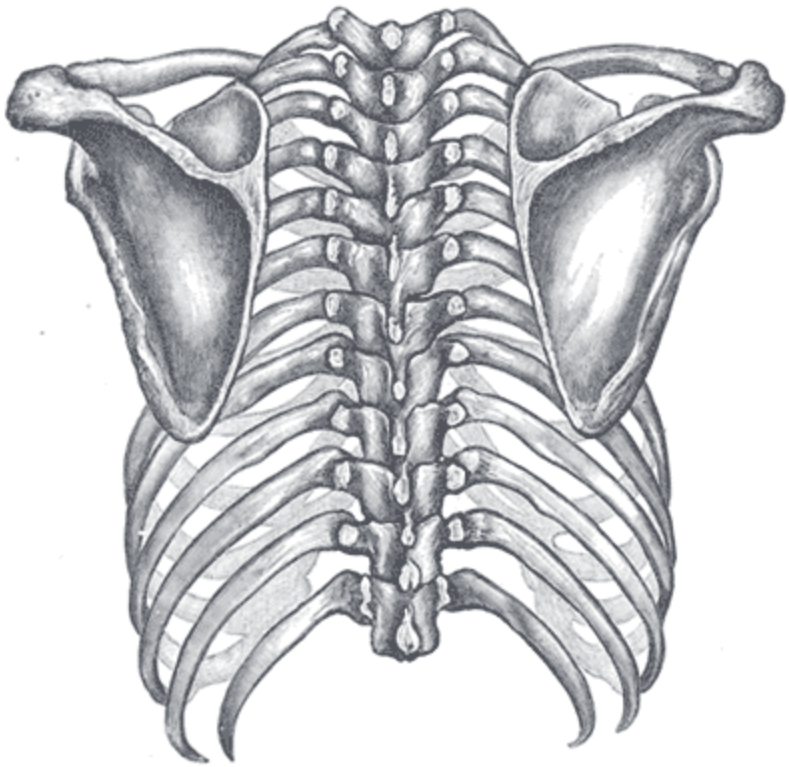
Scapular Dyskinesis

Presented by: Scott Sevinsky MSPT



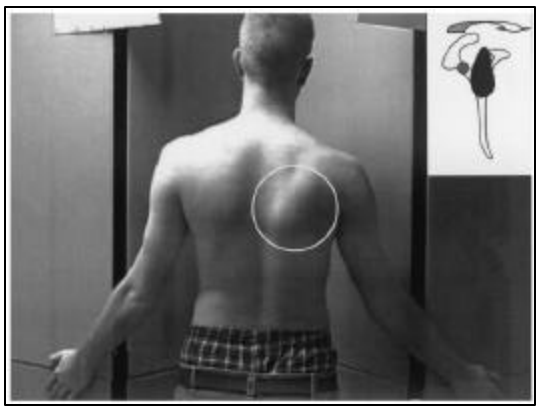
What is Scapular Dyskinesis?

Alteration in the normal static or dynamic position or motion of the scapula during coupled scapulohumeral movements. Other names given to this catch-all phrase include: “floating scapula” and “lateral scapular slide”.[1, 2]

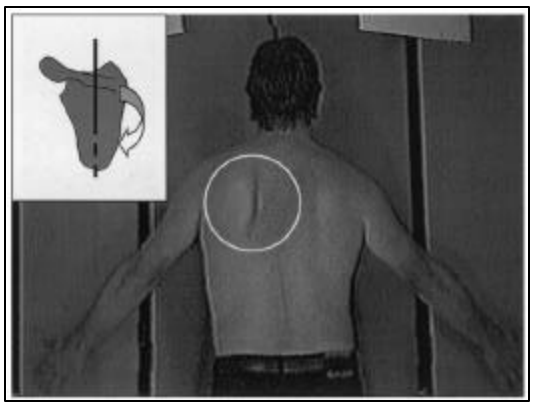
> Alterations in scapular position and motion occur in 68 – 100% of patients with shoulder injuries.[1]

Scapular Dyskinesis Classification System[1, 3]

Pattern	Definitions
Inferior angle (**type I**)	At rest, the inferior medial scapular border may be prominent dorsally. During arm motion, the inferior angle tilts dorsally and the acromion tilts ventrally over the top of the thorax. The axis of the rotation is in the horizontal plane.
Medial border (**type II**)	At rest, the entire medial border may be prominent dorsally. During arm motion, the medial scapular border tilts dorsally off the thorax. The axis of the rotation is vertical in the frontal plane.
Superior border (**type III**)	At rest, the superior border of the scapula may be elevated and the scapula can also be anteriorly displaced. During arm motion, a shoulder shrug initiates movement without significant winging of the scapula occurring. The axis of this motion occurs in the sagittal plane.
Symmetric scapulohumeral (**type IV**)	At rest, the position of both scapula are relatively symmetrical, taking into account that the dominant arm may be slightly lower. During arm motion, the scapulae rotate symmetrically upward such that the inferior angles translate laterally away from the midline and the scapular medial border remains flush against the thoracic wall. The reverse occurs during lowering of the arm.

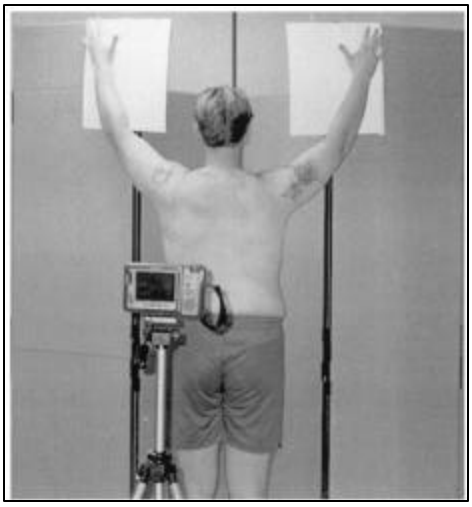


Type I (inferior angle)



Type II (medial border)

Type III (superior angle)



Causes of Scapular Dyskinesis [1]

1. Postural abnormality or anatomical disruption.
- increased cervical lordosis or excessive thoracic kyphosis alters the normal resting position of the scapula and can result in excessive protraction and acromial depression.
- clavicular fractures or resections can shorten or angulate the clavicle thereby changing the normal resting position or altering the ability of the clavicle to posteriorly rotate with overhead motions. Posterior clavicular rotation permits the initial and final 30° of scapular rotation to complete overhead motions.
- AC joint injury(s) or anatomic anomalies [4]

2. Nerve Injury – potential result of surgical procedure, blunt or penetrating trauma, neurapraxia, traction.
- Spinal Accessory Nerve Palsy (CNXI) → Trapezius weakness
  - scapula assumes a position of depression and lateral translation. [5]
- Long Thoracic Nerve Palsy (C5,6,7) → Serratus Anterior weakness
  - scapula assumes a position of superior and medial translation. [5]
- Dorsal Scapular Nerve Palsy (C4, C5) → Rhomboids weakness
  - similar to trapezius palsy: scapular depression and lateral translation [5]
  - pain and/or tenderness along vertebral border; with our without muscle atrophy.

3. Lack of muscular/capsular flexibility or contracture
- tightness in pectoralis minor or short head of biceps can anteriorly tilt the scapula due to their attachments to coracoid process. Additionally, shortening of pectoralis major can restrict posterior clavicular motion thereby affecting normal scapular movement.
- **Glenohumeral Internal Rotation Deficit**: Posterior capsule tightness creates obligatory anterior and superior translation of the humeral head and loss of internal rotation. Abnormal humeral translation is not the result of ligament insufficiency or laxity but rather asymmetrical capsular tightness. [6]

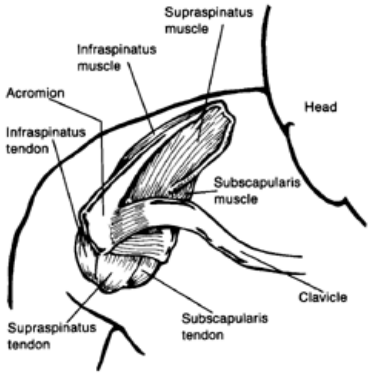
4. Muscle imbalance or weakness [2]
- Scapular muscle fatigue may lead to altered glenohumeral proprioception, muscular inhibition, impaired coordination of scapular movements and timing.
- Muscle inhibition → related to Sherry's law of reciprocal inhibition and the muscle spindle. Activation of a muscle uses stretch reflex connections to stimulate an agonist and to inhibit the antagonist to movement using an inhibitory interneuron. If a muscle, or muscle group(s) are continually recruited in an abnormal pattern (such as forward head posture), eventually the antagonist muscles will become inhibited due to receiving continued inhibitory impulses.
- The most commonly weak or inhibited muscles are the serratus anterior, lower and middle trapezii and rhomboid muscles. Inhibition is seen as both a decreased ability for muscles to exert torque and stabilize the scapula and also as a disorganization of normal muscle firing patterns. More commonly the serratus anterior and lower trapezius is affected first.

5. Proprioceptive Dysfunction [7]
- Proprioception is the ability to detect static or dynamic position of a limb in space. Injury to a joint may cause direct or indirect alterations in sensory information provided by mechanoreceptors; specialized receptors that sense mechanical deformation in soft tissue. Mechanoreceptors function by transducing some form of mechanical deformation into a frequency-modulated neural signal which is transmitted via afferent and efferent pathways.
- Direct physical trauma causes ligament & capsule tearing ending in rupture of innervating nerve fibers. Consequently, the destruction of the messages to and from the joint receptors then causes a "deafferentation" and proprioceptive loss.
- Indirect disruption may result from the effects of effusion or hemarthrosis. Sensory receptors remain intact, but provide incorrect positional information due to increased pressure. In the presence of significant swelling this form of inhibition can deactivate neuromuscular pathways resulting in insufficient or uncoordinated muscle group activation (dyskinesis). In addition, swelling increases intra-articular pressure of the glenohumeral joint thereby decreasing joint stability.

Associated Problems & Impairments

Scapular dyskinesis is a generalized term used to describe the loss of scapular control and motion. The term does not suggest etiology or define patterns that correlate with specific shoulder injuries. However numerous pathologies, problems and impairments may result from abnormal scapular control and motion:

- shoulder pain and/or discomfort at rest or with activity.
- **loss of scapular protraction/retraction control**: too much protraction either due to capsular tightness or coracoid muscle contracture causes the scapula to rotate downward and forward thereby altering scapulohumeral rhythm and leading to **impingement** of any or all of the structures listed below:



1. Supraspinatus tendon
2. Superior joint capsule
3. Subacromial (subdeltoid) bursa
4. Biceps Brachii long head tendon

Painful arc occurs between 60° → 120° of ✓ or ABD !!

In 1934, Codman first described a critical zone in the supraspinatus tendon where a tenuous blood supply exists. The supraspinatus tendon receives its blood supply from the suprascapular and anterior humeral circumflex vessels and has an avascular zone at its insertion site. This avascular zone is also unfortunately the most common site for physical impingement to occur.

1° impingement, typically seen in the older population, results from physical narrowing of the subacromial space and is commonly caused by rotator cuff or busral fibrosis, coracoacromial arch calcification, a hooked acromion, bone spur development, distal clavicle or AC joint degeneration.

2° impingement is the result of functional narrowing of the subacromial space. It is more common in the younger population and frequently results from GH instability as well as posterior capsular tightness and/or weakness and fatigue of the scapulohumeral and scapulothoracic muscles.

- **Excessive protraction** also creates functional anteversion of the glenoid thereby decreasing the normal bony buttress to anterior humeral translation. This places strain on the static anterior shoulder stabilizers (labrum, capsule & anterior / inferior GH ligaments) and can lead to glenohumeral instability: defined as the inability to maintain the humeral head centered and/or in contact with the glenoid fossa.
- **Bicipital** or **rotator cuff tendonitis**: overuse injuries typically due to repetitive overhead activities combined with poor posture and/or abnormal or poor joint position.
- **Rotator cuff tears**: a rotator cuff injury sustained without physical trauma can be thought of as a continuation of an impingement problem, specifically of the supraspinatus tendon because it is directly under the acromion process and has very poor vascularity. Repetitive actions, especially overhead activities cause repeated microtrauma leading to the physical wearing of a hole in the involved tendon(s). This wearing is analogous to rubbing a hole in a piece of rope or wearing a hole in a pair of jeans or a sock from repeated use or wear.
- **Adhesive Capsulitis** ("Frozen Shoulder" or "Arthrofibrosis"): primarily an inflammatory over-reaction in the GH capsule and synovium in response to injury, trauma or prolonged immobilization that subsequently leads to the formation of scar adhesions and capsular fibrosis (thickening). Commonly, the axillary fold/pouch (inferior band of the inferior GH ligament) and the attachment of the capsule at the anatomic neck thickens and becomes shortened or bound down due to this process.

- **S.L.A.P. lesion**: a fraying or degeneration of the glenoid labrum and/or detachment of the long head of the biceps from the supraglenoid tubercle. 4 specific types of detachment have been classified.

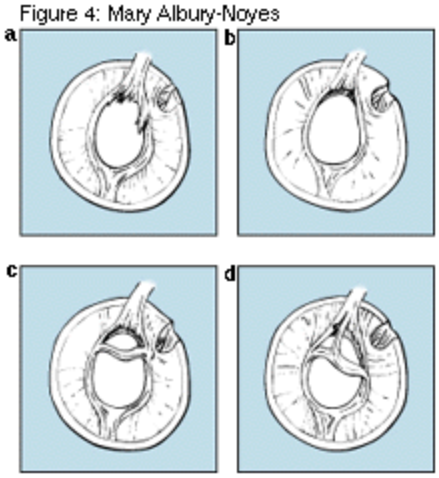
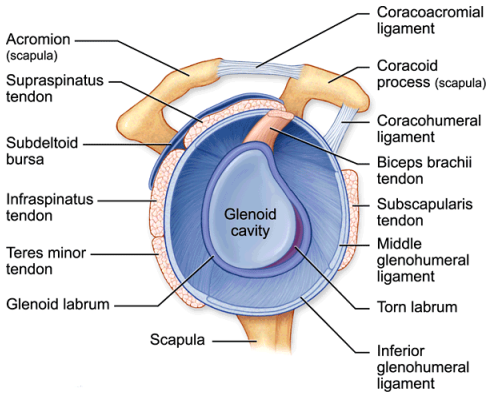
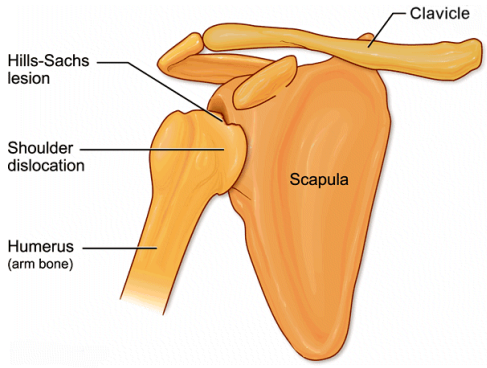


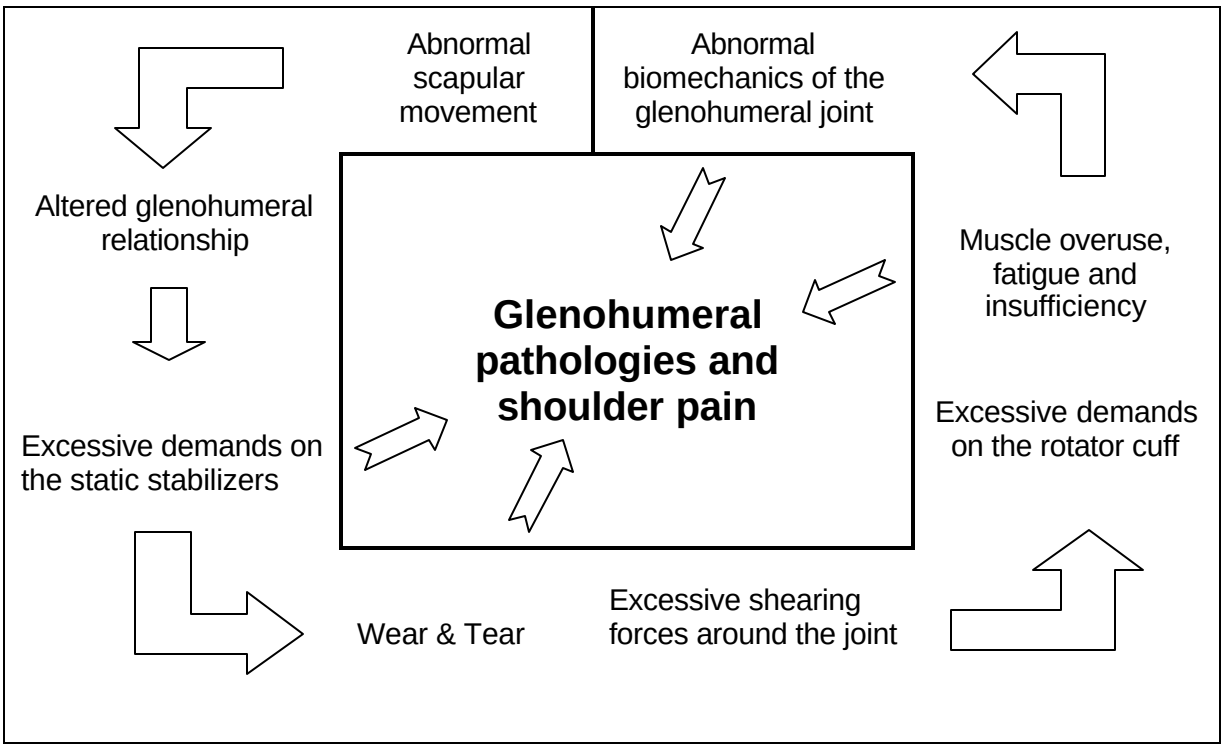
Figure 4. Four types of SLAP injuries have been described. In type 1 (a), the attachment of the labrum to the glenoid is intact, but there is evidence of fraying and degeneration. Type 2 lesions (b) involve detachment of the superior labrum and long-head tendon of the biceps from the glenoid rim. In type 3 injuries (c), the meniscoid superior labrum is torn away and displaced into the joint, but the long-head tendon and its labral rim attachment are intact. In type 4 lesions (d) the tear of the superior labrum extends into the long-head tendon, part of which is displaced into the joint along with the superior labrum. Types 2 and 4 cause shoulder instability that can be remedied by arthroscopic reattachment of the labrum to the glenoid. Types 1 and 3 do not cause instability and are usually treated with arthroscopic debridement.



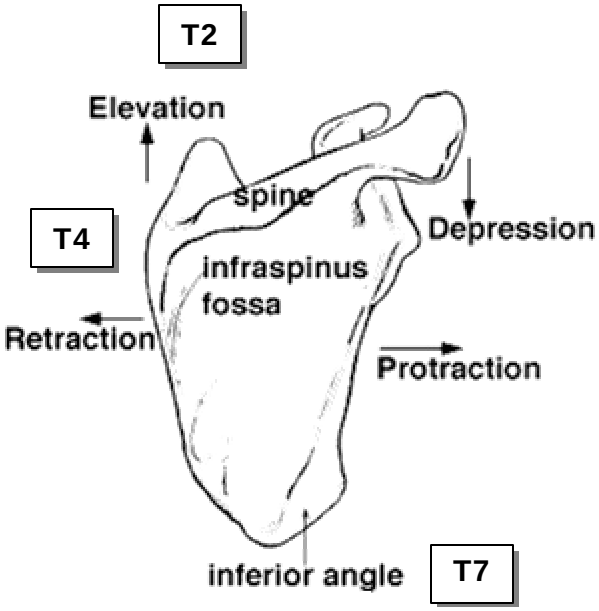


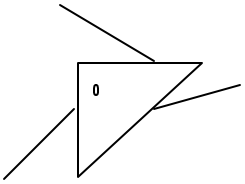
- **Bankart Lesion**: a condition in which the anterior band of the inferior glenohumeral ligament is avulsed along with a portion of the labrum from the glenoid, resulting in anterior-inferior instability.

- **Hill Sach's Lesion**: a lesion also associated with anterior inferior dislocation. A defect of the humeral head in which a portion of the posterior humeral head is fractured or compressed during dislocation. The depression caused by this defect "impales itself" on the glenoid and the labrum causing a bony lock. External rotation of the humerus can cause relocking of the shoulder, therefore therapists must be very careful when having patients perform this motion.


Abnormal scapular movement
Abnormal biomechanics of the glenohumeral joint
Altered glenohumeral relationship
Muscle overuse, fatigue and insufficiency
Glenohumeral pathologies and shoulder pain
Excessive demands on the static stabilizers
Excessive demands on the rotator cuff
Wear & Tear
Excessive shearing forces around the joint

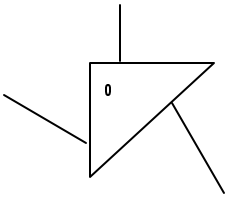
Anatomical and Biomechanical Review





Upward Scapular Rotators

1. Upper Trapezius
2. Lower Trapezius
3. Serratus Anterior



Downward Scapular Rotators

1. Levator Scapulae
2. Pectoralis Minor
3. Rhomboids

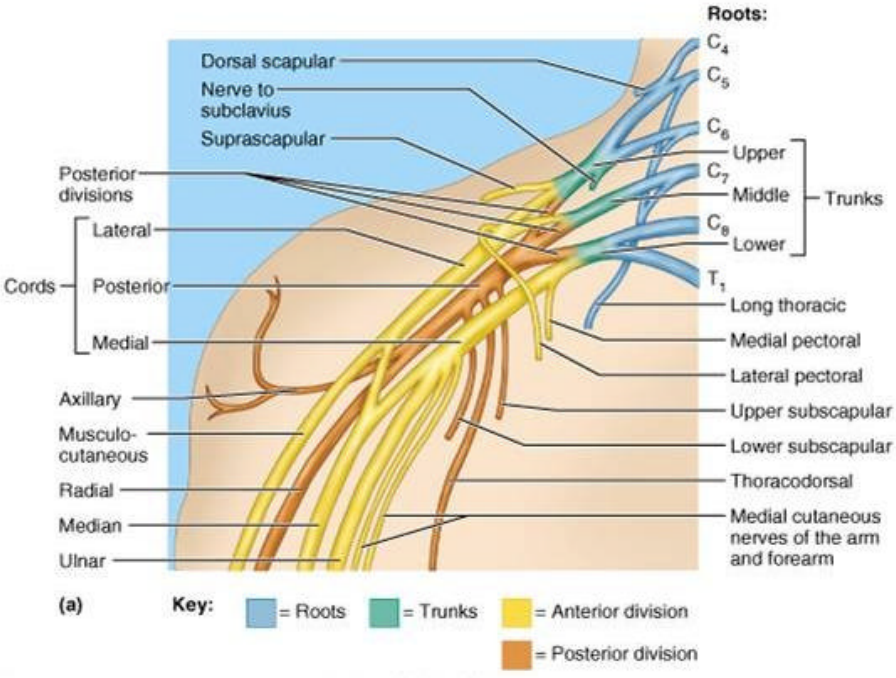
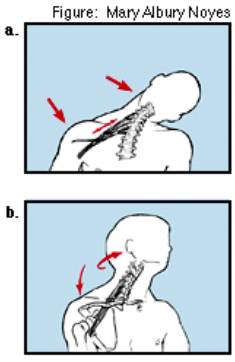


Figure 1. A blow to the head causing lateral flexion and shoulder depression may cause a traction injury (a) to the upper trunk of the brachial plexus. A compression injury (b) can occur when a blow to the supraclavicular region causes lateral flexion with rotation and extension of the cervical spine away from the blow.

Figure: Mary Albury Noyes



Muscles Attaching to Scapula

1. ◆ Rhomboid Minor
2. ◆ Rhomboid Major
3. ◆ Levator Scapulae
4. ◆ Pectoralis Minor
5. ◆ Trapezius
6. ◆ Serratus Anterior
7. ✕ Subscapularis
8. ✕ Supraspinatus
9. ✕ Infraspinatus
10. ✕ Teres Minor
11. ✕ Teres Major
12. ✕ Deltoid
13. ✳ Pectoralis Major
14. ✳ Latissimus Dorsi
15. ▸ Coracobrachialis
16. ▸ Triceps (long head)
17. ▸ Biceps (long head)
18. ▸ Omohyoid

◆ **Scapulothoracic group:** helps maintain the glenoid in an optimal position by directly controlling scapular position. The muscles in this group are the rhomboid minor and major, levator scapula, pectoralis minor, trapezius and serratus anterior. The most important stabilizers acting upon the scapula are the trapezius (middle & lower) & serratus anterior.

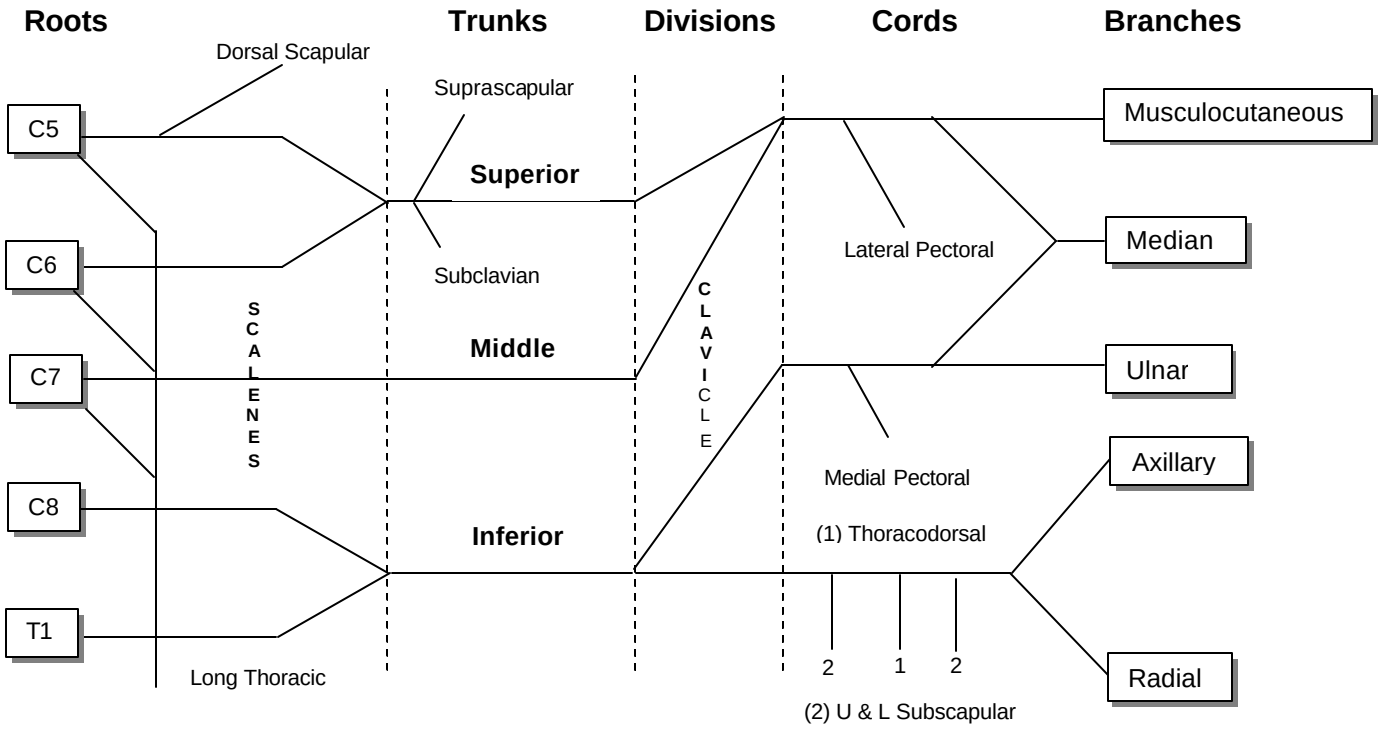
✕ **Scapulohumeral group:** supraspinatus, subscapularis, infraspinatus, teres minor and major, and deltoid originate from the scapula and besides generating movement forces they act to stabilize the head of the humerus.

✳ **Thoracohumeral group:** include the latissimus dorsi and pectoralis major muscles. The superior fibers of the latissimus dorsi frequently cover the inferior angle of the scapula during their oblique course to the humerus.

▸ **Extrinsic muscles:** coracobrachials, biceps, triceps. omhyoid, subclavius

Brachial Plexus C5 – T1

- Roots trunks, divisions (behind clavicle) + cords (in axilla) are all located in the supraclavicular triangle
- Scalenes may impinge the brachial plexus specifically the scaleneus minimus (if present.)



Musculocutaneous
1. Biceps Brachii (long + short heads)
2. Brachialis
3. Coracobrachialis

Median
1. Pronator Teres
2. Pronator Quadratus
3. Palmaris Longus
4. Flexor Carpi Radialis
5. Flexor Digitorum Superficialis
6. Flexor Digitorum Profundus 2 + 3
7. Flexor Pollicus Longus
8. Flexor Pollicis Brevis
9. Abductor Pollicis Brevis
10. Opponens Pollicis
11. Lumbricals 2 + 3

Ulnar
1. Flexor Carpi Ulnaris
2. Flexor Digitorum Profundus 4 + 5
3. Adductor Pollicis
4. Abductor Digiti Minimi
5. Flexor Digiti Minimi
6. Opponens Digiti Minimi
7. Palmaris Brevis
8. Lumbricals 4 + 5
9. 4 Dorsal + 3 Palmar Interossei

Radial
1. Brachioradialis
2. Triceps (med, lat, + long)
3. Anconeus
4. Articularis Cubiti
5. Supinator
6. Extensor Carpi Radialis Brevis
7. Extensor Carpi Radialis Longus
8. Extensor Carpi Ulnaris
9. Extensor Digitorum Communis
10. Extensor Digiti Minimi
11. Extensor Indicis Proprius
12. Extensor Pollicis Brevis
13. Extensor Pollicis Longus
14. Abductor Pollicus Longus

Axillary
1. Teres Minor
2. Anterior Mid. & Posterior Deltoid

Spinal Accessory CN X
1. Upper, Mid. + Lower. Trapezius
2. Sternocleidomastoid

Dorsal Scapular
1. Levator Scapulae
2. Rhomboid Major + Minor

Suprascapular
1. Supraspinatus
2. Infraspinatus

Medial Pectoral
1. Pectoralis Major
2. Pectoralis Minor

Lateral Pectoral
1. Pectoralis Major

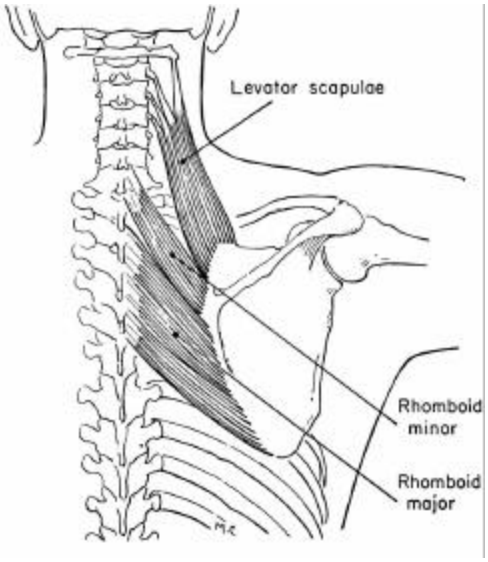
Thoracodorsal
1. Latissimus Dorsi

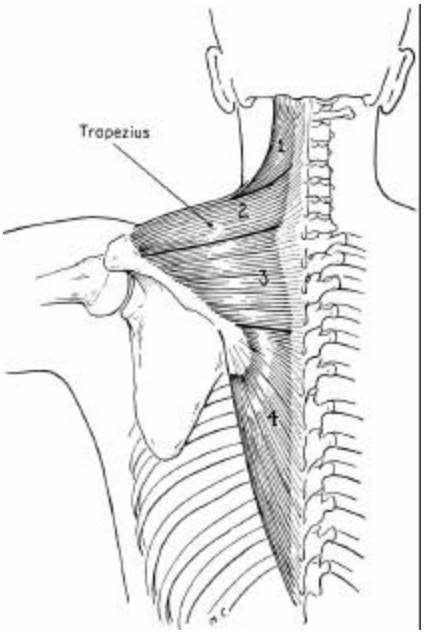
Nerve to Subclavius
1. Subclavius

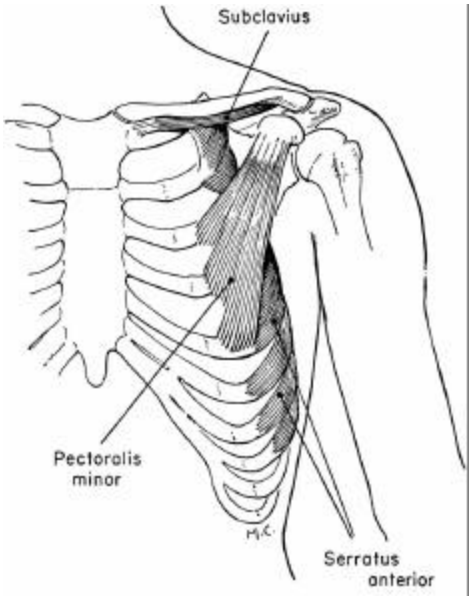
Lower Subscapular
1. Teres Major

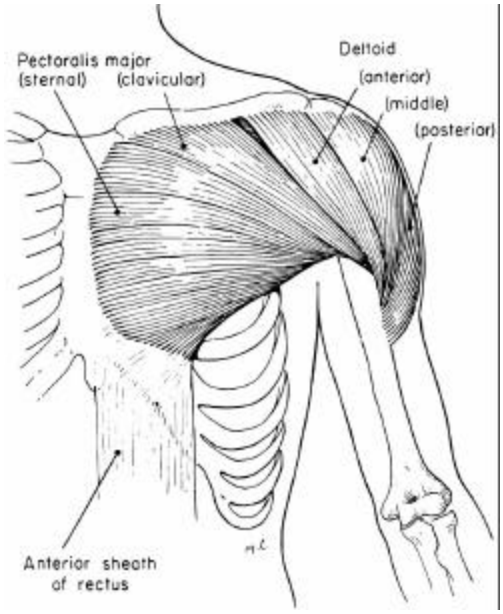
U. & L. Subscapular
1. Subscapularis

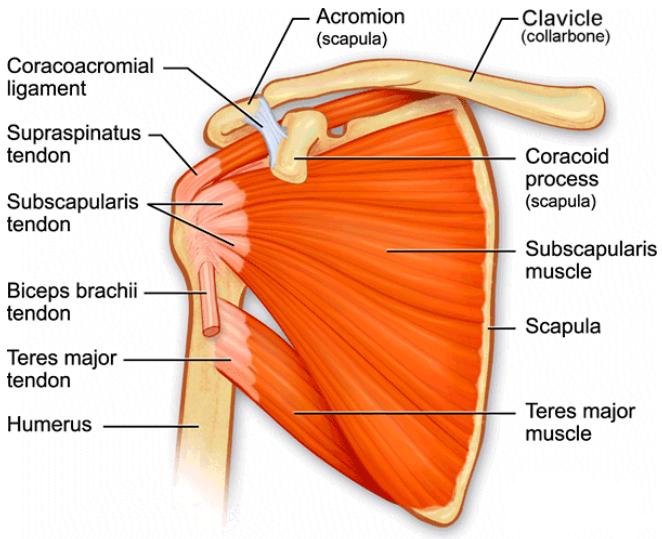
Long Thoracic
1. Serratus Anterior

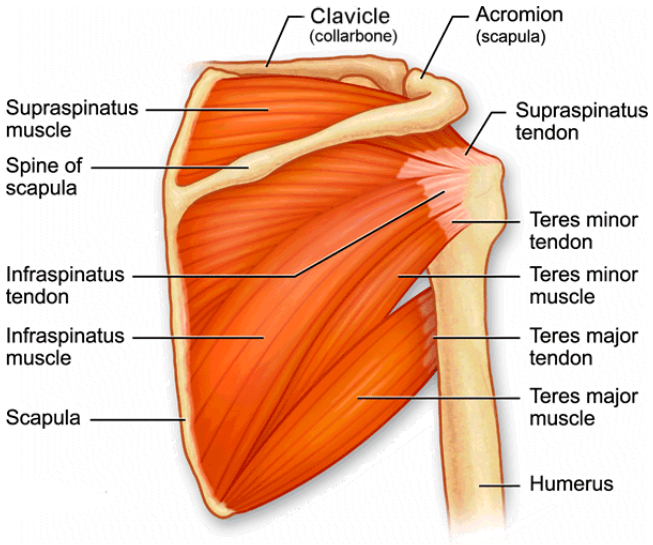

Levator scapulae
Rhomboid minor
Rhomboid major


Trapezius
1
2
3
4


Subclavius
Pectoralis minor
Serratus anterior

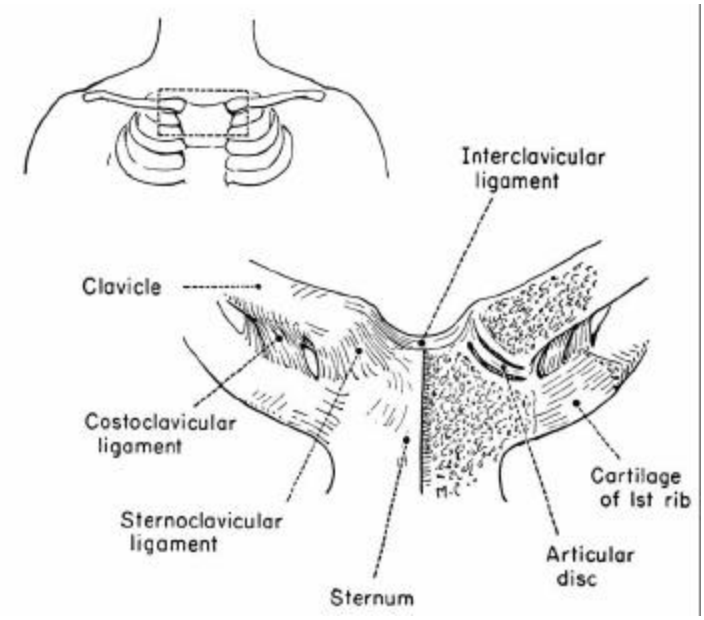

Pectoralis major
(sternal)
(clavicular)
Deltoid
(anterior)
(middle)
(posterior)
Anterior sheath of rectus


Acromion (scapula)
Clavicle (collarbone)
Coracoacromial ligament
Supraspinatus tendon
Subscapularis tendon
Biceps brachii tendon
Teres major tendon
Humerus
Coracoid process (scapula)
Subscapularis muscle
Scapula
Teres major muscle


Clavicle (collarbone)
Acromion (scapula)
Supraspinatus muscle
Spine of scapula
Infraspinatus tendon
Infraspinatus muscle
Scapula
Supraspinatus tendon
Teres minor tendon
Teres minor muscle
Teres major tendon
Teres major muscle
Humerus

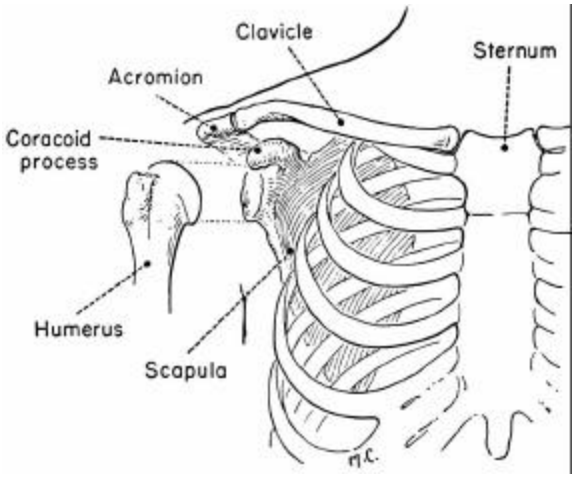
Sternoclavicular Joint

- The SC joint is divided into 2 compartments by an articular disc
- This disc articulates with the anterior and posterior SC ligaments as well as the interclavicular ligament which provides significant amount of joint stability
- The anterior and posterior SC ligaments reinforce the joint capsule anteriorly and posteriorly.
- The interclavicular ligament extends from the sternal end of one clavicle across the manubrium of the sternum to the sternal end of the other clavicle to provide stability superiorly
- The costoclavicular ligament anchors the inferior surface of the sternal end of the clavicle to the 1st rib and costal cartilage



- Dislocation of the SC joint very rare!
- In adults the clavicle will usually fracture before the SC joint dislocates
- In persons under 25 most dislocations of the SC joint results from fractures of the epiphyseal plate at the sternal end.
- With ankylosis (fixation) of the SC joint a center section of the clavicle is usually removed to create a pseudo-joint.

Acromioclavicular Joint



- Articulation of acromion & distal end of clavicle
- Acromioclavicular ligament strengthens superiorly
- Aponeurosis of trapezius & deltoid strengthen posteriorly
- Coracoclavicular ligaments further stabilizes joint:
    1. Connoid (more medial)
    2. Trapezoid

AC Joint Injury Classification

1. Grade I (sprain): partial tear of the joint capsule without joint deformity and minimal ligamentous interruption and instability.

2. Grade II (subluxation): complete tear of the AC ligament, joint is locally tender and painful with motion, the distal clavicle may protrude slightly up.

3. Grade III (dislocation): complete tear of the AC and coracoclavicular ligaments with pain on any attempt to abduct, there is an obvious “step-off” from the superiorly displaced lateral clavicle to acromion process

Glenohumeral Joint

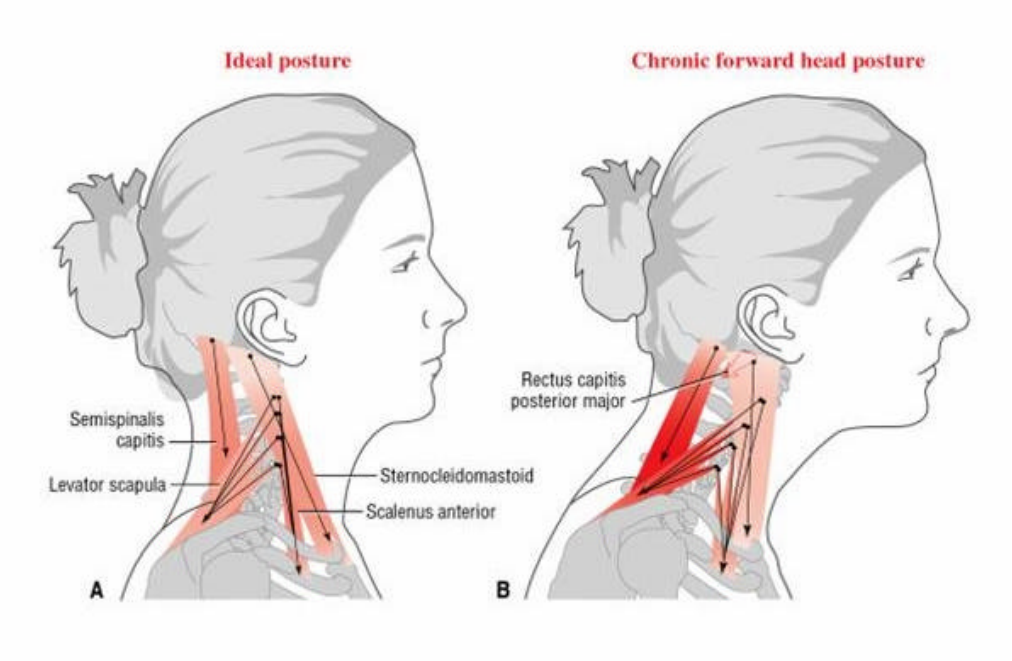
- synovial ball and socket joint with 3 degrees of freedom.
- glenoid fossa is shallow and only contacts 1/3 of the humerus at a time
- glenoid labrum deepens the articular surface for the humeral head.
- The GH joint is inherently unstable as it is designed for mobility NOT stability.

Bursae – synovial fluid filled sacs which function to decrease friction between bony prominences.

1. subacromial
2. subdeltoid
3. subscapular

Joint Capsule

The anterior and posterior circumflex arteries provide the major blood supply to the lateral portions of the capsule in aspect of the capsule is supplied by a periosteal network of the anterior part of the scapula originating from contributions from the vasculature of the over-lying subscapularis.



Stabilizing Structures of the Shoulder

1. **Glenohumeral joint capsule** - taut superiorly; loose anteriorly and inferiorly. The capsule is twice the size of the humeral head and when slack allows ~ 1“ of translatory motion. The GH joint capsule is innervated by the C5 spinal level.

2. **Glenohumeral ligaments** (3 bands all limit ER) – form a reinforcing “Z” in front of the GH joint capsule.
    1. Superior → limits inferior translation
    2. Middle → limits ER in 45° of ABD
    3. Inferior → limits ER in 90° of ABD, also limits IR.

    Arthrokinematics – During ABD + ER, joint capsule “winds up” and tightens. As a result the humeral head migrates posteriorly rather than the expected anterior direction.

    - **Foramen of Weibrecht** [8] – a point of capsular weakness between superior & middle GH ligaments which further predisposes the shoulder to anterior dislocations.
    - **Coracohumeral ligaments** – 2 bands which run from the coracoid process to the greater and lesser tuberosities. Both restrict or limit ER when the arm is ABD, and limit inferior + posterior translation when the humerus is adducted. Post. band is 1° primary restraint to shoulder flexion and anterior band is 1° restraint to extension.
    - **Axillary Pouch** – part of the inferior band of the inferior GH ligament. Allows us to get our arm overhead by permitting the humeral head to drop down inside the redundancy of the pouch. This structure may be affected in adhesive capsultits.

3. **Negative Intra-articular pressure**: Osmotic action by the synovium removes free fluid, keeping a slightly negative pressure within the normal joint. This negative intra-articular pressure holds the joint together with a force proportional to the joint surface area and the magnitude of the negative intra-articular pressure. Because the normal joint is sealed, attempted distraction of the joint surfaces lowers the intra-articular pressure even more, progressively adding substantial resistance to greater displacement. Intra-articular pressure is compromised with arthrography, arthroscopy, articular effusions, hemarthrosis, and in other situations in which free fluid is present within the glenohumeral joint. The limited joint volume effect is also compromised when the capsular boundaries of the joint are very compliant.

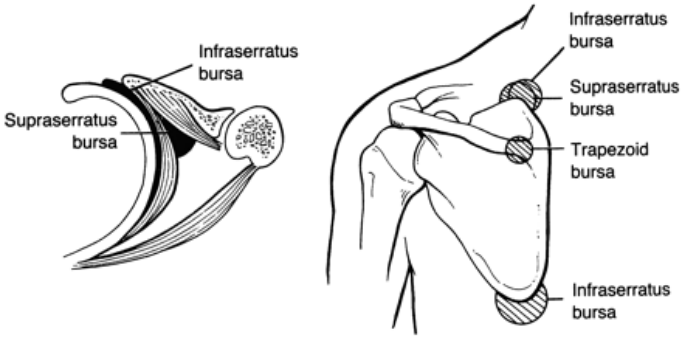
4. **Glenoid labrum**: a redundant fold of fibrous connective tissue which functions to increase articular surface area for the humeral head by deepening the glenoid fossa. Additionally the labrum cushions against impact of humeral head in forceful movements. Loosely attached superiorly, inferiorly firmly attached and relatively immobile. Serves as an attachment for the glenohumeral ligaments and the long head biceps tendon to the glenoid. Anteriorly the labrum is continuous with the inferior glenohumeral ligament. The posterior-superior labrum is continuous with the long head tendon of the biceps. This site may be more vulnerable to injury and age-related degenerative changes because of a relatively poor blood supply as the labrum has a rich vascular supply to all but its superior aspect.

5. **Rotator Cuff**: S.S.I.T.→ (**s**ubscapularis, **s**upraspinatus, **i**nfraspinatus, **t**eres minor) The rotator cuff functions as a dynamic GH joint stabilizer. Dynamic stabilization is achieved through a force couple with the deltoid. Acting alone, the deltoid produces a superior translator force on the humeral head. Along with the rotator cuff a net translatory force is produced causing simultaneous depression and compression of the humeral head in the glenoid fossa. In addition to their stabilizing roles the infraspinatus and teres minor contribute to abduction by assisting external rotation of the humerus to prevent the greater tubercle from impacting the acromion. The RTC and deltoid function in a force couple with serratus anterior, upper and lower trapezii to produce the “Scapulohumeral Rhythm”.

6. **Long head of the biceps**: proposed as a GH stabilizer functioning in humeral head depression and acceleration and deceleration of the arm. The tendon is intra-articular but extra-synovial and may have a varied origin; the posterior glenoid labrum, the supraglenoid tubercle or both.

Scapulothoracic Joint

- A 'physiologic' joint. Not a true joint because the only osseous link between the scapula and axial skeleton occurs at the clavicle. The ST joint is the least congruent joint in the body. The scapula moves through a gliding mechanism in which the concave anterior surface of the scapula moves on the convex posterolateral surface of the thoracic rib cage. Smooth scapular gliding is assisted by bursa located at the superior and inferior angles and base of the scapular spine.



Scapulo-humeral Rhythm – describes the movement of the scapula in relationship to the humerus. As the head of the humerus moves, the scapula simultaneously seeks a position of stability in relation to the humerus to maintain the humeral head in optimal alignment within the glenoid fossa. Scapulo-humeral rhythm serves at least two purposes…

1. Preservation of the length-tension relationships of the glenohumeral muscles; the muscles do not shorten as much as they would without the scapula's upward rotation, and so they can sustain their force production through a larger portion of the range of motion.

If a stable osseous base does not exist for scapular musculature, stability is sacrificed. Muscles without a stable base of origin, muscles cannot develop appropriate or maximal concentric torque, resulting in decreased strength, muscular imbalance and compensatory functioning of other muscles.

2. It prevents impingement between the humerus and the acromion. Because of the difference in size between the glenoid fossa and the humeral head, subacromial impingement can occur unless relative movement between the humerus and scapula is limited. Simultaneous movement of the humerus and scapula during shoulder elevation limits relative (arthrokinematic) movement between the two bones.

    - Initial arm position can greatly affect scapulo-humeral rhythm.
    - Produced by a force couple: RTC + deltoid; serratus anterior & upper and lower trapezius

2:1 ratio … 2° of GH motion for every 1° of ST !

1. **Glenohumeral Abduction**
    - produced by the force couple of the rotator cuff and deltoid.
    - accounts for 1/3rd (60°) of total GH motion

2. **Upward Rotation of Scapula**
    - produced by the force couple of serratus anterior and the upper and lower trapezii.
    - accounts for 2/3^{rds} (120°) of total GH motion

- remember that during the initial 60° of flexion and 30° of abduction of the humerus, the scapula seeks a position of stability in relation to the humerus, whereas the motion occurs primarily at the glenohumeral joint. This illustrates the importance of the scapula being able to maintain a position of stability prior to movement.

Lower trapezius activation is essential in maintaining the normal path of the instant center of scapular motion as the arm elevates. This is due to the muscle's mechanical advantage of its attachment to the medial aspect of the scapular spine which progresses to a straight line of pull as the arm elevates.

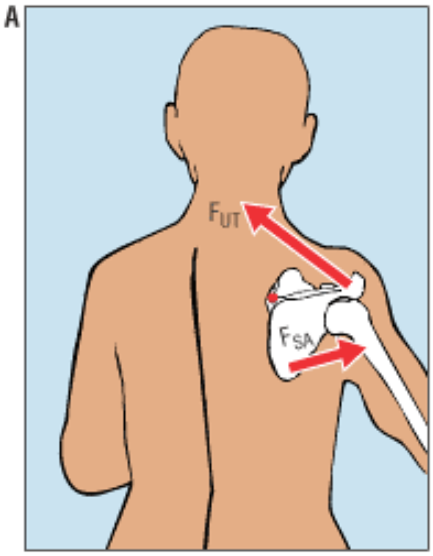
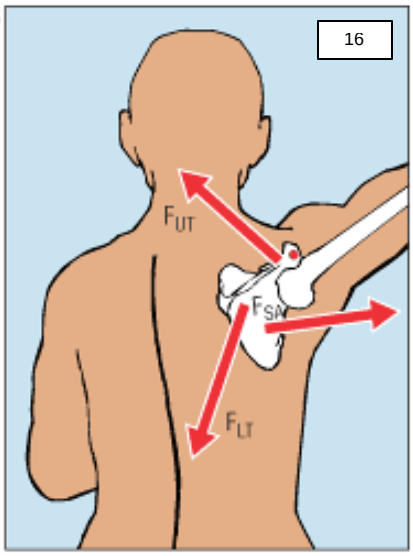
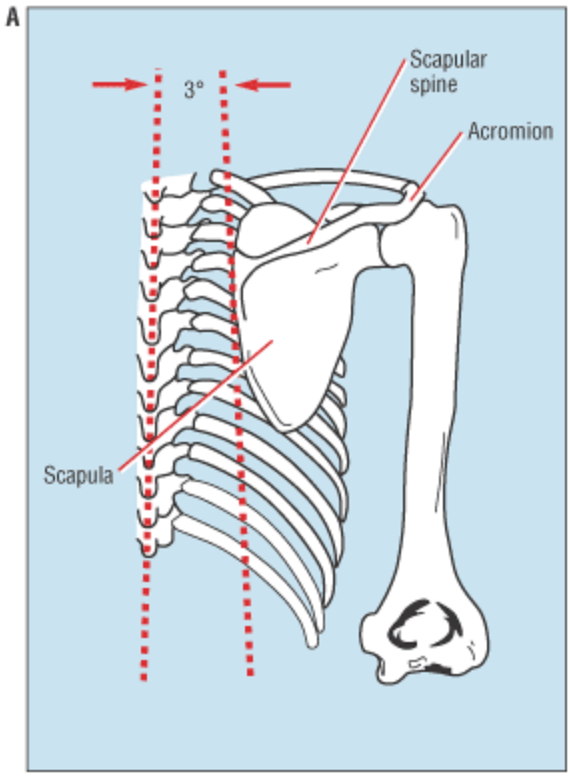


FIGURE 2. At less than 100° humeral elevation (A), the force of the upper trapezius fibers (F_{UT}) counteracts the lateral pull of the deltoid and upwardly rotates the acromion. Simultaneously,. the serratus anterior (F_{SA}) protracts the scapula and pulls the inferior angle anterolaterally (arrow). These two muscles act as a force couple, causing upward scapular rotation around the root of the scapular spine (red dot).



When the humerus is raised above 100° (B), the scapula begins to rotate around the acromioclavicular joint (blue dot). At this point, the lower trapezius (F_{LT}) becomes more active as the lower serratus anterior (F_{SA}) fibers drag the inferior scapular angle inferolaterally. These muscle force couples act synergistically to shift the glenoid to maintain glenohumeral congruity during the humeral elevation.

Figures 1-2: Mary Schill



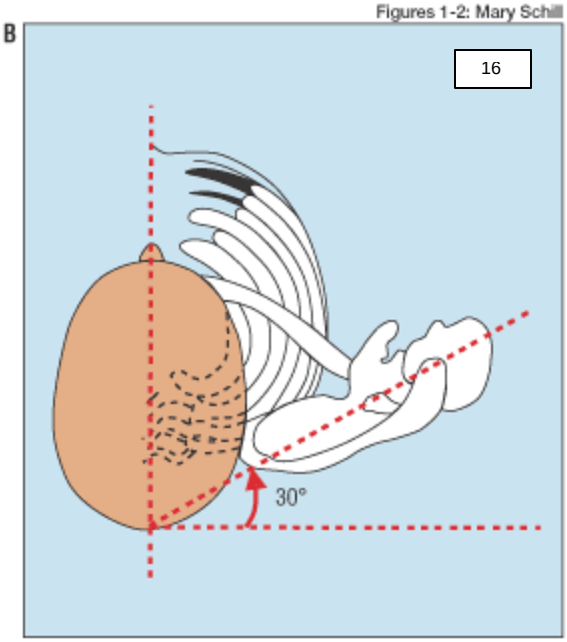
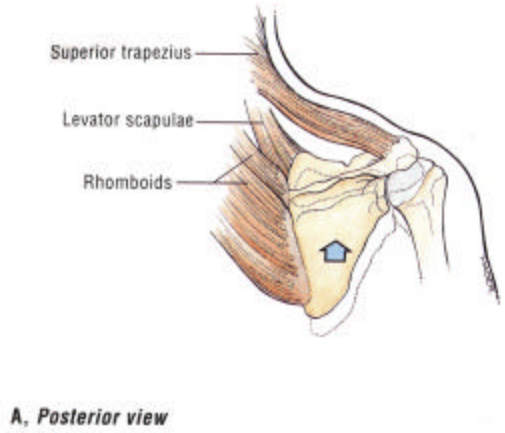
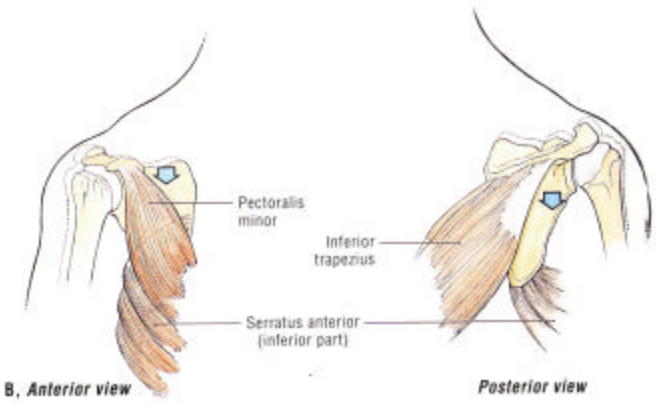


FIGURE 1. A posterior view of the scapula in the coronal plane (A), and a superior view of the position of the scapula in the transverse plane (B). The medial border of the scapula is not parallel to the spine but deviates 3° laterally. The scapula has a 30° anterior angulation relative to the coronal plane. This angulation is commonly referred to as the plane of the scapula.

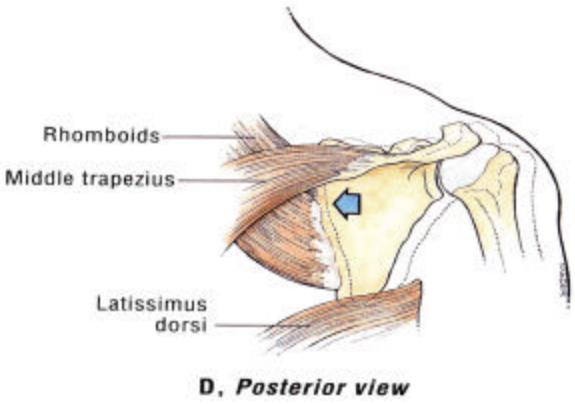
Scapular Elevation



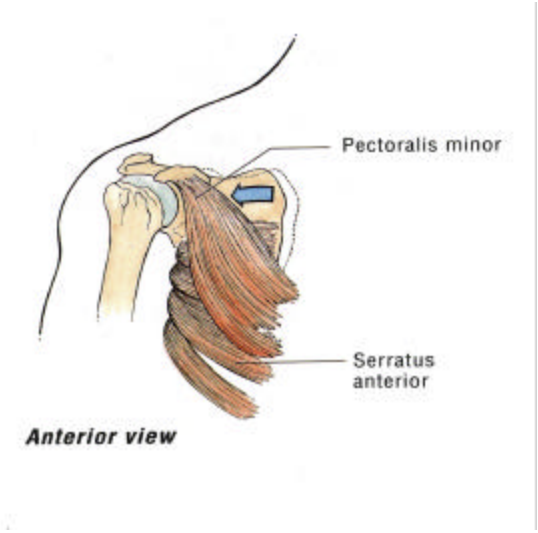
Scapular Depression



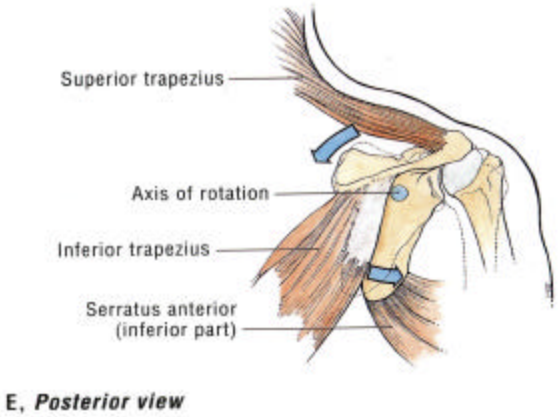
Scapular Retraction



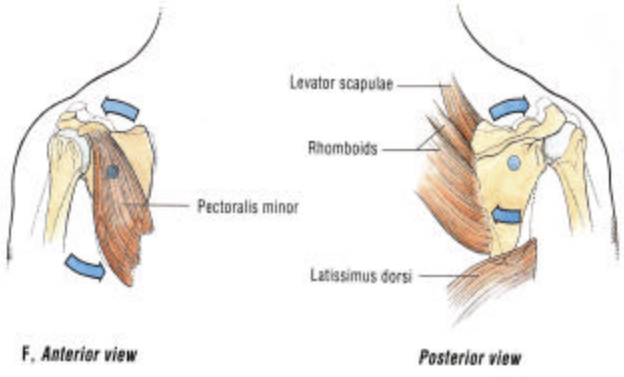
Scapular Protraction



Upward Rotation



Downward Rotation



Patient Examination [1]

Ideally, the patient should be examined with their shirt off or in a sports bra to thoroughly assess posture, quality of motion and strength. Examine overhead shoulder motion in ascending and descending phases. Abnormalities typically present in the descending phase during eccentric lowering. When the scapula is unstable an actual reversal of muscle origin and insertion occurs. This reversal of muscle function pulls the scapula laterally because the more stable and distal end is the humerus rather than the proximal end of the scapula. This is referred to as a 'reverse scapulohumeral rhythm' and is characterized by "shoulder hiking" followed by excessive scapular movement with activities > than 60° of flexion or abduction. At ~ 60° of abduction the deltoid has its highest mechanical advantage.

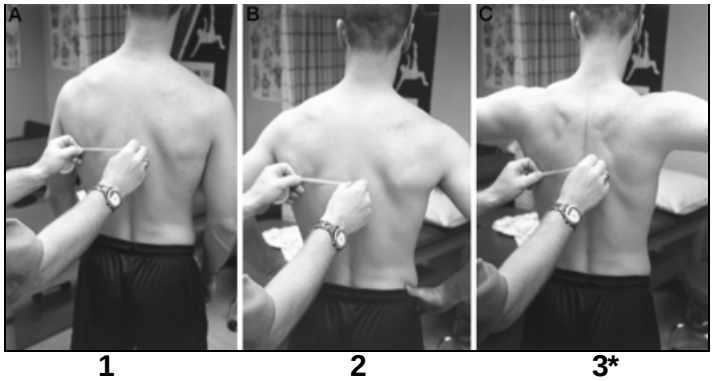
- ✓ or rule out the presence of cervical pathology (radiculopathy, lateral foraminal stenosis, etc.)
- ✓ increased thoracic kyphosis or cervical lordosis → forward head rounded shoulders posture
- ✓ for thoracic spine extension restrictions: t-spine restrictions can lead to lower trapezius inhibition.
- ✓ scoliotic curves or abnormal curvature creates an abnormal surface contour for scapular motion.
- ✓ position of affected shoulder in bilateral comparison (carrying position at rest): with long standing dysfunction winging at rest may be seen.
- ✓ level of shoulders and contour of clavicles.
- ✓ bony prominences: inferior angle, vertebral scapular borders, anterior tipping, level of coracoids.
- ✓ muscular bulk and symmetry → atrophy? spasm? tenderness? adaptive shortening?
- ✓ palpation of soft tissue structures for point tenderness or trigger points

- ❑ **Scapular Retraction Test (SRT)** [1] **–** designed to evaluate rhomboids strength. The patient is asked to retract both shoulders and sustain an isometric contraction for approximately 10 – 15 seconds or longer. An inability to maintain a sustained contraction along with pain or burning in the region of the rhomboids suggests paresis. Questionable if this technique is superior to a simple rhomboid MMT.

- ❑ **Scapular Assistance Test (SAT)** [1] – useful for determining if impingement symptoms are the result of poor scapular control or weakness in the serratus anterior or lower trapezius musculature. The examiner pushes laterally and upward on the inferior medial scapular border to simulate the serratus anterior/lower trapezius portion of the elevation force couple. A positive test is indicated by a decrease or abolishment of impingement symptoms suggesting paresis or inhibition of the serratus anterior and lower trapezius muscle(s).

- ❑ **Lennie Test –** compare scapular measurements at 3 positions
  1. T2 (superior angle) 2. T4 (scapular spine) 3. T7 or T8 (inferior angle)

- ❑ **Lateral Scapular Slide** [2] – utilizes the measurement of the amount of lateral scapular 'slide' from a fixed vertebral landmark in 3 positions of increasing muscular demand.



1 **2** **3***

Position 2: minimal activation of serratus anterior & middle traps.

Position 3: upper and lower traps, serratus anterior & rhomboids work at 40% of maximum.

*A 1 – 1.5 cm (0.75") difference suggests abnormality: usually seen in position 3 (Kibler).

- ❑ **Scapular Load Test –** in addition resisted testing may be performed at positions 1, 2, 3 and at 120 & 150° of elevation to examine for the presence of dynamic scapular winging.

Glenohumeral Stability Tests [9]

- **Inferior sulcus sign:** tests for inferior instability of the gleno-humeral joint by assessing the integrity of the coracohumeral and superior glenohumeral ligaments. The examiner stands beside the patient with the patient's arm hanging at his side. The examiner then gives an inferiorly directed traction to the shoulder (pulls down on the elbow) a positive test results when there is a noticeable inferior slide of the humeral head or where there is a marked increase in the space between the humeral head and the acromion. The scale is below used to grade the sulcus:
  - .5 – 1 cm = + 1 sulcus
  - 1 – 2 cm = + 2 sulcus
  - 2 – 3 cm = + 3 sulcus
- **Feagin Test:** another test for inferior glenohumeral instability. The patient's arm is abducted to 90° with their distal forearm resting on the examiner's shoulder. The examiner cups or clasps their hands together on the top of the subject's proximal humerus approximately at the level of the belly of the biceps and exerts an anterior-inferior directed force. Pain or apprehension is a positive test.
- **Apprehension (Crank) test for anterior shoulder dislocation:** a test designed to determine whether a patient has a history of anterior dislocations. With the patient supine, the examiner slowly abducts and externally rotates the patient's arm. The test is positive is the patient becomes apprehensive and resists (muscle guards) against further motion. No translation should be expected in the normal shoulder because this test is performed in a position where the anterior ligaments are placed under tension.
- **Jobe Relocation Sign:** performed in conjunction with the crank test. A posterior directed force is applied to the test extremity resulting in the disappearance of patient's apprehension or muscle guarding.
- **Apprehension test for posterior shoulder dislocation:** a test designed to determine whether a patient has a history of posterior dislocations. With the patient supine, the examiner slowly flexes the patient's arm to 90° and the patient's elbow to 90°. The examiner then internally rotates the patient's arm. An axial load is then applied to the patient's elbow. The test is positive if the patient becomes apprehensive and resists (muscle guards) against further motion.
- **Jerk Test:** another test for posterior glenohumeral instability. With the patient lying supine and a pillow resting under the scapula of the test side, the test extremity is axially loaded through the elbow and taken into horizontal adduction. (forward flexed and internally rotated to 90°) The feeling of a sudden 'jerk' caused by the subluxing of the humeral head off the back of the glenoid is indicative of a positive test for posterior glenohumeral instability. Reduce by removing axial load and taking test extremity into ABD and ER allowing an anterior roll and glide of the humeral head. As the arm is returned to the original position of 90-degree abduction, a second jerk may be observed, that of the humeral head returning to the glenoid.

Glenoid Labrum Tear/Pathology [9]

- **Clunk (Labral) Test:** a test used to determine if there is a tear of the glenoid labrum. The examiner is standing at the head of the patient who is lying supine. The examiner places one hand under the posterior portion of the shoulder while the other holds the arm just proximal to the elbow. The examiner takes the test extremity and fully abducts it over the patient's head and simultaneously moves the humeral head anteriorly with the proximal hand and while externally rotating the humerus with the distal hand. The presence of a "clunk" or grinding sensation at the glenohumeral joint indicates a positive test for a labral tear. The test may also cause apprehension if anterior instability is present.

Rotator Cuff Integrity Tests [9]

- **Empty-Can (Supraspinatus) test:** a test designed to identify a tear in the supraspinatus tendon. The patient is either seated or standing. The patient's upper limbs are positioned horizontally at 30° anterior to the frontal plane, abducted to 90° and internally rotated. (empty-can position) The examiner applies a downward force on the patient's limbs. The test is positive if pain and weakness are present.
- **Drop-arm (Codman's) test:** a test designed to determine presence of a torn rotator cuff. With the patient seated, the examiner abducts the patient's shoulder to 90°. The patient is then asked to slowly lower the test extremity to their side. The test is positive if the patient is unable to lower the arm slowly to their side in the same arc of movement or has severe pain when attempting to do so. This is a highly provocative test because it requires eccentric contraction of the supraspinatus.
- **Gerber Lift-Off Sign:** a test used to rule out a rupture of the subscapularis tendon. The patient is seated or standing with the test arm behind their back; hand resting on their flank. The examiner stabilizes the patient's scapula while moving the resting arm away from the body. Apprehension, muscle guarding or pain localized to the anterior shoulder may indicate rupture.

Impingement Tests [9]

- **Neer test:** a test to identify impingement of the supraspinatus tendon or long head of the biceps in the coracoacromial arch. While stabilizing the scapula, the examiner internally rotates the shoulder and then brings the shoulder into flexion. Pain reproduced over the coracoacromial arch indicates a positive test.
- **Kennedy – Hawkin's test:** the examiner brings the patient's arm into 90° of flexion with the elbow bent to 90°. The arm is then forced into internal rotation. Pain over the coracoacromial arch would indicate a positive test for impingement.
- **Cross – Over Impingement (Horizontal adduction) test:** a test designed to identify inflammation of tissues within the subacromial space. The patient's test extremity is moved into internal rotation and horizontal flexion (a.k.a. horizontal adduction) by the examiner. This maneuver is thought to decrease the space between the head of the humerus and acromion process. The test is positive if the patient reports pain, indicating impingement of long head of the biceps or supraspinatus tendon.

Bicipital Tendonitis [9]

- **Speed's test (biceps test):** a test designed to determine whether bicipital tendonitis is present. With the forearm supinated and elbow fully extended, the patient tries to flex the arm against resistance applied by the examiner. The test is positive if the patient reports increased pain in the area of the bicipital groove. Pain is due to biceps tendon attempting to slide or move inside the bicipital groove while inflamed.
- **Yergason's biceps tendonitis test:** a test designed to identify tendonitis of the long head of the biceps. The seated patient's arm is positioned at his or her side with the elbow flexed to 90°. Supination of the forearm against resistance produces pain in the biceps tendon in the area of the bicipital groove.

Subluxing Biceps Tendon [9]

- **Transverse Humreral Ligament (Booth & Marvel) test:** this test indicates a rupture or stretching of the retinaculum or transverse humeral ligament holding the long head biceps tendon in the bicipital groove. The examiner bends the elbow to 90° with the shoulder relaxed. The examiner then gently pulls inferiorly on the elbow putting traction on the shoulder joint and then attempts to externally rotate the shoulder. The free hand should palpate over the biceps groove feeling for a subluxation (popping) of the tendon from the groove. Subluxation, pain, popping or clicking indicates a positive test.

Ruptured Biceps [9]

- **Ludington's test:** a test designed for determining whether there has been a rupture of the long head of the biceps tendon. The patient is seated and clasps both hands on top of his or her head, supporting the weight of the upper limbs. The patient then alternately contracts and relaxes the biceps muscles. The test is positive if the examiner cannot palpate the long head of the biceps tendon of the affected arm during the contractions.

SLAP Lesions [9]

- **Anterior slide:** Patient stands with hands on hips. One of the examiner's hands is placed over the shoulder and the other hand behind the elbow. A force is then applied anteriorly and superiorly, and the patient is asked to push back against the force. The test is positive if pain is localized to the antero-superior aspect of the shoulder, if there is a pop or a click in that region, or if the maneuver reproduces that patient's symptoms.
- **O'Brien test:** The patient's shoulder is held in 90° of forward flexion, 30 to 45° of horizontal adduction and maximal internal rotation. The examiner grabs the patient's wrist and resists the patient's attempt to horizontally adduct and forward flex the shoulder. Pain, clicking or apprehension suggests a positive test.
- **Crank test:** The patient's shoulder is abducted 90° and slowly internally and externally rotated while a gentle axial load is applied through the glenohumeral joint. The test is considered positive if the patient reports pain, catching, or grinding in the shoulder suggesting impingement of the superior labrum between the humeral head and glenoid.

AC Joint Integrity [9]

- **AC Shear Test:** a test used to assess the integrity of the acromioclavicular or coracoclavicular ligaments. The examiner cups their hands cup over the patient's shoulder (acromion + coracoid processes) and compresses. A positive test is indicated by pain due to tearing of the connoid and trapezoid ligaments attaching to the clavicle. MOI is typically a fall on an outstretched hand causing the acromion to be forcefully jammed up under the clavicle. Since the Upper Trap + Deltoid normally create a tonic pull on the clavicle you see what is referred to as a "step – off deformity"

- **Active Compression Test**: used to assess AC joint integrity and also useful in ruling out a potential S.L.A.P. lesion. The examiner stands behind the patient asking the patient to actively elevate the test extremity to 90° of flexion, ~ 10 – 15° of adduction and maximal internal rotation. The patient is then instructed to resist the examiner applying a uniform downward force directly below the olecranon process. It is important to ensure the patient is resisting the examiner's downward force and not the examiner resisting the patient's attempt to actively forward flex the humerus past 90° otherwise false interpretations may result. The test is only considered to be positive if the patient reports alleviation of pain or symptoms with maximal supination or external rotation of the hand.

    (a) SLAP reasoning: with the arm place in the above described test position, the theory is the long head of the biceps is displaced medially and inferiorly, placing tension on the bicipital-labral complex and creating shear forces at the glenoid. Test only differs from O'Brien's test in amount of adduction.

    (b) AC joint reasoning: with the arm place in the above described test position the belief is maximal tension is placed on the AC joint and if the coracoclavicular ligaments are stable it is the result of the greater tubercule rotating under the acromion and by positioning elevates the inferiorly displaced caroming thereby "locking & loading the AC joint.

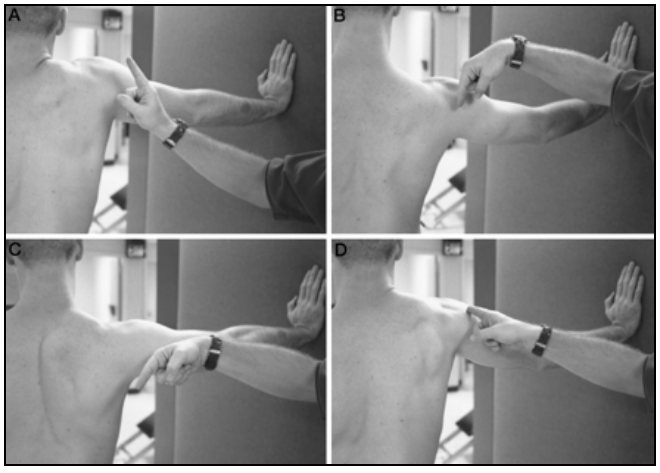
Rehabilitation Suggestions & Considerations

Rehabilitation is based on a proximal → distal regain of motion, control, and strength, however always remember nothing is set in stone, each patient must have an individualized exercise prescription!

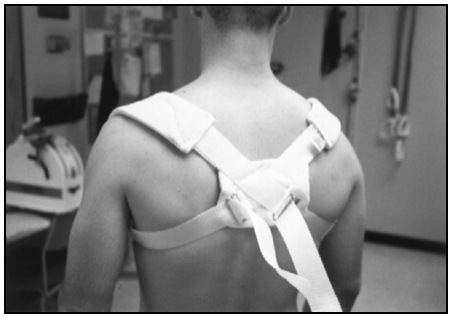
- r/o out the possibility of an undiscovered brachial plexus injury (Erb's or Klumpke's palsies?)
  - ➲ was there a positional mechanism of injury?
- Remember to ask about vocation! → desk job? Repetitive or excessive overhead manual labor?
- Is patient's sleeping positions contributing to problem? Night pain? Think impingement!

Acute Phase (0 – 3 weeks)

- avoid painful UE movements (usually > 90° ✓, ABD) & fatigue of the scapulohumeral/thoracic muscles.
- correct postural dysfunction: lumbar, thoracic or cervical.
- start at the base of the kinetic chain: look for thoracic or lumbar strength/flexibility issues
- include activities which involve using of hip and trunk musculature (mass movement patterns)
  - ➲ trunk strengthening: abdominal crunches and/or prone UE/LE opposition for para-spinals)
  - ➲ trunk extension + lateral rotation facilitates scapular retraction.
  - ➲ trunk flexion + medial rotation facilitates scapular protraction
- regain proximal scapular control and strength including trunk flexibility before loading the rotator cuff!
- soft tissue or joint mobilization if indicated: weak muscles cannot be strengthened if their antagonist counterparts are adaptively shortened and not stretched
  - ➲ Scapular retractions combined with massage to ↓ contracture of coracoid based muscles.
  - ➲ Myofasical release near anterior clavicle or delto-pectoral triangle.
  - ➲ Manual stretching of scalenes, levator scapulae, pectoralis minor.
  - ➲ "Sleeper" stretches to stretch posterior capsule and posterior rotator cuff muscles.
  - ➲ Posterior GH joint mobs (1 – 2). Posterior GH capsule restrictions will cause abnormal anterior and superior humeral translations (GH capsular restrictions tend to be inferior and posterior)
  - ➲ start off with closed chain (CKC) activities before progressing to open chain (OKC). CKC activities help to reproduce or provide proprioceptive stimulation to joint mechanoreceptors (GTO, mm spindle etc,) which helps to reorganize and re-establish normal muscle firing patterns. In addition CKC activities are protective in that they help to decrease muscular shear force on injured joints or healing tissues by promoting muscular co-contraction. [9]
- pain relief modalities as needed (IFC, US, iontophoresis, cryotherapy, vapo-coolant spray and stretch)
- CKC activities can include weight shifts, scapular clock (below), rhythmic ball oscillations (< 90°) and wall-push ups.



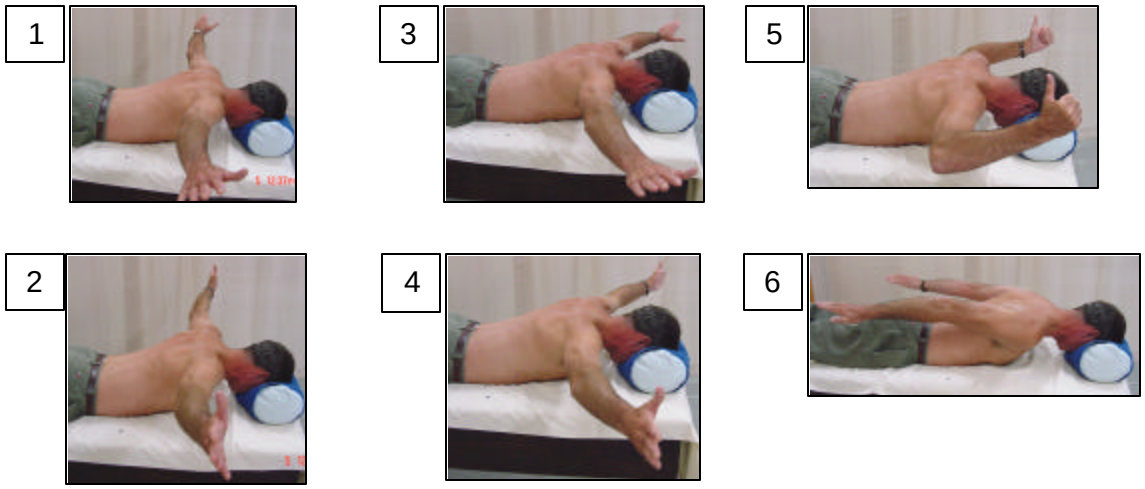
Closed Chain Scapular Clock Exercises [2]



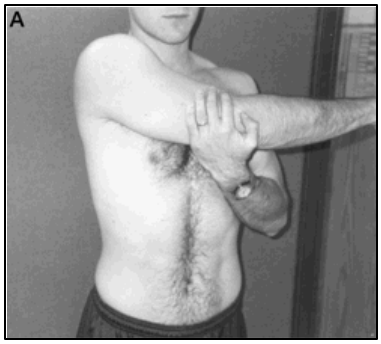
A figure 8 clavicle collar may be used in acute stages to assist scapular elevation and retraction by helping to sensitize glenohumeral proprioceptors. [2]

Recovery Phase (3 – 8 weeks)

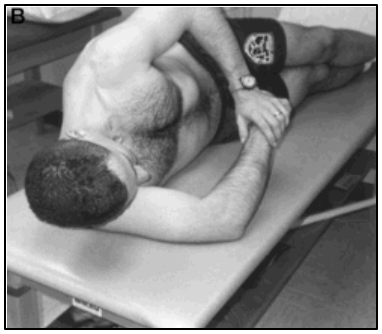
- Begin with isometric → active assistive → concentric → eccentric contractions.
- If initial loads are too great during active arm elevation use axially-loaded AROM exercises (using a wall, table or ball) as a transition to OKC exercises. [1, 12]
  - ➲ Flexion or scaption slides
  - ➲ Abduction or diagonal glides
  - ➲ Finger ladder (avoiding positions > 90° flexion or abduction until substitutions eliminated)
  - ➲ Wand/cane exercises.
- Begin kinetic chain tubing exercises
  - ➲ PNF D2 pattern
  - ➲ 'Fencing' exercise
- Blackburn exercises: # 1 – 6 (do not use dumbbells until the required loads exceed 5 pounds) [13]



- standing ER with theraband towel roll under axilla cueing pt. to avoid trunk rotation.
- side lying ER (no > 5# initially) with towel roll under axilla emphasizing technique & slow eccentric lowering.
- single arm "bow pulls" emphasizing scapular 'setting' retraction before initiating movement.



Posterior shoulder capsular stretching. To the left, motion is mainly between scapula and thoracic wall, which increases scapular slide because the scapula is not stabilized. To the right "sleeper stretch" (scapula stabilized) allows stretch at appropriate location: teres minor, infraspinatus, posterior deltoid & posterior inferior capsule/glenohumeral ligament [2]



- serratus anterior punch/press into wall with pillow or deflated ball. (standing, arm neutral at side elbow in 90° of flexion) progress to arm at or just below 90°
- standing alternating unilateral "serratus press" with ipsilateral LE lunge using thera-band. [12]
- Supine AG "serratus-press" with cuff weights on arm (start in retraction end in protraction).
- Seated rows emphasizing setting of the scapula prior to each repetition, finishing each set in retraction.
- Prone unilateral arm raises; without → with weight (same position as lower trapezius) MMT [14]
- Shoulder horizontal extension with external rotation; without → with weight in prone (works mid trap) [14]

Maintenance Phase (6 – 10 weeks)

- Must have good scapular control and motion throughout range of shoulder motion for this phase.

➲ plyometrics with medicine ball: [2]
plyometric activities dynamically challenge scapular stabilizers. The weight of the ball provides an eccentric stretch which is then converted to a concentric contraction. Progress to unilateral throwing of smaller weighted medicine balls or bilateral overhead ball toss against a spring trampoline.

- combine OKC UE exercises with LE and trunk mass movement patterns.
  - ➲ "lawn mower" exercise [1, 9]
  - ➲ shoulder flexion with ipsilateral step-up [1, 9]
- lower trap pulls with TB (*squeeze/pinch shoulder blades)
- middle trap pulls with TB (*palms up, externally rotate and retract shoulders)
- scapular retraction depression with thera-band (4 positions) [13]
  - ➲ hold 6 seconds. Maintain good head and neck posture in each of the four positions:




- modified push-ups ("**push ups with a +**") [1, 15]
- seated scapular depressions
  - ➲ chair push ups or seated dips (keep elbows locked!).
- closed chain scapular elevation/depression, protraction/retraction ("scapular clock") against wall in both flexion and abduction. (place opposite arm back behind head to promote good posture).
- prone 1-arm rows: arm at 0°, 45° and 90° of ABD. [14]
- latissimus pull downs → works downward scapular rotation, aids in lumbar stabilization and may help to decrease inferior angle protrusion due to the latissimus attachment to the inferior angle.
  - ➲ squeeze shoulder blades together at the start and finish of each repetition.
- standing against wall w/ VB behind occiput
  - ➲ ball provides proprioceptive input to maintain cervical lordosis, while scapular and shoulder muscles are strengthened.
    - Forward, lateral raises (avoid motion greater than 90° initially)
    - "Scaption" arm in 30 – 45° abduction
- Rhythmic stabilization of rotator cuff muscles:
  - ➲ Patient supine, arm straight with closed fist; therapist taps affected arm ⇆,⇅, and on diagonals.
  - ➲ Progress to patient standing with arm at or below 90°
- Eccentric lowering activities against finger ladder; provides visual feedback to control UE descent.

Guidelines for Integrated Rehabilitation of Scapular Dyskinesis [1]	
Exercises	Weeks (estimate)
Scapular Motion	
Thoracic posture	1 – 3
Trunk flexion/extension/rotation	1 – 3
Lower abdominal / hip extensors	1 – 5
Muscular Flexibility	
Massage	1 – 2
Modalities (US, electrical stimulation)	1 – 3
Stretching (AA, Passive, PNF)	1 – 8
Corner stretches (pectoralis minor)	1 – 3
Towel roll stretches (pectoralis minor)	1 – 3
Levator scapulae stretches	1 – 3
"Sleeper" position stretches (shoulder external rotators)	1 – 3
Closed Kinetic Chain Co-contraction Exercises	
Weight shifting	1 – 2
Balance board	1 – 2
Scapular clock	1 – 2
Rhythmic ball stabilization	2
Weight-bearing isometric extension	1 – 2
Wall push-ups	2
Table push-ups	3 – 5
Modified prone push ups	5 – 8
Axially Loaded AROM Exercises	
Scaption slide	2 – 5
Flexion slide	2 – 5
Abduction glide	3 – 5
Diagonal slides	2 – 6
Integrated Open Chain Exercises	
Scapular motion exercises plus arm elevation	3 – 8
Unilateral/bilateral tubing pulls with trunk motion	4 – 8
Modified lawn mower series	3 – 6
Dumbbell punches with stride (progressive height & resistance)	6 – 8
Lunge series with dumbbell reaches	5 – 8
Plyometric Sports Specific Exercises	
Medicine ball and catch	6 – 10
Reciprocal tubing exercises	6 – 10

Muscular Strength of the Shoulder Complex

1. adduction
2. extension
3. flexion
4. abduction
5. internal rotation
6. external rotation

STRONGEST

WEAKEST

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