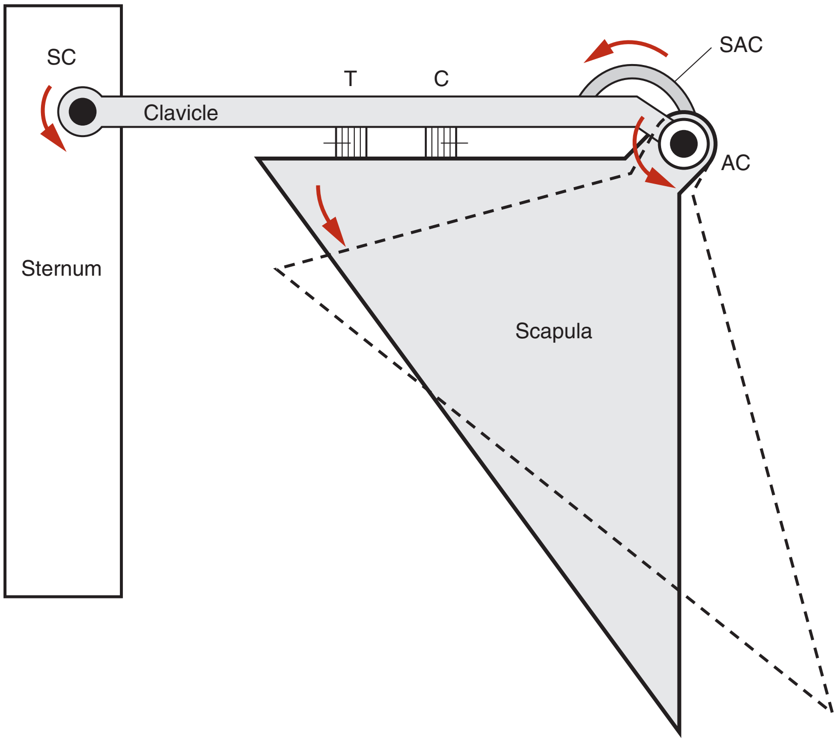

FIGURE 4.4

Static Support of Scapula by Claviculoscapular Ligaments Clavicle acts as a strut from sternum at sternoclavicular joint (SC). Scapula articulates on end of clavicle at acromioclavicular joint (AC). By its eccentric weight, scapula should mechanically rotate about this AC joint (dotted lines on scapula) except for restraint by claviculoscapular trapezium (T) and conoid (C) ligaments. Superior acromioclavicular ligament (SAC) assists and replaces support of other ligaments when they are severed by any trauma.

While the scapula statically maintains the upper extremity, it also functions in coordinated action with the remainder of the arm when the upper extremity performs its function or functions (Figure 4.13). One of its primary functions is to place the glenoid fossa and the acromion in their proper position during any movement of the humerus. The glenoid fossa is at the superior lateral aspect of the scapula under the acromion and lateral to the coracoid process. The glenoid fossa is a pear-shaped shallow depression, which is made deeper by a fibrous labrum that encircles the fossa (Figure 4.14). It normally faces up and out when the scapula is physiologically centered (Figure 4.15).

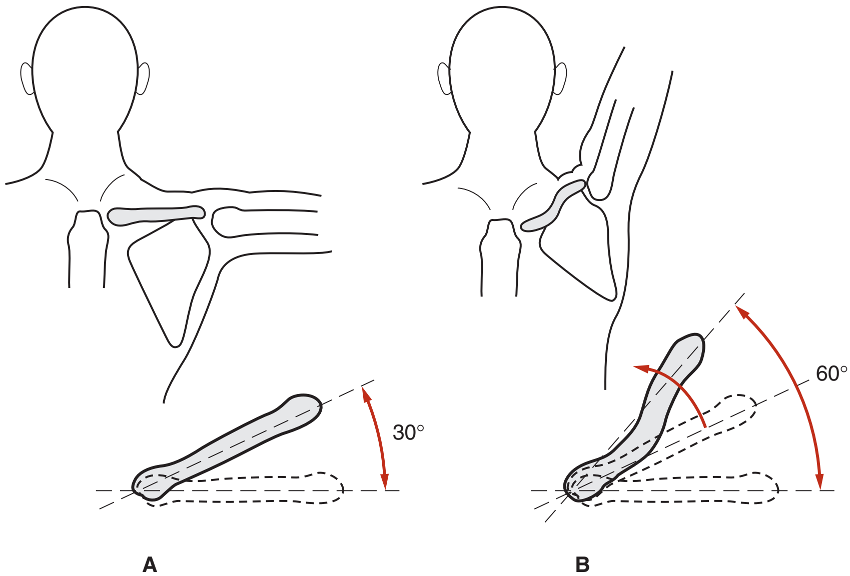

FIGURE 4.5

Rotation of Clavicle on Arm Overhead Elevation A, Without clavicular rotation about sternoclavicular joint, arm can elevate only 30 degrees. B, As there is rotation of clavicle, scapula elevates 60 degrees.

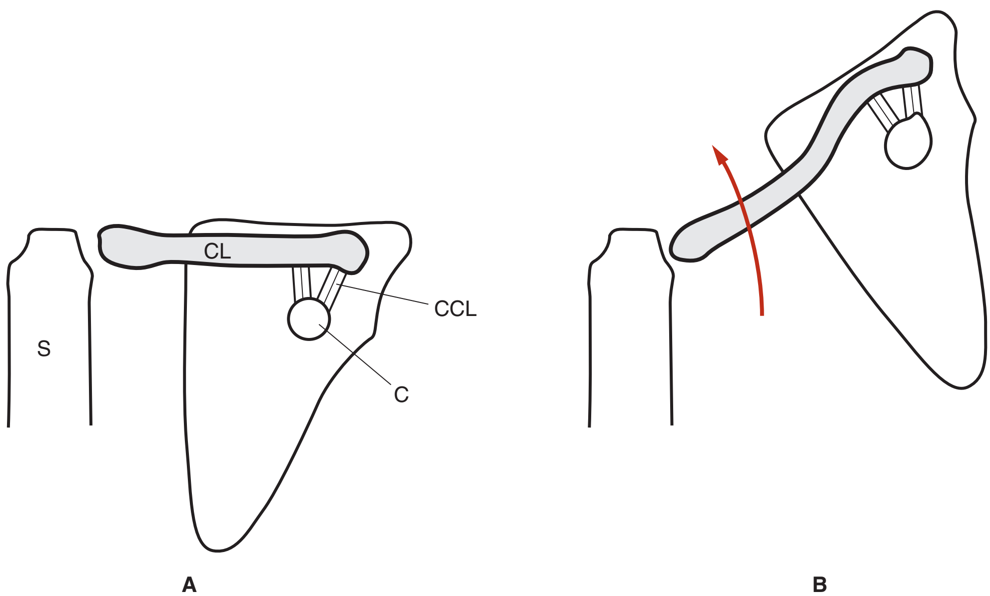

FIGURE 4.6

Effect of Clavicular Rotation on Conoid and Trapezoid Ligaments A, Coracoclavicular ligaments (CCL). C indicates coracoid process; CL, clavicle; S, sternum. B, Due to rotation of clavicle, coracoclavicular ligaments never are overstretched.

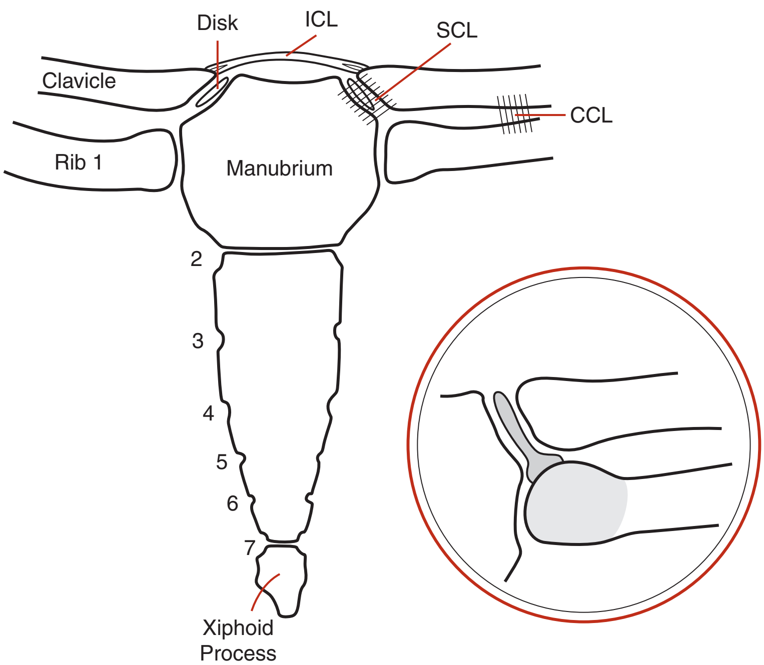

FIGURE 4.7

Sternoclavicular Joint Sternoclavicular joint is formed by medial portion of clavicle articulating on manubrium sterni and also with cartilaginous end of first rib. Interclavicular (ICL), sternoclavicular (SCL), and costoclavicular ligaments (CCL) stabilize joint. There is fibroelastic disk between medial clavicle and sternum (inset).

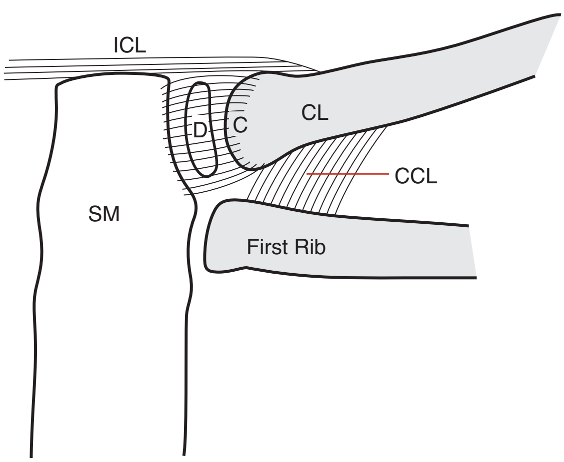

FIGURE 4.8

Ligaments of Sternoclavicular Joint Disk (D) between medial end of clavicle (CL) and sternum (SM) is supported by claviculocostal ligament (CCL), interclavicular ligament (ICL), and capsular ligaments (C).

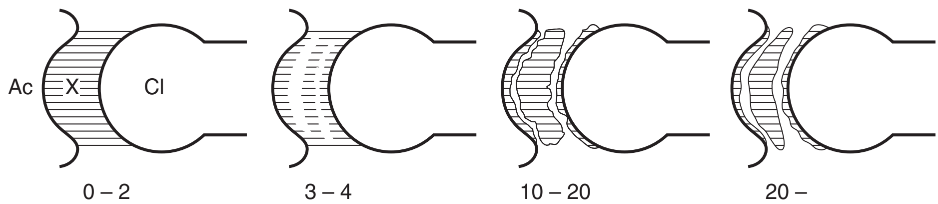

FIGURE 4.9

Evolution of Acromioclavicular Disk (Meniscus) From birth to age 2 years, acromioclavicular joint has a fibrocartilaginous bridge (X) connecting medial end of acromion (Ac) to lateral end of clavicle (Cl). From ages 3 to 4 years, cavities form on either side of what will become meniscus. These tears probably occur because of rotatory torque of this joint. In first to second decades of life, meniscus forms but gradually disappears from age 20 years and on.

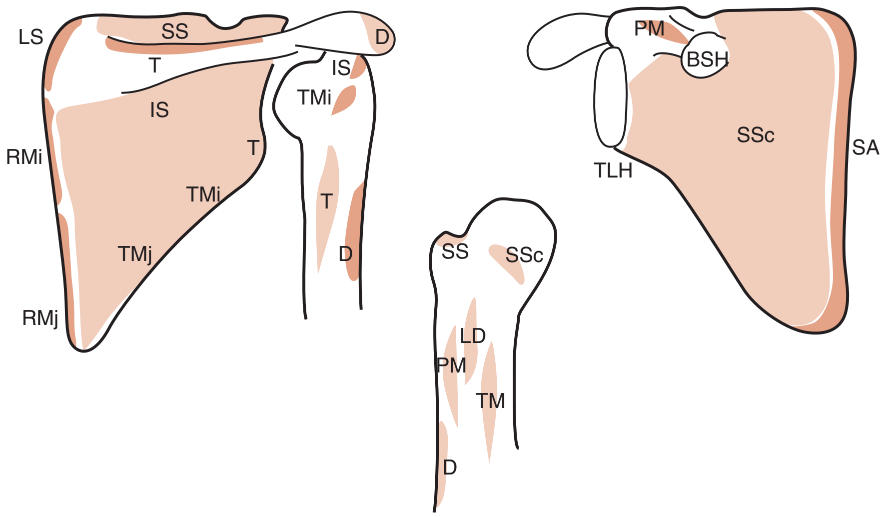

FIGURE 4.10

Muscle on and From Scapula The muscles on and from the scapula are shown. SS indicates supraspinous; LS, levator muscle of scapula; D, deltoid; T, trapezius; RMi, rhomboid minor; RMj, rhomboid major; IS, infraspinous; TMi, teres minor; TMj, teres major; SSc, subscapular; BSH, biceps short head; TLH, triceps long head; PM, pectoralis major (greater pectoral); SA, anterior serratus; LD, latissimus dorsi.

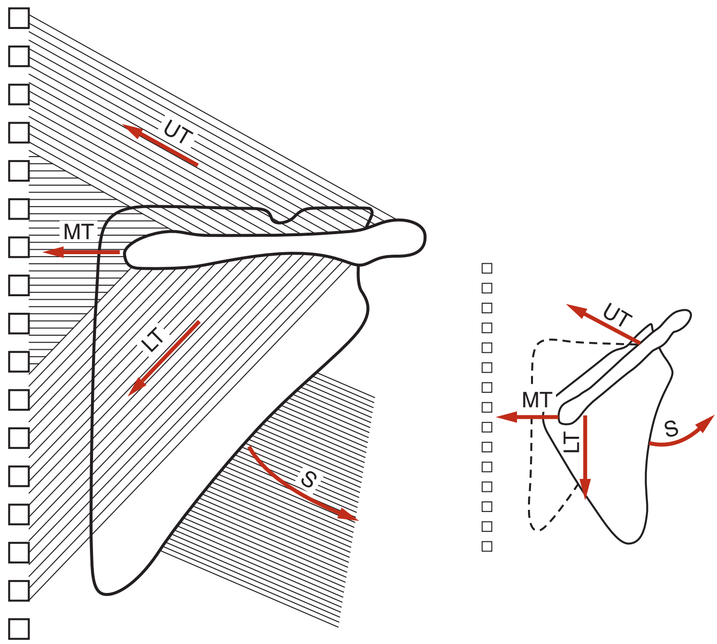

FIGURE 4.11

Scapular Rotators Muscles that support and rotate scapula are upper trapezius (UT), middle trapezius (MT), and lower trapezius (LT), and serratus (S).

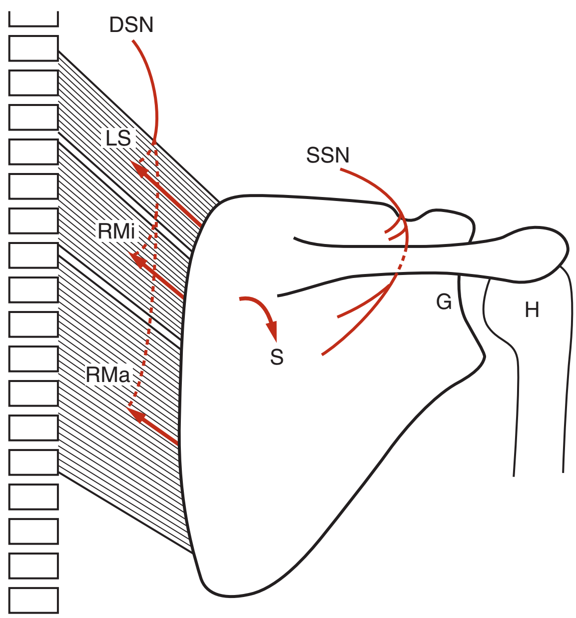

FIGURE 4.12

Downward Scapular Rotators Downward rotators of scapula (S) (curved arrow) are levator scapulae (LS), rhomboid major (RMa), and rhomboid minor (RMi). These muscles are innervated by dorsal scapular nerve (DSN). SSN indicates suprascapular nerve; G, glenoid fossa; and H, humerus.

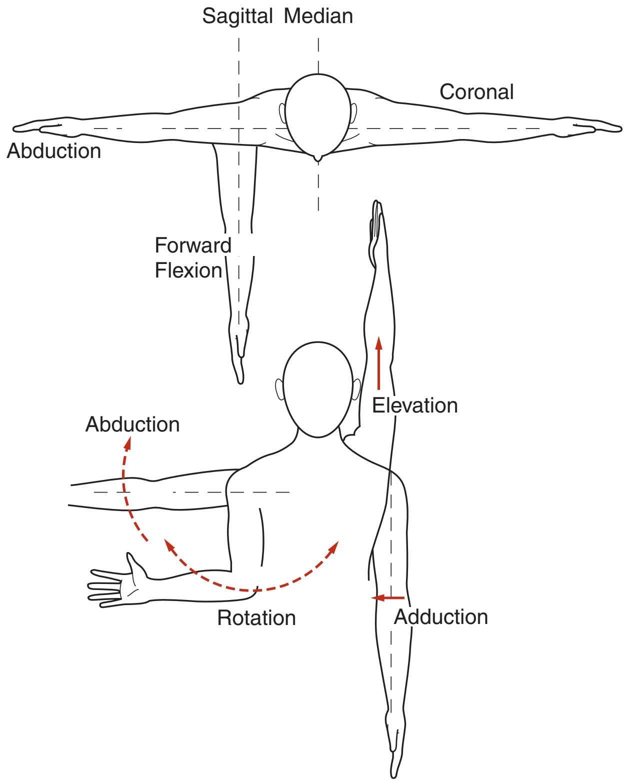

FIGURE 4.13

Planes of Arm Movement Planes of arm movement indicate direction of movement as relates to the body. All planes are related to those viewed from above and from front.

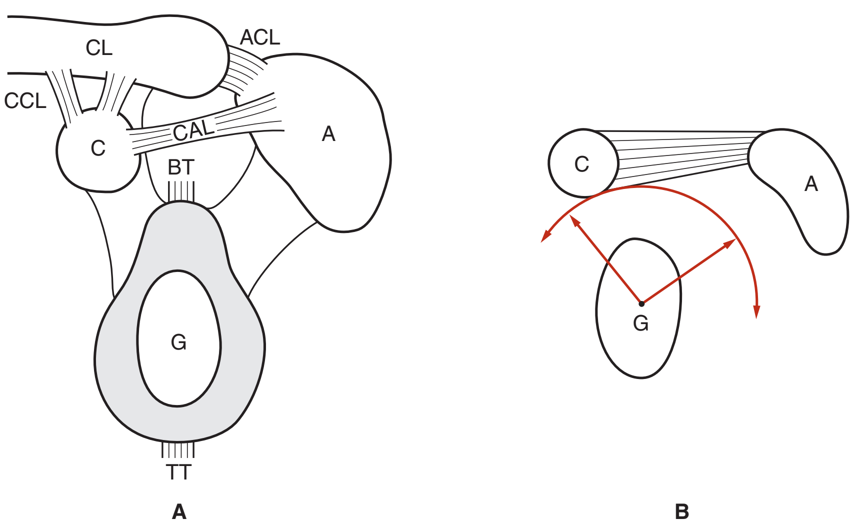

FIGURE 4.14

Site of Glenoid Fossa A, Glenoid fossa (G) is below and lateral to coracoid process (C) and below acromion (A). Biceps tendon (BT) originates from upper margin of fossa. B, Movement (arrows) of humeral head within fossa. ACL indicates acromioclavicular ligament; CCL, coracoclavicular ligaments; CL, clavicle; CAL, coracoacromial ligament; and TT, triceps tendon.

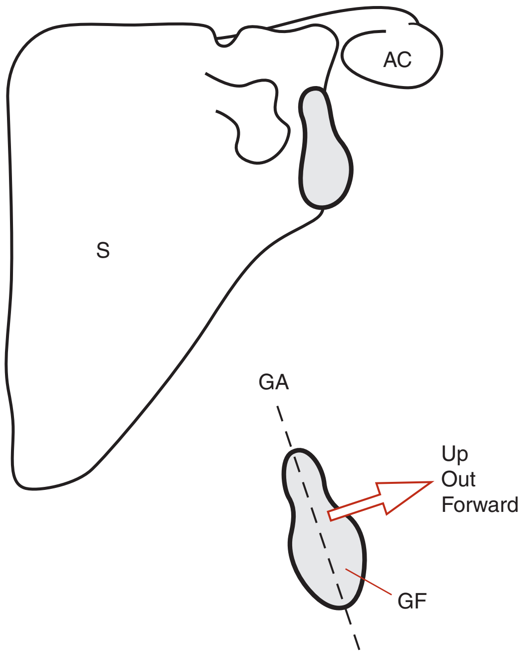

FIGURE 4.15

Facing of Glenoid Fossa Glenoid fossa (GF) and its angulation. AC indicates acromium; S, scapula; and GA, glenoid angle.

THE GLENOHUMERAL JOINT

The glenohumeral joint, the humeral head within the glenoid fossa, is clinically termed the "shoulder joint," as most arm-hand-finger functions require movement or stabilization of the joint. It has been made apparent, however, that the scapulocostal joint is equally important in upper extremity movement.

The glenohumeral joint contains many tissues that are functionally needed and simultaneously are the tissue sites of injury or impairment. The "joint" composes the area of the acromion and coracoacromial ligament overhead and the glenoid fossa of the scapula medially. The long head of the biceps tendon passes over the humeral head in its sulcus. The "rotator cuff," composed of the conjoined tendon of the supraspinous, infraspinous, and teres major muscles, passes over the humerus and attaches to its greater tuberosity. The synovial capsule contains synovial fluid to lubricate all these tissues during movement (Figure 4.16).

The glenoid fossa exemplifies congruency, an engineering term initially defined by MacConnaill[1-3] (Figure 4.17). This concept of joint movement needs to be highlighted in a discussion of functional anatomy, as congruity plays a vital role in how most, if not all, joints of the body function. Rotation occurs about an axis at right angles to the weight-bearing surface

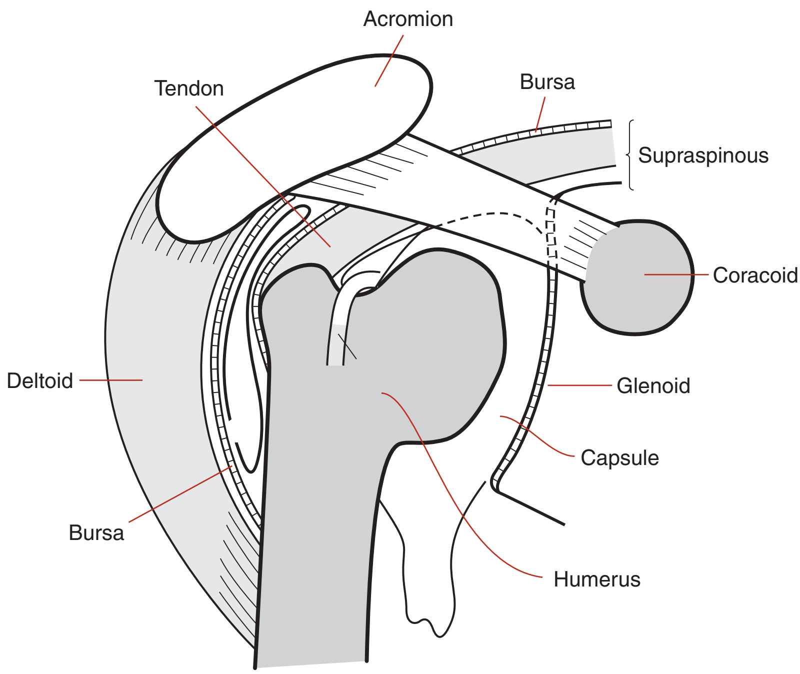

FIGURE 4.16

Contents of Glenohumeral Joint Contents of glenohumeral joint include head of humerus, glenoid fossa, subdeltoid bursa, glenohumeral capsule, tendon of long head of biceps, conjoined tendon of rotator cuff, fascia between undersurface of deltoid muscle, and coracoacromial ligament. Space between coracoacromial ligament and humeral head is termed ***suprahumeral joint***.

of a joint but cannot be brought about by single muscles, which, by contracting, cause a mixture of swing and rotation.[4]

In the static shoulder with the arm dependent, the humerus would, by virtue of gravity and the weight of the upper extremity, literally dislocate downward out of the shallow glenoid fossa, which is also at an angle from pure verticality (Figure 4.18).

The glenohumeral capsule is very thin and has limited flexibility (Figure 4.19). It is not strong enough to prevent downward subluxation if not assisted by the rotator cuff. It retracts when the arm is abducted or forward flexed, further allowing instability of the joint during these movements (Figure 4.20).

The integrity of the capsule to stabilize the glenohumeral joint is compounded by the structure of the capsule, which has 3 strands forming "ligaments" and a structural foramen (foramen of Weitbrecht); this foramen allows dislocation of the humeral head (Figure 4.21).

The head of the humerus is thus maintained with stability in the glenoid fossa by the combined action of the rotator cuff and the capsule (Figure 4.22).

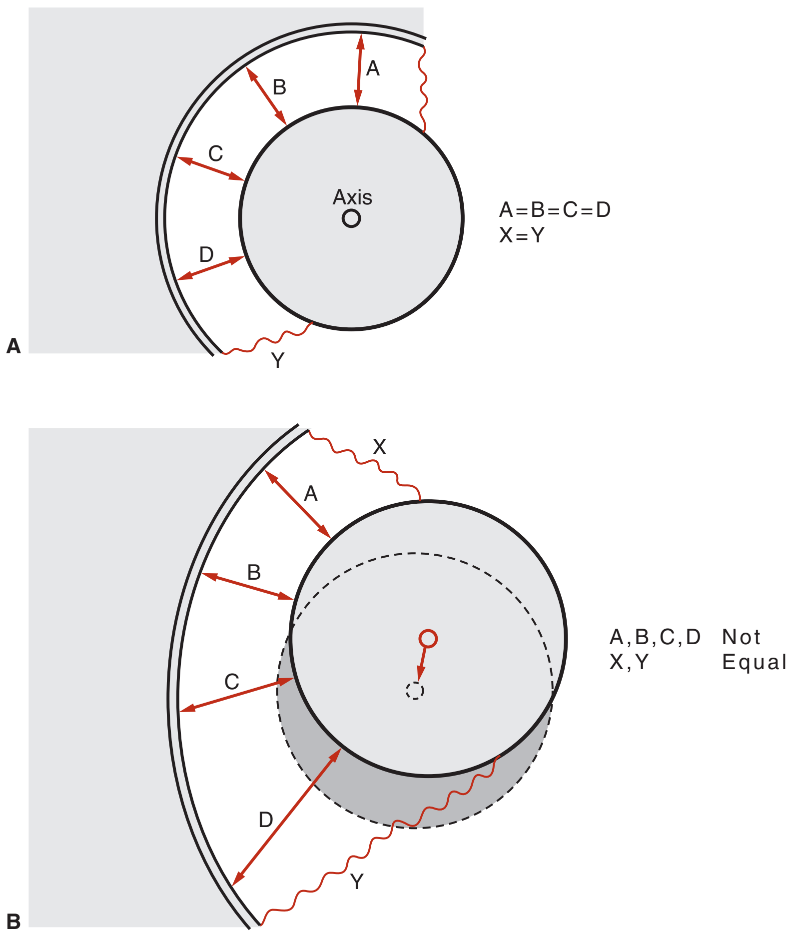

FIGURE 4.17

Congruous and Incongruous Joints A, Congruous joint with symmetrical concave-convex surfaces being equidistant from each other at all points of curvature (A = B = C = D). Rotation of this joint occurs about a fixed central axis of rotation. Muscular (M) action on this joint allows motion but is not needed for stability when the scapula is immobile. Capsule has symmetrical elongation. B, Incongruous joint has asymmetrical articular surface, with concavity and convexity being different; thus, spaces between surfaces are unequal. Convex portion is not "seated" within concave portion and thus may slide down. Movement is gliding, not rotation. Stability requires capsular and muscular intervention. Capsule length varies at all levels of movement.

Rotator Cuff

The so-called rotator cuff is the conjoined tendons of the supraspinous, infraspinous, and teres minor muscles that attach to the greater tuberosity of the humeral head. In the static dependent arm, the supraspinous muscle sustains the head of the humerus in the glenoid fossa by isometric contraction. The tonus of the muscle (ie, the isometric contraction) is determined by the spindle system and the Golgi apparatus as to force, which was discussed in Chapter 1 (Figure 4.23).

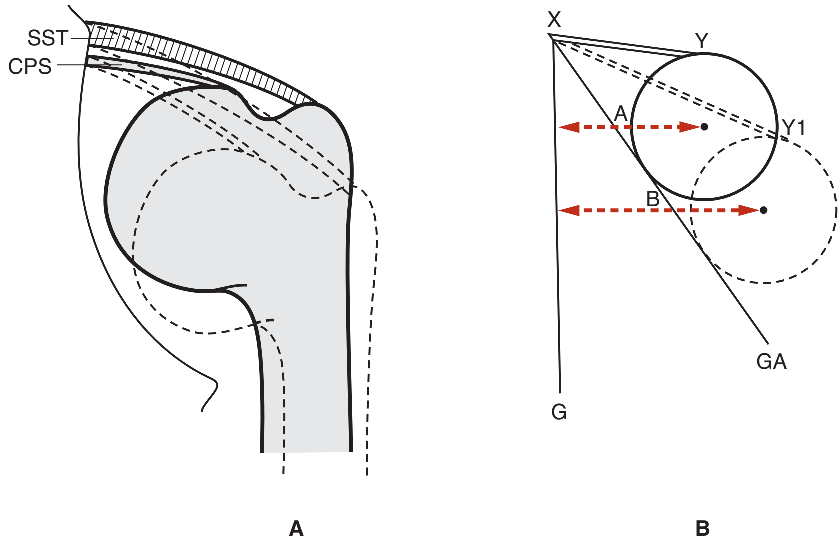

FIGURE 4.18

Downward Glide of Humeral Head on Glenoid Fossa A, Support of humerus by virtue of rotator cuff: supraspinous muscle (SST) and superior aspect of synovial capsule (CPS). B, Vertical gravity force (X-G) compared with inclined line of fossa surface (X-GA). Head of humerus, virtually a ball, tends to roll down inclined plane with its center of axis of rotation (A) moving laterally (B). Capsule and cuff (X-Y) elongate to (X-Y1) and prevent further rolling if intact.

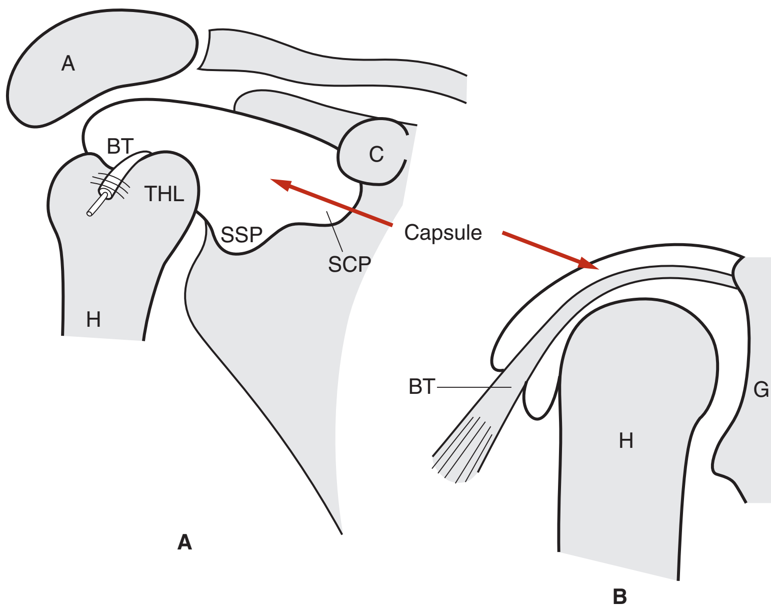

FIGURE 4.19

Glenohumeral Synovial Capsule A, Spacious capsule (C) covers entire humeral head (H). Biceps tendon (BT) invaginates capsule, accompanying it down past transverse humeral ligament (THL), which contains tendon. There are 2 pouches in capsule: subcoracoid (SCP) and subscapular (SSP). B, Invagination of biceps tendon (BT) as well as its attachments to glenoid fossa (G).

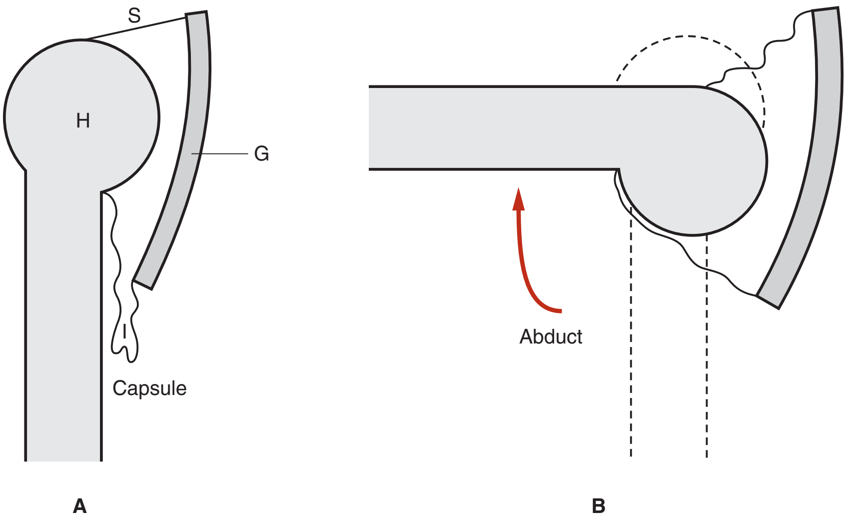

FIGURE 4.20

Flexibility of Glenohumeral Capsule A, Superior capsule (S) being taut during dependency of arm, keeping humeral head (H) seated within glenoid fossa (G). Inferior capsule (I) is redundant. B, During abduction, both capsules become slack.

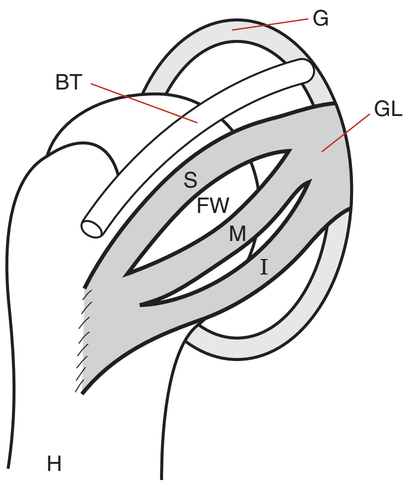

FIGURE 4.21

Anterior Capsule and Glenohumeral Ligaments Three folds of anterior capsule forming glenohumeral ligaments (GL): superior (S), middle (M), and inferior (I). These ligaments attach from anterior ridge of humerus (H) to glenoid fossa (G). Between S and M is foramen of Weitbrecht (FW). BT indicates biceps tendon.

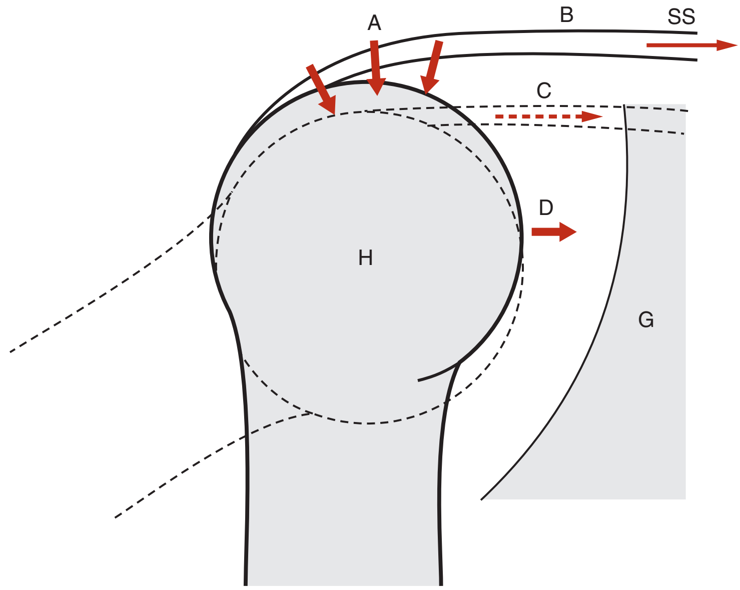

FIGURE 4.22

Support Structures of Glenohumeral Joint Humeral head (H) seated in glenoid fossa (G) prevents downward subluxation against gravity (A, thick, long arrows) by inward pull (thin arrow and dotted arrow) of conjoined tendon (B) of supraspinous muscle (SS) and superior aspect of capsule (C). D indicates active lateral displacement, which is possible.

Kinetic Action of Muscles of the Glenohumeral Joint

As the humerus either abducts or flexes anteriorly or posteriorly, the humeral head must glide-rotate on the glenoid fossa. This is the decalage mentioned by MacConnaill[4]—essentially "coupling" of the humerus on the glenoid fossa.

Glenohumeral movement is a complex action dictated by the anatomical structures of the articulation. As the arm (humerus) begins abduction or flexion, it moves to a degree ultimately limited by the overhanging acromion or the coracoacromial ligament or both. With the arm "neutral" (no rotation) and no scapular motion, 90 degrees of abduction is possible before the greater tuberosity, which lies lateral to the bicipital groove impinges on the overhanging acromion and the coracoacromial ligament. With the arm internally rotated, the greater tuberosity impinges after only 60 degrees of abduction. With external rotation, the greater tuberosity

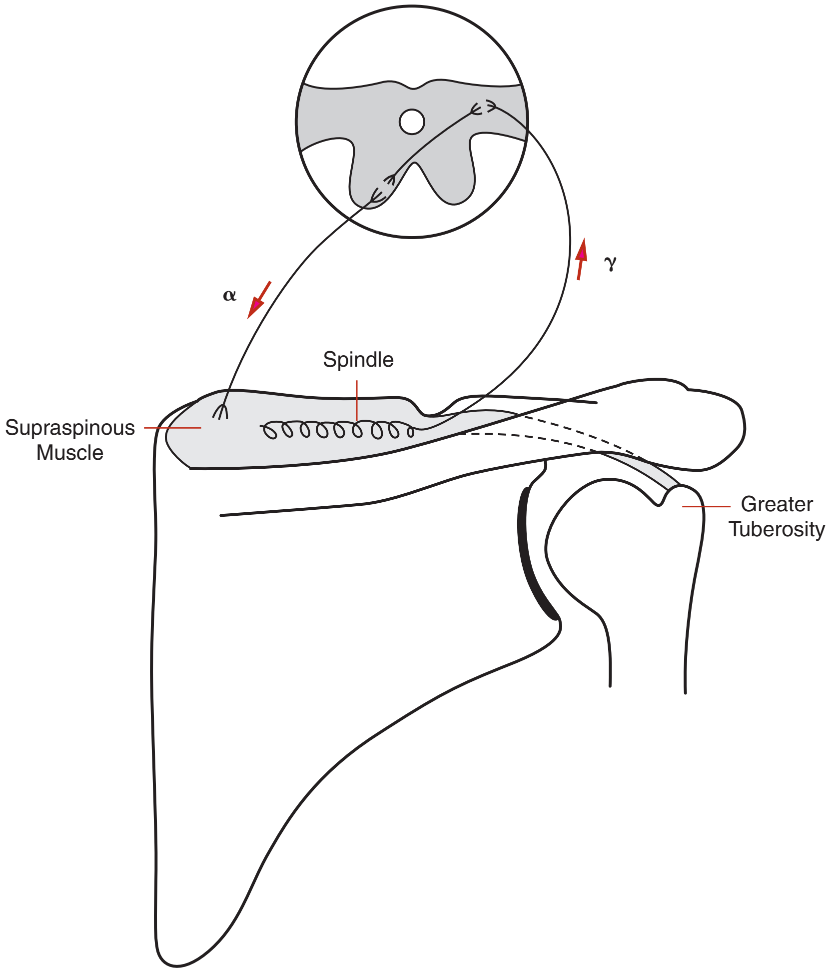

FIGURE 4.23

Supraspinous Muscle Function in Static Arm Posture Supraspinous muscle, which originates in supraspinous sulcus of scapula, has its tendon pass under acromion and attach to greater tuberosity of humeral head. Muscle sustains appropriate amount of tension as mediated by spindle system, which has efferent (motor, alpha) fibers and sensory (gamma) fibers to spinal cord.

passes behind the coracoacromial ligament and the overhanging acromial process and is able to abduct and elevate to approximately 120 degrees. This indicates that abduction and overhead elevation of the arm requires simultaneous external rotation of the humerus (Figure 4.24).

The term *rotator cuff* indicates that, in addition to static support of the dependent arm, the cuff abducts and forward flexes the arm with simultaneous rotation as needed to pass by the acromion and coracoacromial ligament (Figures 4.25, 4.26, 4.27).

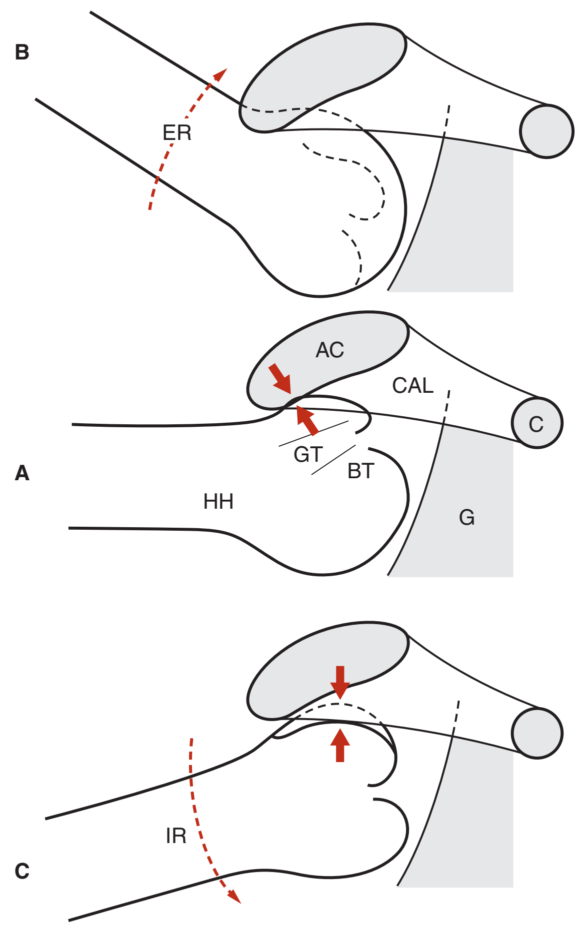

FIGURE 4.24

Overhead Movement of Arm at Glenohumeral Joint A, In neutral rotation, abduction of arm is possible to 90 degrees before greater tuberosity (GT) of humeral head (HH) impinges on acromial process (AC) and/or coracoacromial ligament (CAL). B, With simultaneous external rotation (ER) of humerus, arm can raise to 120 degrees as greater tuberosity passes behind coracoacromial ligament. C, With internally rotated humerus (IR), impingement occurs early, permitting only 60 degrees of abduction. G indicates glenoid fossa; BT, bicipital tendon.

The conjoined tendon that attaches from the muscles to the greater tuberosity is poorly supplied by the vascular system, causing a "critical zone" that limits the stresses the tendon can endure. Most tendons are substantially avascular with limited arterial supply (Figure 4.28).

There are muscles that rotate the humerus other than muscles originating from the scapula, namely, the latissimus dorsi and the greater and smaller pectoral muscles (Figures 4.29, 4.30).

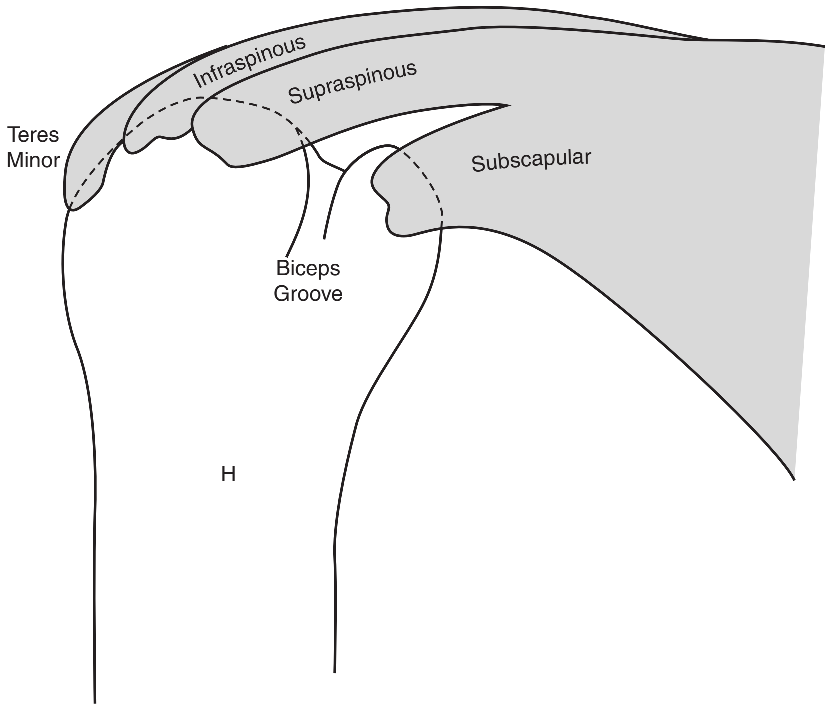

FIGURE 4.25

Rotator Cuff Rotator cuff is a conjoined tendon of several muscles—supraspinous, infraspinous, subscapular, and teres minor muscles. All these muscles except subscapular attach to greater tuberosity of head of humerus (H), lateral to bicipital groove, and subscapular muscle tendon attaches to lesser tuberosity.

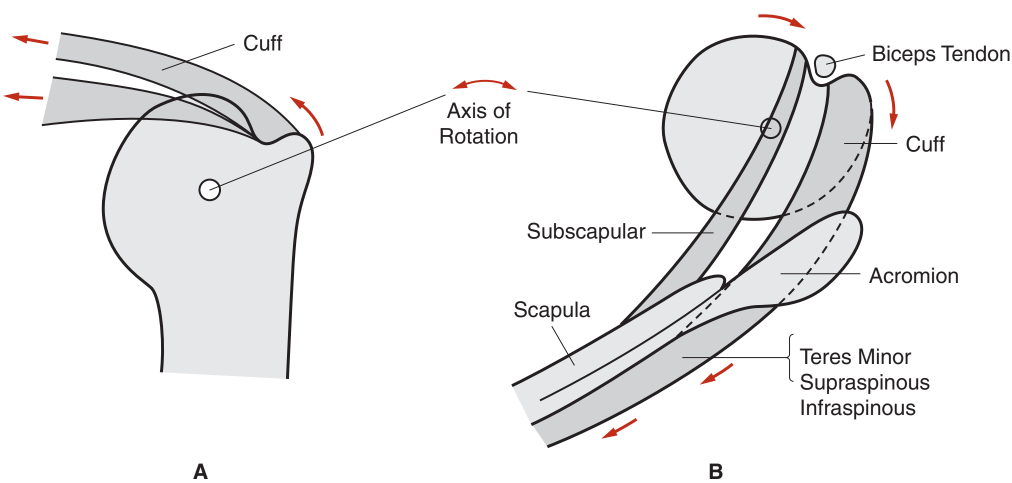

FIGURE 4.26

Rotational Axis of Rotation of Cuff Action A, Abduction about axis of rotation by cuff contraction. B, External rotation of humerus from cuff contraction about that axis. Cuff originates on external surface of scapula and is eccentric to humeral axis. Subscapular muscle originates on internal surface of scapula and internally rotates humerus.

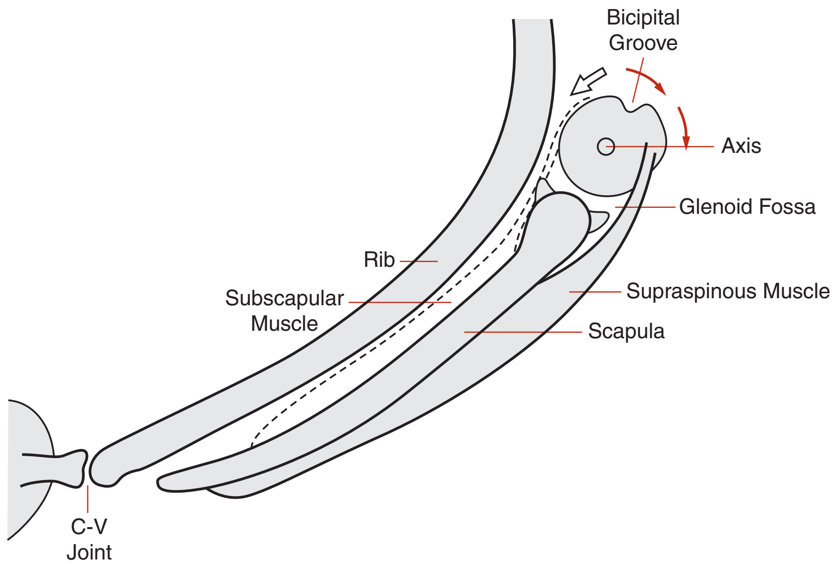

FIGURE 4.27

Rotators of Humerus Viewed from above, scapula lies on rib cage. Supraspinous muscle originates from external surface, is attached to greater tuberosity eccentric to axis of rotation, and externally rotates arm. Subscapular muscle (dotted line) internally rotates arm. C-V indicates costovertebral.

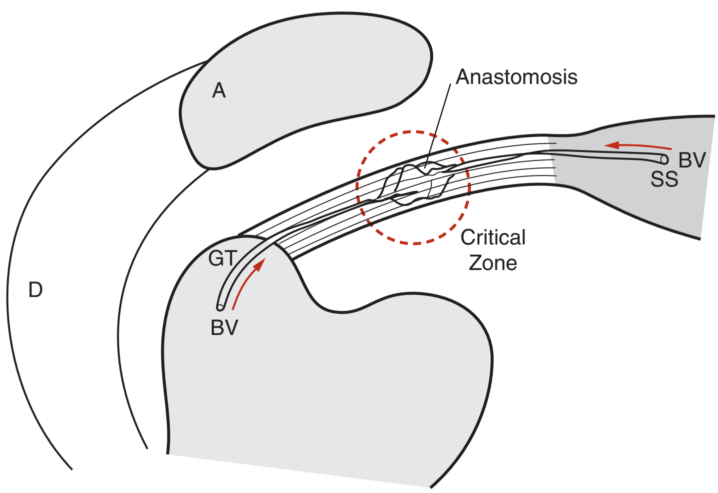

FIGURE 4.28

Critical Zone of Conjoined Tendon Conjoined tendon receives its blood supply from bony arteries of humerus (BV) at greater tuberosity (GT) and descending arteries from supraspinous muscle (SS). Central anastomosis forms critical zone that is susceptible to traction and compressive forces. A indicates acromion; D, deltoid muscle.

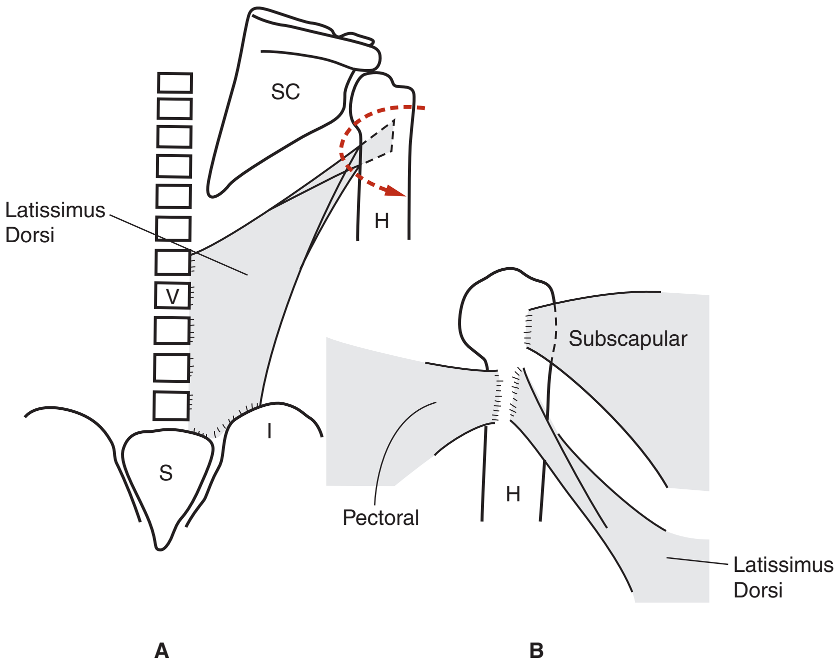

FIGURE 4.29

Rotators of Arm A, Viewed from rear, latissimus dorsi muscle originates from lower thoracic vertebrae and all lumbar vertebrae (V) and os ilium (I) to attach to inner aspect of humerus (H), thus becoming an internal rotator (curved arrow). S indicates sacrum; SC, scapula. B, Viewed from front, greater and smaller pectoral muscles attach from rib cage to insert on anterior aspect of humerus and thus contract to internally rotate humerus. Attachment sites of latissimus dorsi and subscapular muscles are shown.

The head of the humerus is supported by the musculature in every aspect except the inferior aspect (Figures 4.31, 4.32).

Kinetic Motion of the Glenohumeral Joint

The movement of the glenohumeral joint is a complex action that emphasizes the incongruity of that joint. As the arm abducts, or forward-posteriorly flexes, the head of the humerus glides down and forward and backward on the glenoid fossa. This is a muscular action of the rotator cuff and other glenohumeral muscles, such as the deltoid, latissimus dorsi, and the greater and smaller pectoral muscles acting in coordination. From total dependency (0 degrees) to overhead elevation (180 degrees), the humerus must abduct (forward flexion); then it gradually and simultaneously externally rotates to avoid the rotator cuff tendon being impinged on the overhanging acromion and coracohumeral ligament, known as the "painful arc" between 60 and 120 degrees (Figure 4.33).

The muscle action that abducts and totally elevates the arm involves the muscles of the rotator cuff and the deltoid muscle. The deltoid muscle, by far the more powerful, is not an abductor initially on abduction and forward

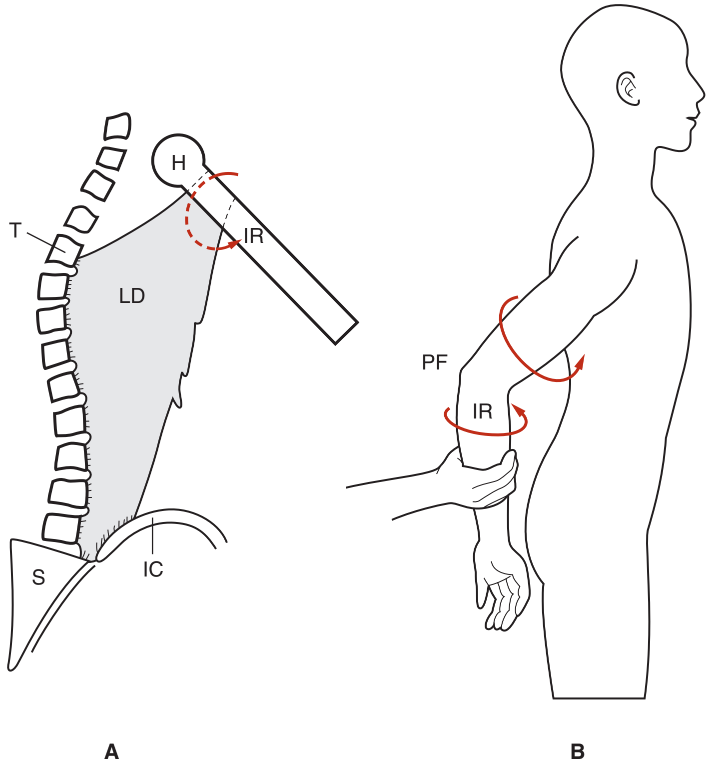

FIGURE 4.30

Functional Testing of Latissimus Dorsi Muscle A, Origin and insertion of latissimus dorsi muscle (LD), inserting on humerus (H) and causing internal rotation (curved arrow, IR). S indicates sacrum; IC, iliac crest; T, thoracic vertebrae. B, Examiner resisting posterior flexion (PF) and internal rotation (IR), which are motions of latissimus dorsi muscle.

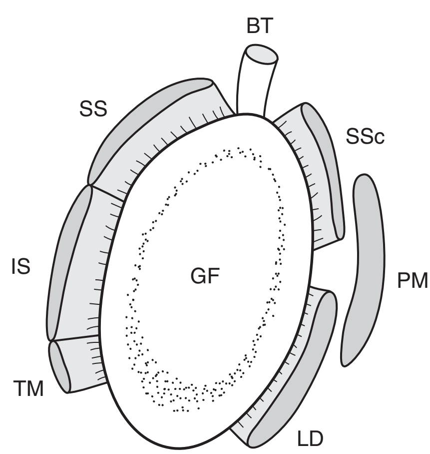

FIGURE 4.31

Muscles Stabilizing Humeral Head During Action Glenoid fossa (GF) that seats head of humerus is encircled by numerous muscles: supraspinous (SS), infraspinous (IS), teres minor (TM), subscapular (SSc), latissimus dorsi (LD), and greater pectoral (pectoralis major, PM). Biceps tendon (BT) also stabilizes head of humerus.

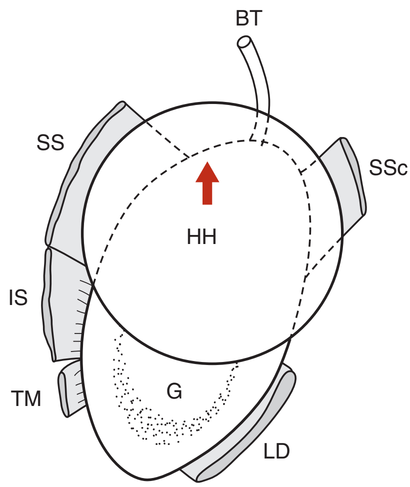

FIGURE 4.32

Head of Humerus in Confines of Cuff Musculature Head of humerus (HH) is supported superiorly (arrow), but there is deficiency inferiorly between teres minor (TM) and latissimus dorsi (LD) muscles. G indicates glenoid fossa; BT, biceps tendon; SS, supraspinous muscle; IS, infraspinous muscle; SSc, subscapular muscle.

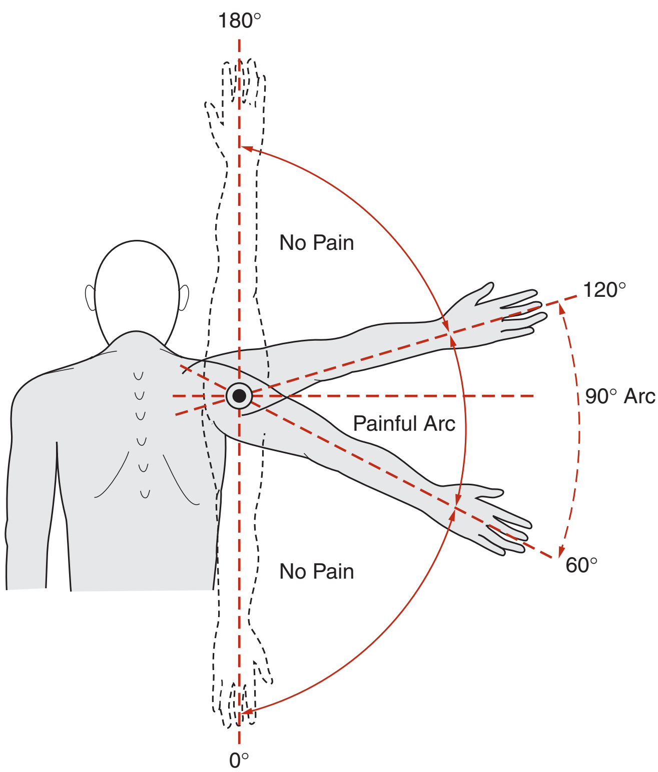

FIGURE 4.33

Painful Arc of Arm: Abduction-Elevation Viewed from behind, arm goes from total dependency (0 degrees) to total overhead elevation (180 degrees). Between 60 and 120 degrees, arm must abduct-forward flex and externally rotate to avoid impingement on acromion and coracoacromial ligament.

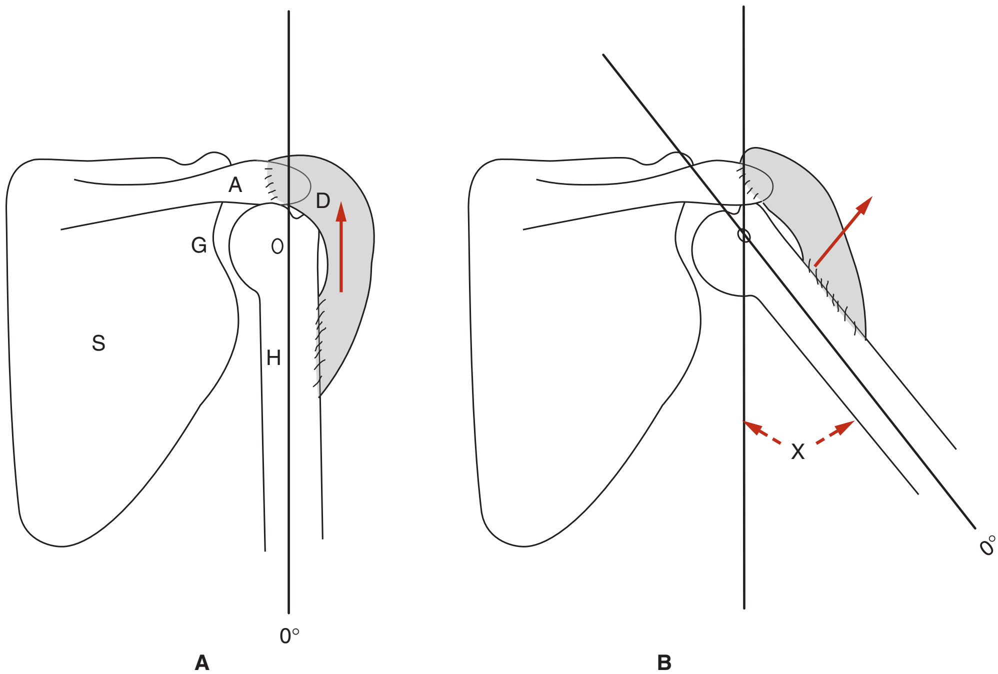

FIGURE 4.34

Action of Deltoid Muscle on Humerus A, With humerus (H) dependent, deltoid muscle (D) originates from acromion (A) and inserts on midshaft of humerus. Its contraction is thus elevation of humerus (dotted arrow in figure B). B, Once abducted (by cuff muscles), deltoid muscle acts at an angle (X) and becomes an abductor and forward flexor.

flexion; in that position, the origin and insertion of the muscles on the humerus are to elevate the arm and avoid impinging the head of the humerus on the overhanging acromion (Figure 4.34).

The rotator cuff muscles abduct and flex the arm while simultaneously depressing the head of the humerus on the glenoid fossa (Figure 4.35).

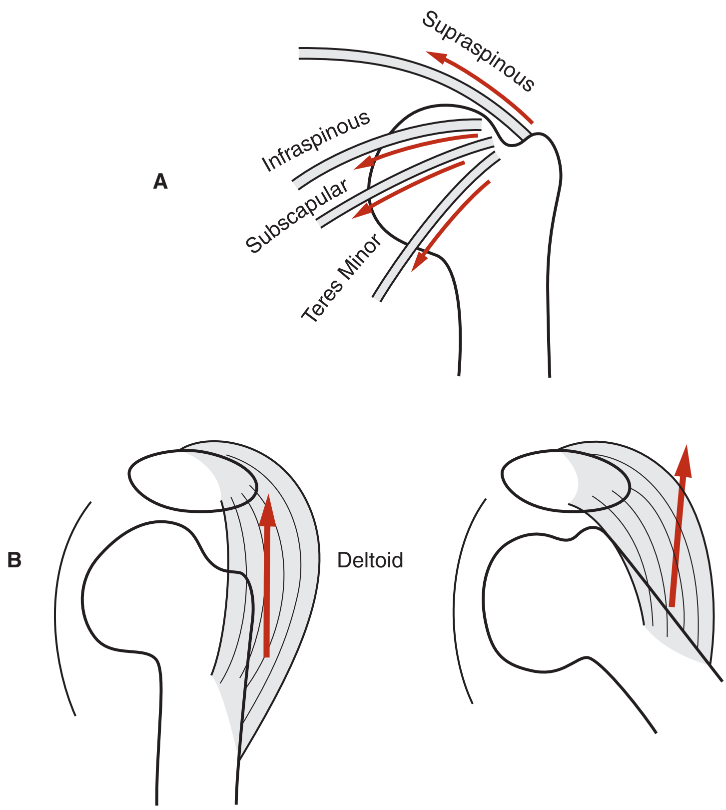

FIGURE 4.35

Muscles Acting on Humeral Head A, Lines of pull of rotator cuff muscles. Supraspinous and infraspinous muscles abduct and rotate head of humerus. Subscapular muscle abducts to lesser degree but also rotates and depresses head of humerus. B, Assistance of deltoid muscle on humerus.

SCAPULOHUMERAL RHYTHM

It has become apparent that without further scapular motion the humerus can abduct and overhead elevate to only 120 degrees when the acromion prevents further motion. The scapula must therefore rotate to remove the acromion from obstruction. This occurs with the scapula rotating about its scapulocostal joint by the muscles that attach to the scapula.

A "rhythm" has been postulated, depicting the degrees of scapular rotation as contrasted to the degrees of glenohumeral rotation. A ratio of 2:1—2 degrees of glenohumeral rotation to every degree of scapular rotation—has been simplistically formulated. This is the *scapulohumeral rhythm* (Figure 4.36).

As the scapula must rotate 60 degrees, the clavicle, which attaches to the acromion, must also rotate 45 degrees (Figure 4.37).

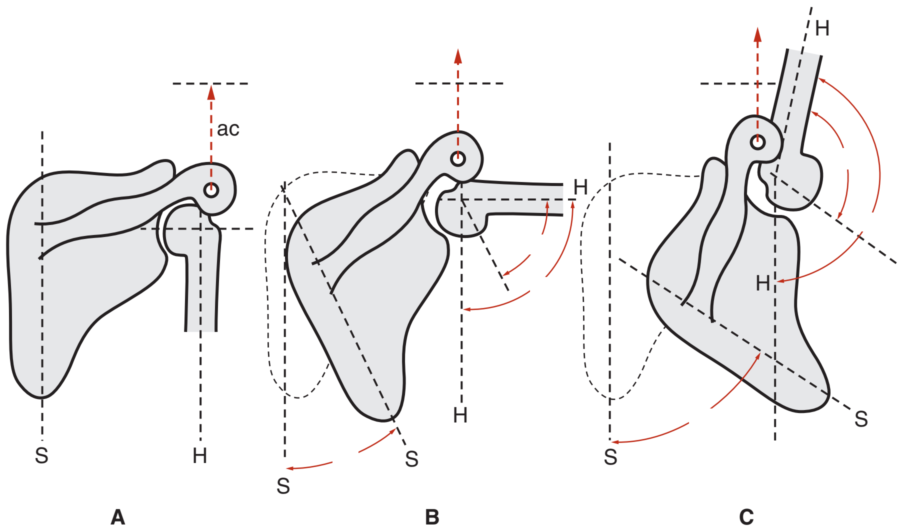

FIGURE 4.36

Scapulohumeral Rhythm A, Dependent arm with vertical alignment of scapula (S) and humerus (H) about axis of acromioclavicular joint (ac). B, As abduction occurs, scapula rotates 30 degrees and humerus rotates 60 degrees, for a total of 90 degrees of arm abduction. C, For further arm overhead elevation (180 degrees), scapula rotates 60 degrees, and humerus rotates on glenoid fossa 120 degrees. Ratio is thus 2:1.

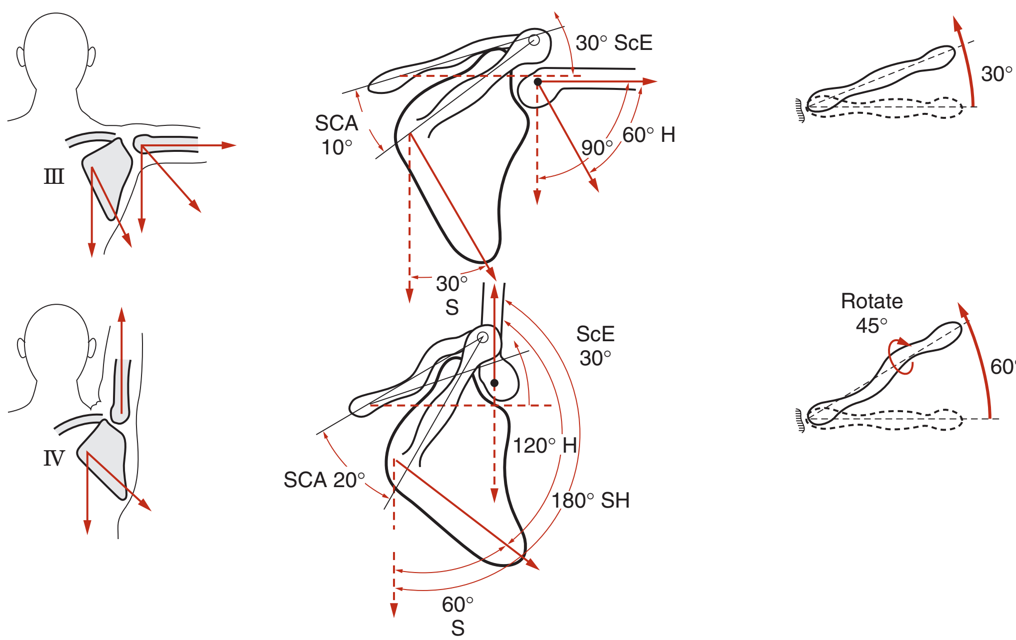

FIGURE 4.37

Clavicular Component of Scapulohumeral Rhythm Third (III, top) phase of scapulohumeral rhythm. Clavicle has elevated 30 degrees without rotation (top right). Fourth (IV, bottom) phase of rhythm, in which clavicle has rotated 45 degrees and scapulohumeral (SH) has elevated to 180 degrees. SCA indicates scapuloclavicular angle; 30 degrees, rotation of scapula (S); ScE, scapular elevation; and H, humerus.

BICIPITAL MECHANISM OF GLENOHUMERAL ACTION

The origin of the long head of the biceps tendon is on the supraglenoid tubercle of the scapula. The tendon leaves the joint through an exit between the superior part of the capsule and the humeral head and enters the intertubercular groove on its way to insert on the radius. As the tendon of the long head passes into the intertubercular groove, it crosses over the humeral head at a right angle (Figure 4.38).

As the arm abducts or forward flexes, the tendon acts as a pulley, causing the humerus to be forced downward. This force is a vector with the biceps contraction and the weight of the arm.

As the arm abducts and externally rotates, the biceps tendon lines up directly over the superior aspect of the humeral head and acts as pulley. The biceps tendon exerts a downward force, preventing the humerus from ascending in the glenohumeral joint. The force of the biceps and the weight of the arm construct a force vector (resultant)[5] (Figure 4.39).

A summary of the scapulohumeral rhythm is now appropriate to include all 4 articulations of the shoulder complex involved.[6,7] The intricate interplay of all these joints results in a coordinated shoulder girdle motion placing the hand in its functional area.

During the first 30 degrees of abduction, the scapula stabilizes the upper extremity. However, once this phase has been reached, the scapula and the humerus move at a 2:1 ratio of movement; thus, for every 2 degrees of

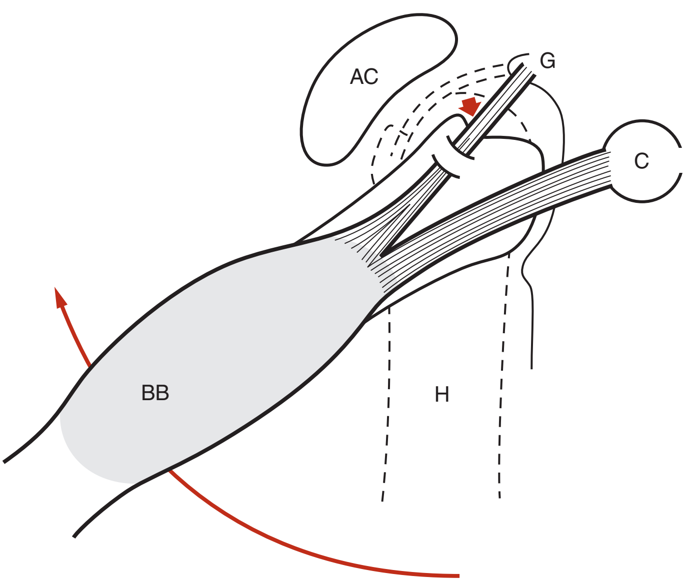

FIGURE 4.38

Biceps Mechanism Long head of biceps (BB), which attaches to supraglenoid tubercle of scapula (G), presses down on humeral head (H) as it abducts. Short head of biceps originates from coracoid process (C). AC indicates acromion.

humeral motion, there is 1 degree of scapular motion. Ultimately, the total arm may reach full (180-degree) overhead elevation.

The 60 degrees of scapular rotation on the chest wall is allowed by the combined motions of the sternoclavicular and the acromioclavicular joints, with commensurate rotation at each. The muscles that activate the scapulohumeral rhythm are all the scapular muscles and the combined glenohumeral muscles: the rotators and the deltoid.

The precise rhythm ratio of 2:1 has been challenged. For instance, one author reported that 175 degrees of arm elevation uses only 50 degrees of scapular rotation,[8] and another report[9] stated that for every 2 degrees of scapular motion there were 3 degrees of humeral motion. These modifications do not greatly alter the accepted 2:1 ratio initially postulated.

Posture has been alluded to throughout this text, and it does play a major role in movement of the shoulder girdle. If there is excessive dorsal kyphosis ("rounded shoulder posture"), the scapula rotates excessively downward and thus places the acromion at a lower level, enhancing earlier entrapment of the abducting-forward flexing humerus as it attempts total elevation (Figure 4.40).

In a limited elevation of the scapulohumeral arm due to whatever cause, only one arm is denied full overhead elevation and thus may mimic postural deficiency, but, by affecting only one arm, posture is not affected (Figure 4.41).

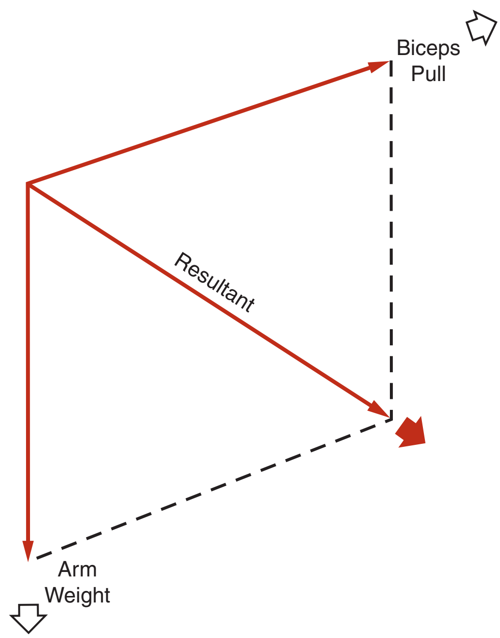

FIGURE 4.39

Vector Forces of Biceps Tendon Vector force is formed by force of biceps muscle through its tendon on head of humerus and weight of arm. Resultant vector force keeps humeral head down.

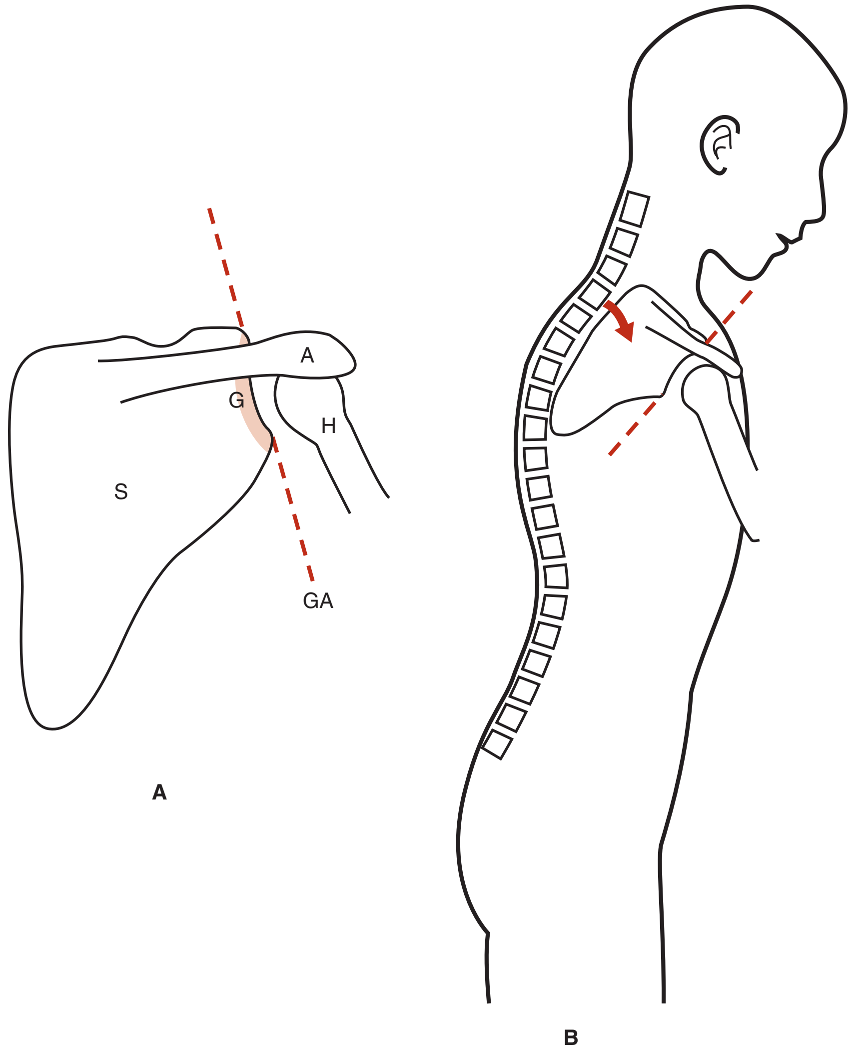

FIGURE 4.40

Effect of Posture on Shoulder Action A, Glenoid angle (GA) with scapula (S) in a physiological position. A indicates acromium; H, humerus. B, The dorsal kyphotic posture rotates (curved arrow) the scapula downward and changes the glenoid angle and the position of the acromium.

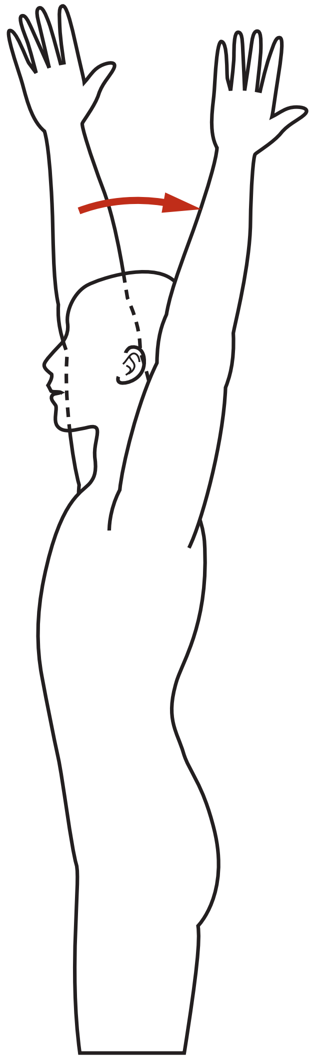

FIGURE 4.41

Unilateral Impaired Overhead Elevation of Arm Overhead elevation of only left arm (right in figure) is restricted, indicating unilateral glenohumeral restriction, not postural component.

THORACIC OUTLET

As there are controversial diagnoses of a thoracic outlet syndrome, the functional anatomical structures of the outlet need clarification. The thoracic outlet consists of the space between the first rib and the scalene muscles, through which the brachial plexus and the subclavian artery and vein pass as they descend as a neurovascular bundle between the first rib and the clavicle (Figures 4.42, 4.43).

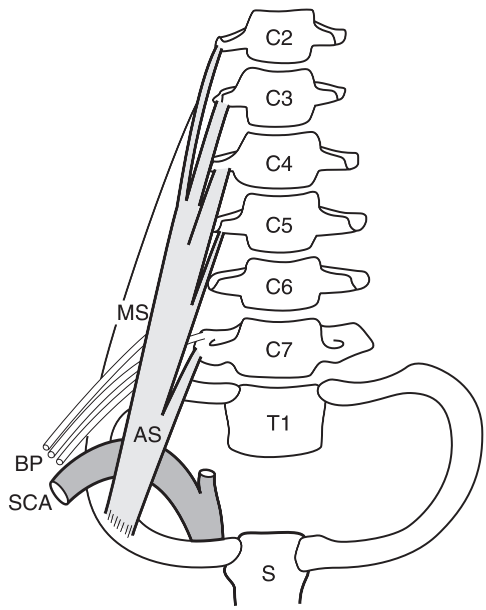

FIGURE 4.42

Thoracic Outlet Anterior scalene muscle (AS), which originates from lateral process of cervical vertebrae (C2 through C7), descends to attach to first rib. Middle scalene muscle (MS) has similar origin but attaches more laterally to first rib, forming opening through which brachial plexus (BP) and subclavian artery (SCA) pass.

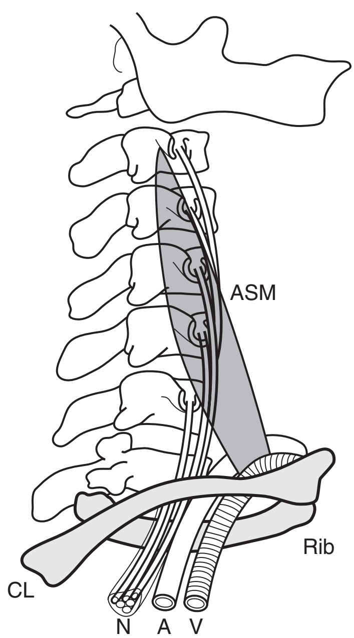

FIGURE 4.43

Neurovascular Bundle Passing Through Outlet Neurovascular bundle passing through thoracic outlet contains nerves (N), artery (A), and vein (V), which are divided by anterior scalene muscle (ASM). Neurovascular bundle between first rib and ultimately behind clavicle (CL).

FUNCTIONAL ANATOMY OF PAINFUL SYNDROMES

Painful syndromes of the shoulder rotator cuff become evidenced by a "painful arc." (Refer to Figure 4.33.) There is pain when the inflamed rotator tendon passes under the overhanging acromion and coracoacromial ligament, causing pain and ultimately limitation of movement. By limited range of motion at the glenohumeral joint, the scapular "rhythm" is impaired and the scapular phase becomes the mover of the shoulder girdle, with no glenohumeral motion causing the "shrugging motion" on abduction (Figure 4.44).

Another classic term used in shoulder pathology is the use of the Codman exercise, which merits discussion in functional anatomy. The purpose of this exercise is to maintain and improve the glenohumeral range without using active muscular contraction (Figure 4.45).

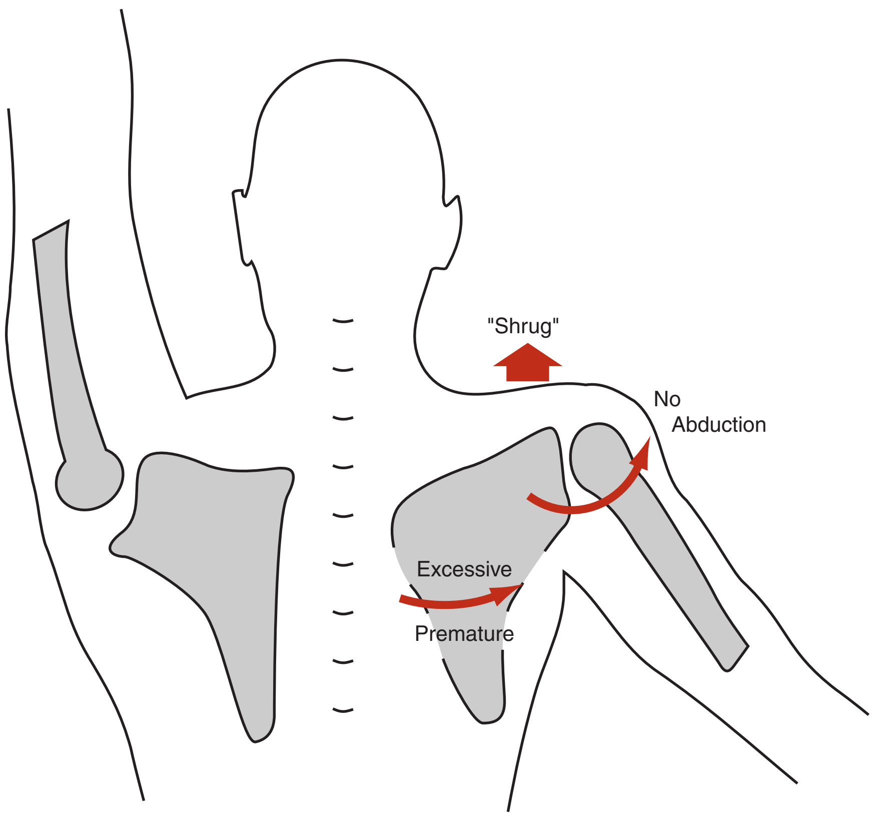

FIGURE 4.44

Shrugging Mechanism As glenohumeral motion is impaired or totally restricted, scapula begins its rotation prematurely, if not exclusively, thus causing shoulder girdle to "shrug."

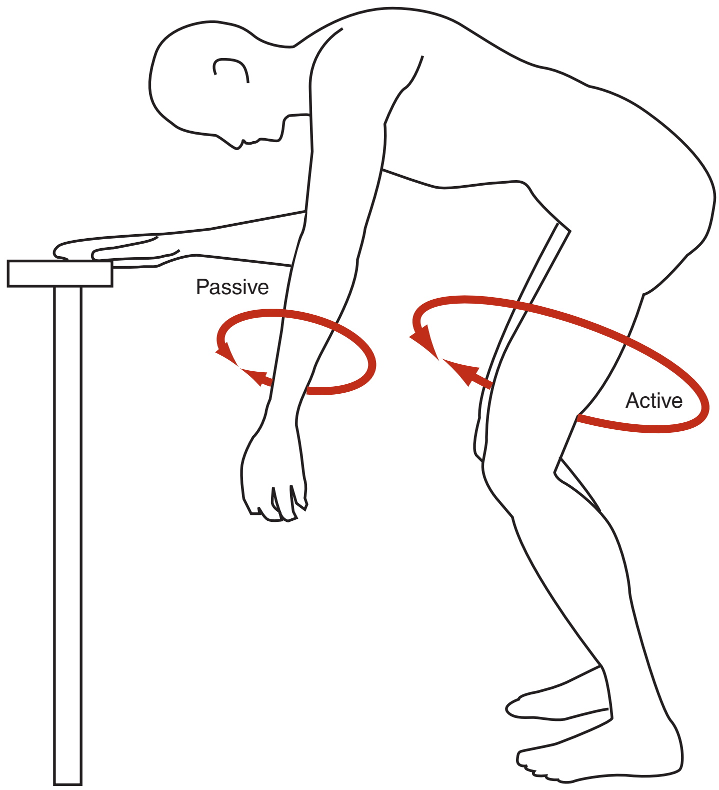

FIGURE 4.45

Codman Exercise With arm totally dependent, traction from weight of arm is applied to glenohumeral joint. Body then makes circumduction of glenohumeral joint without eliciting any muscular contraction of joint muscles.

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