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Clinical Mechanics of the Shoulder

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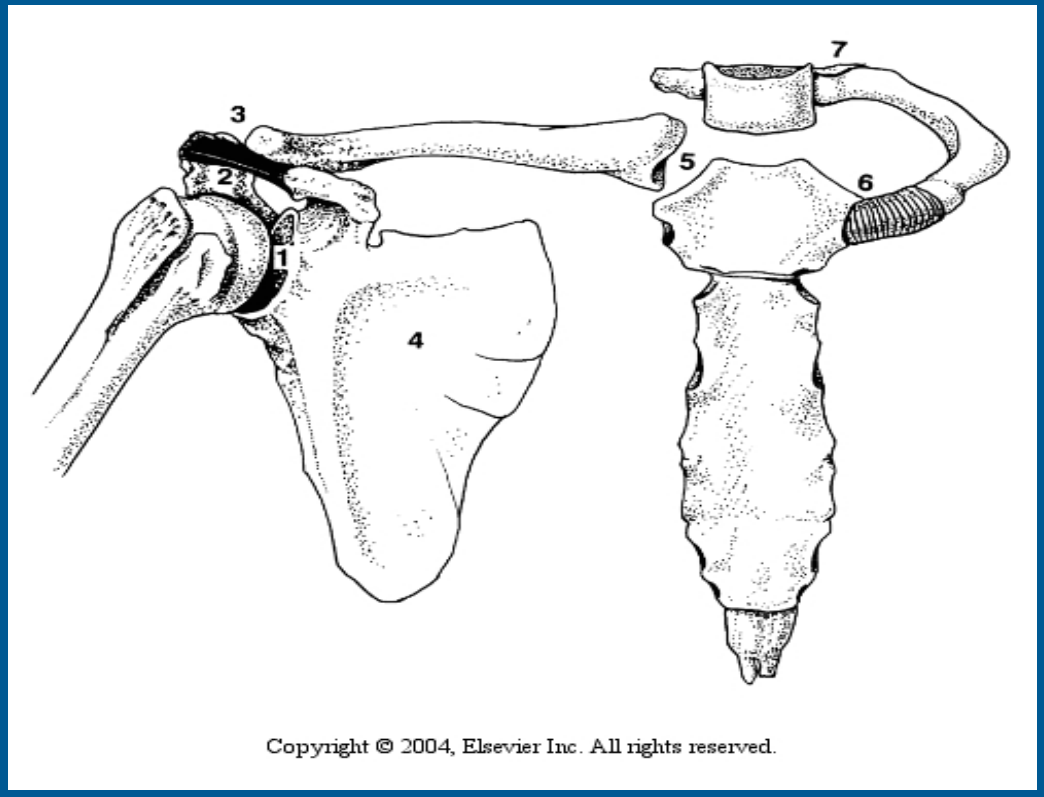
Objectives

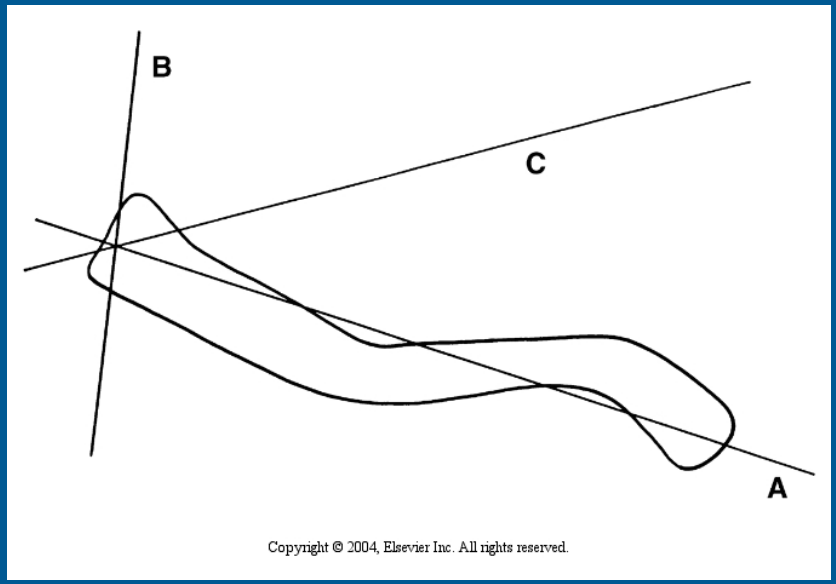
1. Correctly identify the structures and understand the biomechanics of the shoulder.
2. Identify necessary components of assessment for examination of the shoulder.
3. Identify common pathology of the shoulder.

The Shoulder Complex



Bones

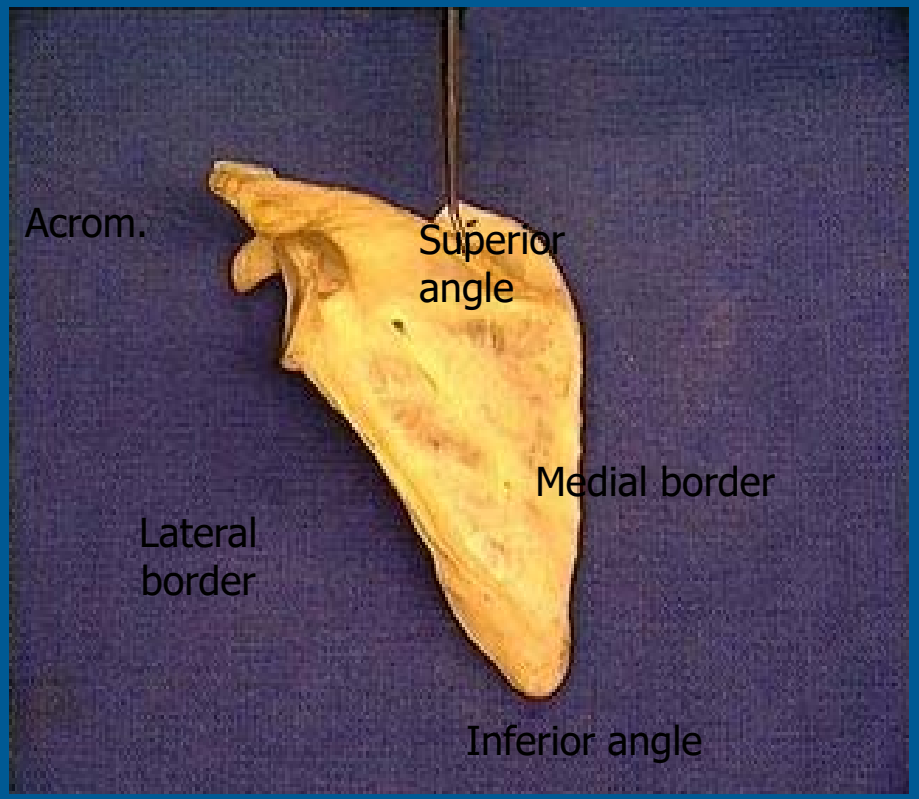
- Clavicle
  - Connects axial skeleton and upper limb
  - Serves as attachment site for muscles controlling upper extremity
  - Protects the neurovascular bundle from neck to arm
  - 30 degrees of clavicular elevation with 130 forward elevation



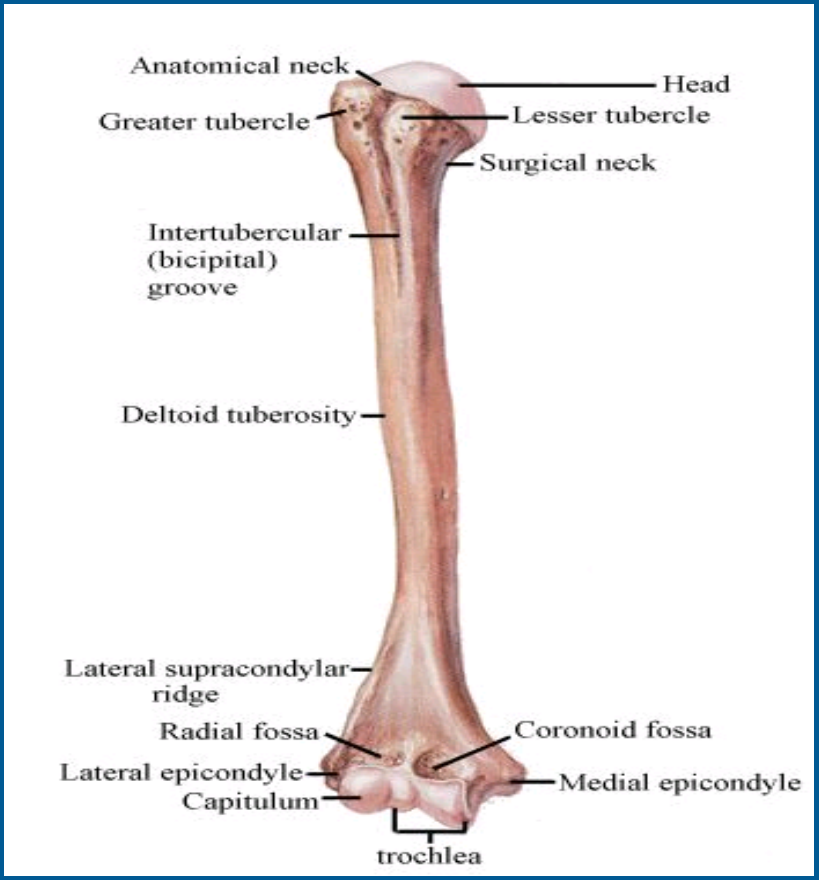
Bones

Scapula

- Lies over ribs 2-7
- 30° anterior to the coronal plane, 10° on the frontal tilt.
- Provides a stability for shoulder complex
- Serves as an attachment site for muscles
- Transmits energy proximal to distal
- Landmarks: Spine, Acromion process, Glenoid fossa, Coracoid process

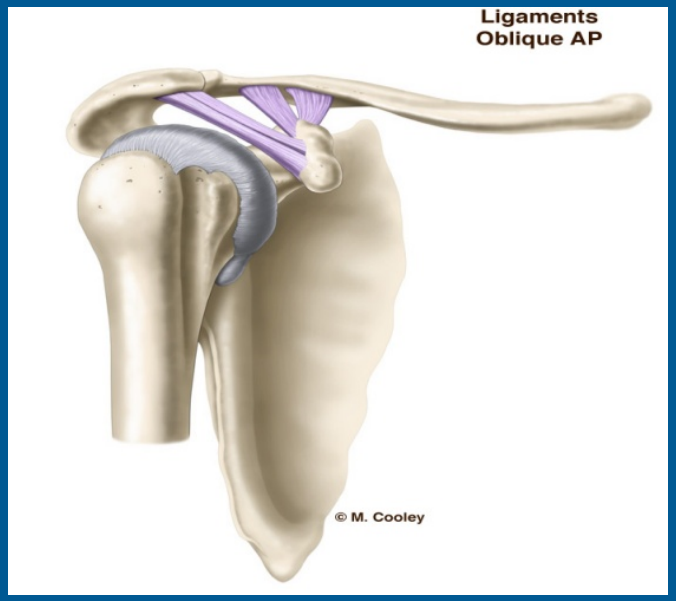


Bones



- Humerus
  - Proximal lever arm of the upper limb
  - Attachment site for prime movers of shoulder and elbow
  - Landmarks
    - **Greater tubercle: insertion for supraspinatus, infraspinatus, teres minor**
    - **Lesser tubercle: insertion for subscapularis**
    - **Surgical neck**
    - **Anatomical neck**
    - **Shaft**

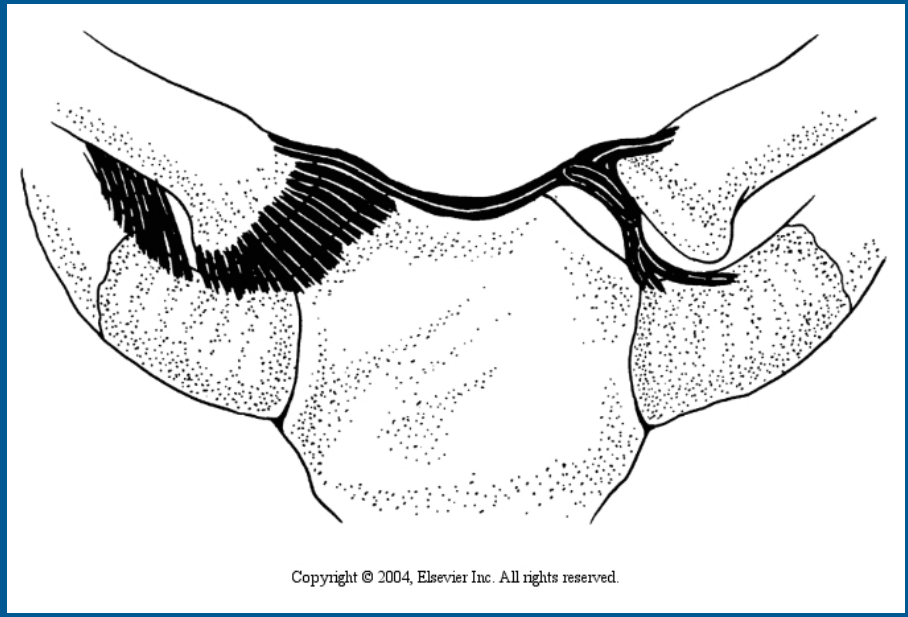
Shoulder Joints



- Acromioclavicular (AC) joint:
  - Formed by acromion of the scapula and distal clavicle
  - Movement: Primarily slides during shoulder motion to conform to changes in the relationship between the scapula & the humerus
  - The AC capsule limits anterior and posterior translation of distal clavicle.

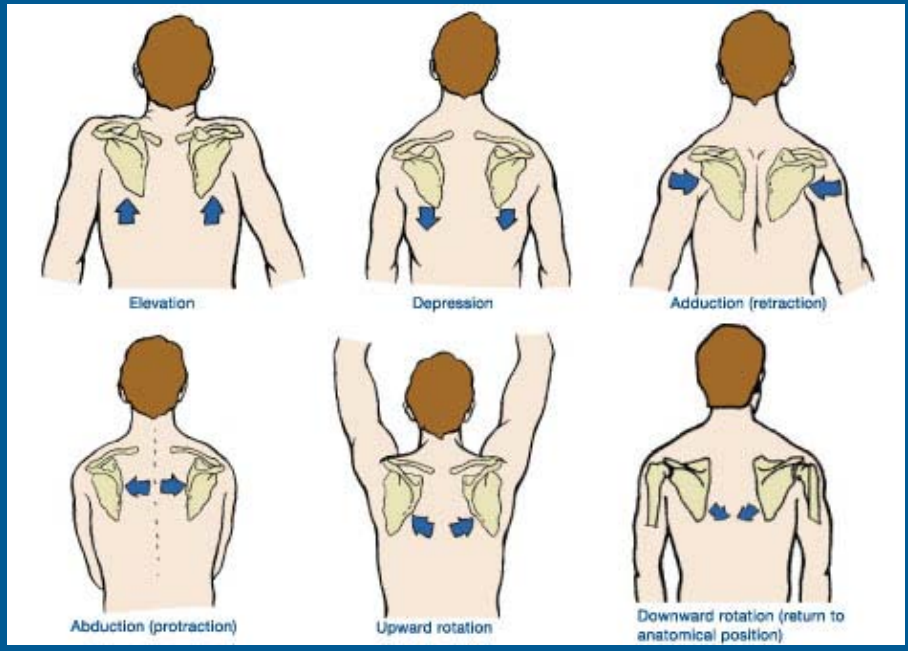
Shoulder Joints

- Sternoclavicular joint:
  - Proximal clavicle and sternum
  - Only articulation between the axial skeleton and the upper limb
  - Movement: protraction, retraction, rotation, elevation and depression
  - Stability:
    - Ligaments: costoclavicular, sternoclavicular (anterior and posterior), interclavicular, articular disk, joint capsule



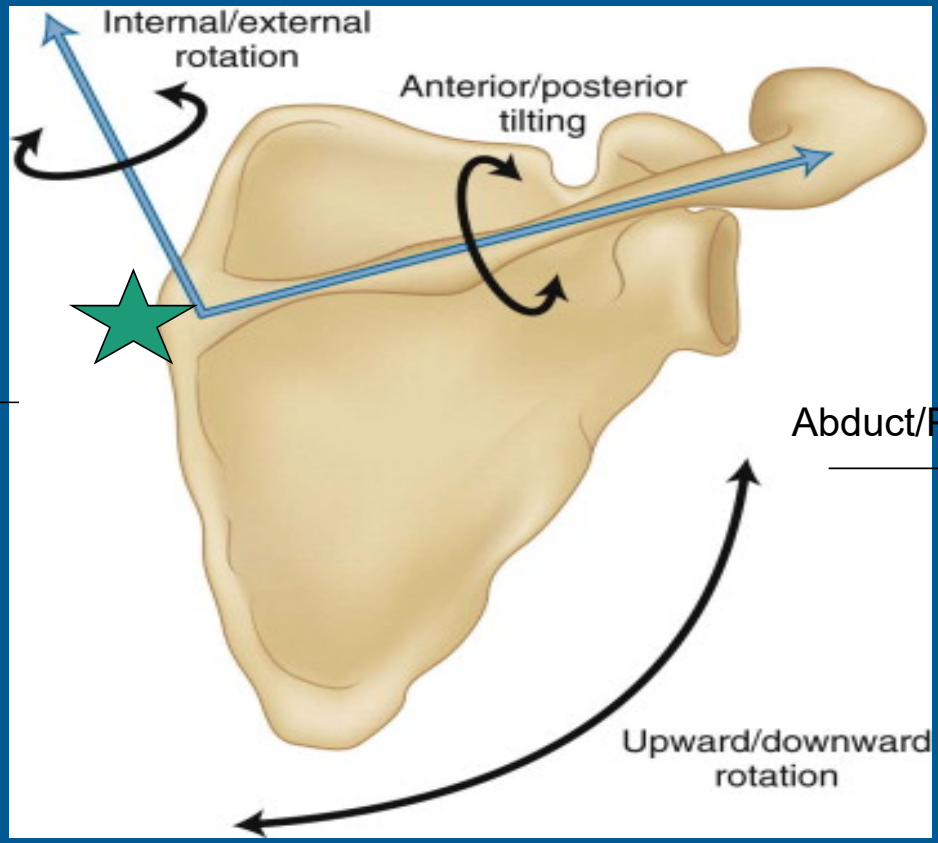
Shoulder Joints

- Scapulothoracic joint:
  - Formed between the scapula and the thoracic wall
  - Not a "true" articulation
  - Movement: protraction, retraction, elevation, depression, upward & downward rotation
  - Stabilized by muscles



Orthobullets.com

Definitions of Scapular Motion

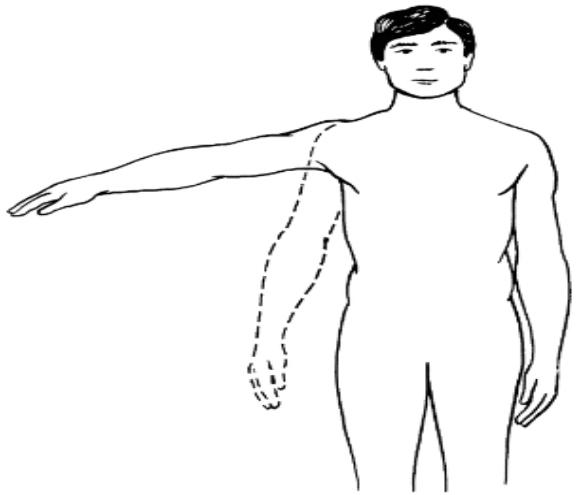


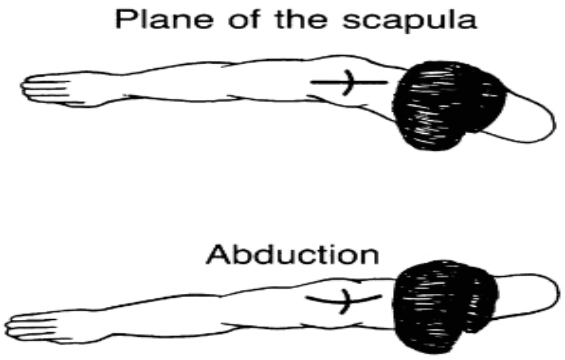
Adduct/Retract

Abduct/Protract

Functional Biomechanics[2]

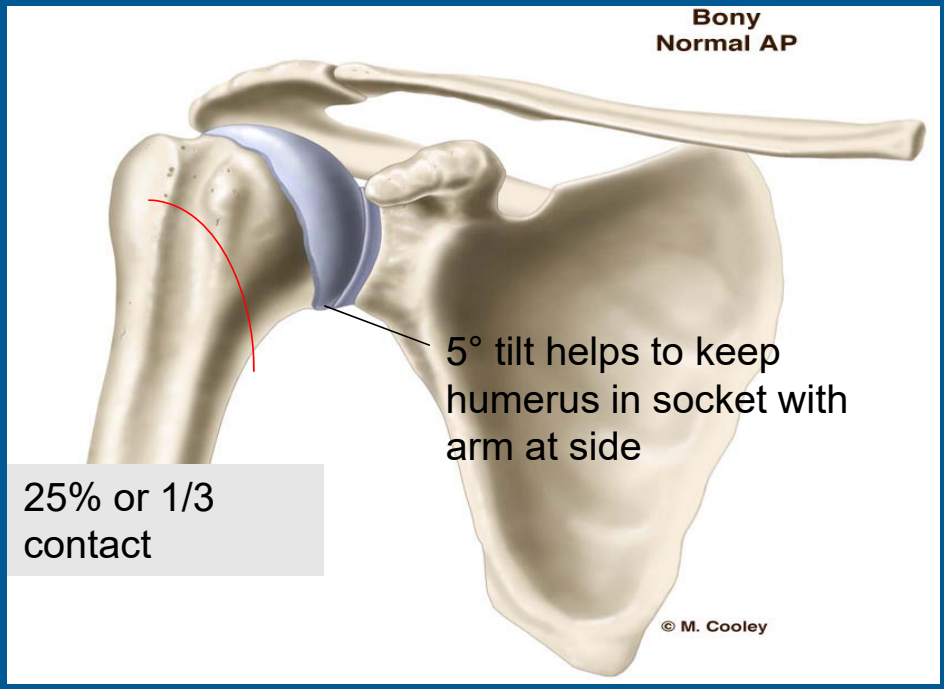
- Plane of the Scapula or Scaption (POS)
  - 30-45° anterior to the frontal plane
  - True plane of movement of the shoulder





Glenohumeral joint

- Formed by glenoid fossa of the scapula and the head of the humerus
- Ball and socket joint that sacrifices stability for mobility
- Movement: flexion, extension, abduction, adduction, external and internal rotation

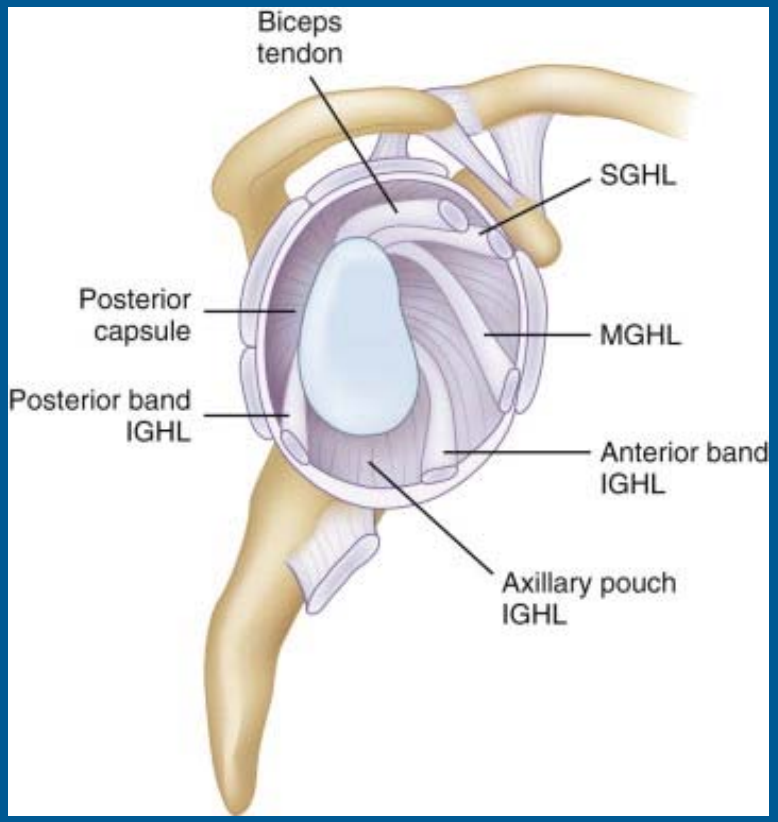


Glenohumeral joint

- Subacromial space: space between acromion, coracoacromial ligament, coracoid process and the superior humeral head
- Glenoid Labrum
  - Fibrocartilaginous complex that deepens the glenoid fossa
  - Generally loose superiorly and tighter inferiorly

Static Shoulder Stabilizing Structures

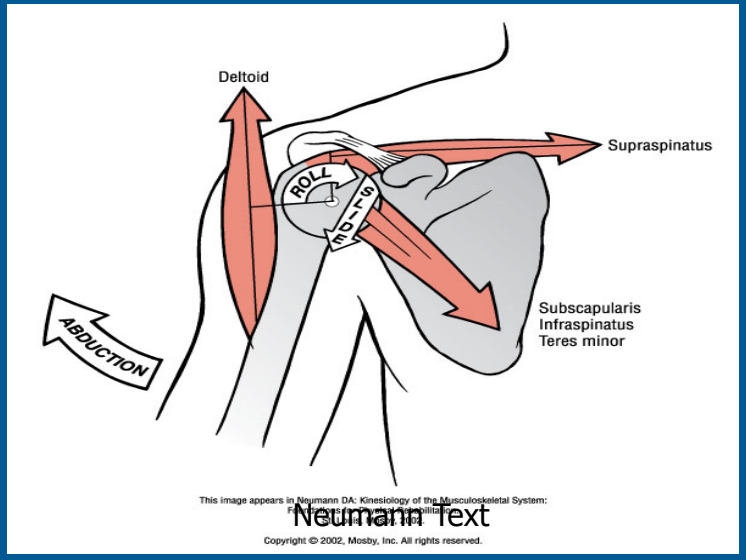
- **Superior Glenohumeral Ligament (SGHL)**
- **Middle Glenohumeral Ligament (MGHL)**
- **Inferior glenohumeral ligament (IGHL)**
  - Thickened bands that form a hammock to support the humerus in the axillary pouch
  - Pathology: adhesive capsulitis



Rotator Cuff

- The subscap, infraspinatus, and teres minor depress the humeral head, counteracting the upward pull of the deltoid.
- The infraspinatus becomes a head depressor with the arm at 90 degrees of abduction and neutral rotation
- The subscap acts as a head depressor in external rotation.
- The RC provides direct joint compression, keeps the humeral head centered within the glenoid and allows the deltoid to function.

S Supraspinatus
I Infraspinatus
T Teres minor
S Subscapularis



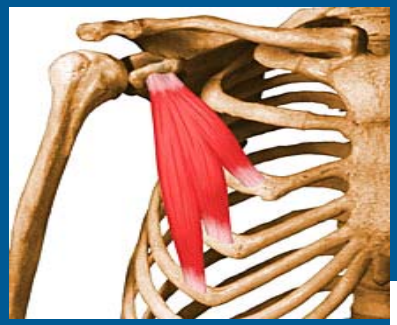
Neumann Text

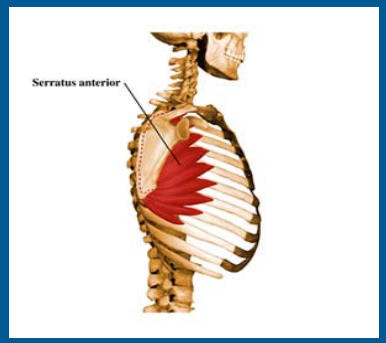
Rehab of the Hand 6th ed

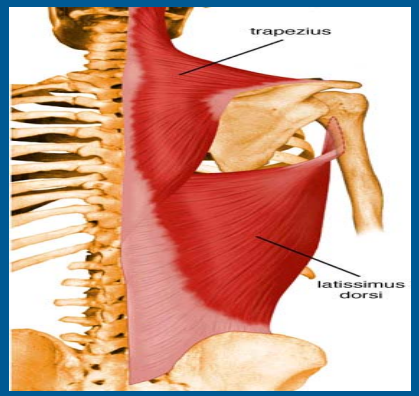
Muscles: Scapular Motion

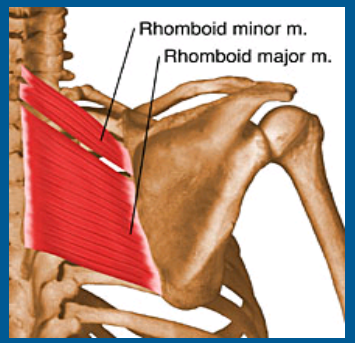
- Depression: Pecs minor-major, lower traps.
- Protraction (abd): serratus, pecs minor-major
- Retraction (add): middle traps, rhomboids

Look at the muscle origin and insertion- can often tell you the motion.









Muscles : Humeral Motion

- Flexion: anterior deltoid, coracobrachialis, biceps short head
- Extension: Latissimus, teres major, posterior deltoid, infraspinatus, teres minor, long head of triceps
- Abduction: middle deltoids, supraspinatus
- Adduction: pec major, latissimus, teres major, coracobrachialis, subscapularis
- External rotation: Infraspinatus, teres minor, posterior deltoid
- Internal rotation: Subscapularis, latissimus, teres major, anterior deltoid, pec major
- Horizontal adduction: anterior deltoid, clavicular head of pec major, coracobrachialis
- Horizontal abduction: posterior deltoid, infraspinatus, teres minor

Phase of Elevation

- Early phase (0-90 degrees)
  - 2:1 GH to ST movement (60/30)
  - First 20-30 degrees no scapular movement
  - Should have movement by 70 degrees
- 60-140°: Critical phase
  - Greatest scapula rotation occurs in this phase

- **Late Phase of Elevation** (90° -180°)
  - Critical phase
    1:1 GH to ST ratio

Elsevier 2006

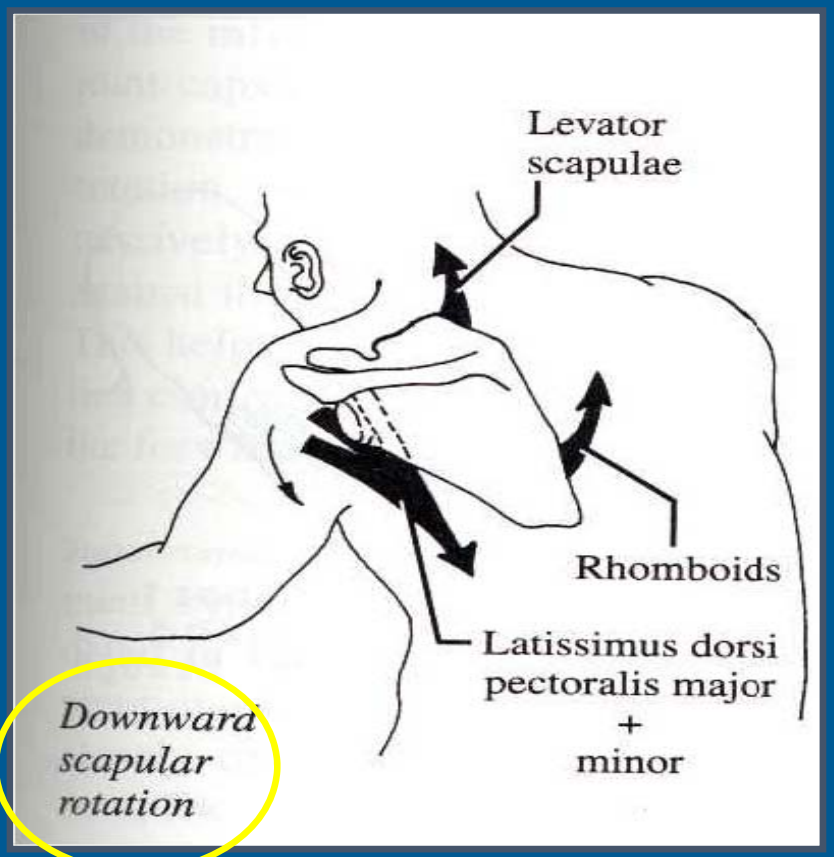
Neumann Text

General Shoulder Evaluation

- History
- Chief complaint/ Mechanism of injury (if applicable)
- Pain: aggravating factors
- Functional deficits including ROM and strength
- Posture including scapular mobility
- Palpation
- Special tests

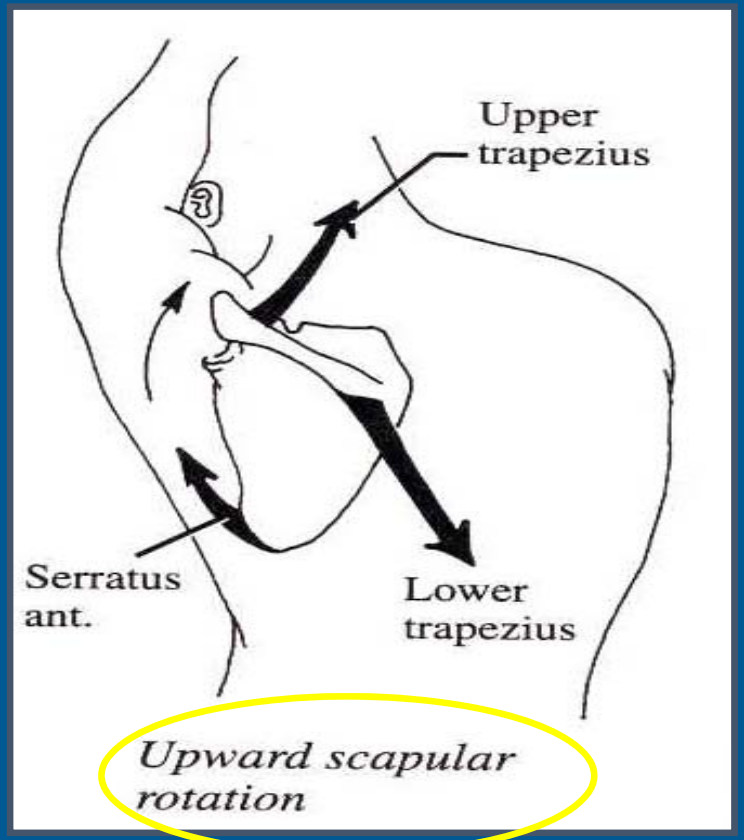
Typical Position of Poor Posture

Muscles often tight



Neumann Text

Muscles generally weak



Neumann Text

Range of Motion

- AROM
  - Observe quality of movement
  - Scapulo-humeral rhythm
  - Note excessive movement at one joint if restriction at another—may give the appearance of “normal” motion
  - Note if painful arc of motion is present
- PROM
  - Note irritability and end feel
  - Pay attention to substitution at surrounding joints

MMT/Resisted Testing

- MMT positions are often painful or difficult for patient to achieve
- Assessment of pain and strength to detect lesion
- Isometric test at safe position
- Abduction, adduction, flexion, extension, ER, IR, elbow flexion and extension
- Test at 0°, 45°, 90° as able

- Strong/painless:
  - normal
- Strong/painful
  - Lesion within muscle or tendon
  - Can range from tendonitis to partial or small full thickness tear
- Weak/painful
  - Significant injury to muscle or tendon
  - Large RTC tear would present with weak/painful shoulder abd and ER
- Weak/painless:
  - muscle or tendon rupture

Special Tests

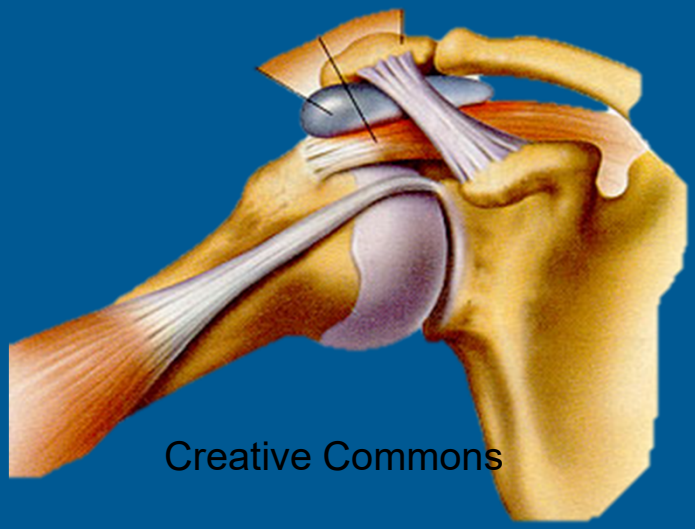
- Hawkins-Kennedy Impingement Test
- Neer Impingement Test
- Yokum Test: impingement
- Patte Test: loss of Teres Minor
- Painful Arc Test: Impingement
- Cross-Over Impingement Test
- Lock Test: Impinge. Supraspinatus
- Drop Arm Test: Full thickness RC tear
- Clunk Test: Labral Tear
- Crank Test: Labral Tear
- Speeds Test: Labral Tear/Bicipital Tendonitis
- Yergason's Test: Bicipital Tendon Disorders
- O'Brien's Test: Labral Abnormality
- Anterior Slide Test: Superior Labral Tears
- Sulcus Sign: Inferior Instability
- Apprehension Test: Instability
- Rockwood Test: Ant Instability

Mark Dutton Test

Subacromial Impingement

Contents of the subacromial space

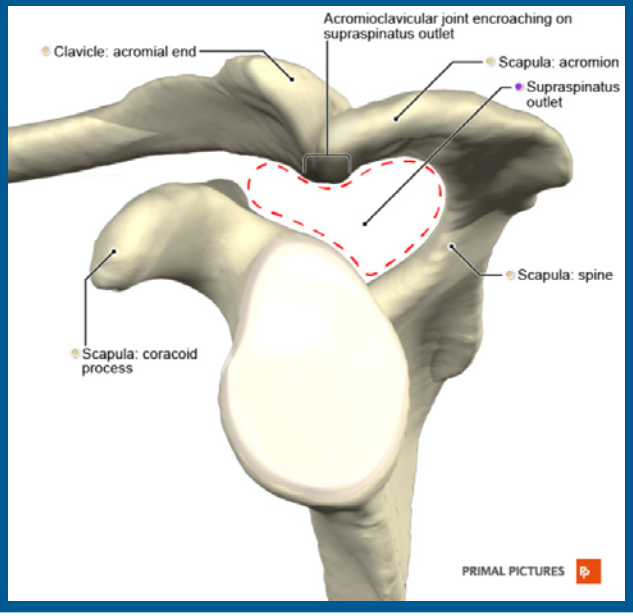
1. Long head biceps tendon
2. Bursa
3. Supraspinatus



Van Zuydam, et al, 2015; Michener & McClure 2009

Impingement

- Pressure of the supraspinatus and /or long head of the biceps tendon in the subacromial space with elevation of the arm



- Extrinsic Factor of Impingement
  - Weak, fatigued or injured rotator cuff muscles
  - Poor scapulo-humeral rhythm
- Intrinsic Factors of Impingement
  - Anatomic variations of the acromion

Rotator Cuff Tear and Repair

- Classification
  - Thickness
    - Full thickness—tear compromises the entire muscle from bursal to articular surface
    - Partial thickness—can occur on bursal or articular side
  - Size
    - Small=less than 1 cm.
    - Medium=1-3 cm.
    - Large=3-5 cm
    - Massive=> 5 cm.
- Chronic—degenerative, occurs insidiously
  - See causes of impingement
- Acute—traumatic incident
  - Fall on an outstretched hand, traction injury, tensile overload or forceful overhead activity

Clinical Presentation of RTC Tears

- Pain
- Abnormal posture and scapula position
- May have pain with palpation of subacromial space
- May have limited A/PROM
  - Full thickness tears will most likely have limited active with not as much pain
  - Partial thickness may present similar to impingement
  - Observe scapular motion with movement—usually irregular
- Manual Muscle Testing/Resisted testing
  - Full thickness *may* be weak and painless
  - Partial thickness may be weak and painful
- Special tests
  - Empty can--supraspinatus
  - Lift off--subscapularis
  - Drop Arm—supraspinatus
  - External Rotator Lag Test—infraspinatus/teres minor

Adhesive Capsulitis

- Definition: thickening and contracture of the glenohumeral joint capsule causing loss of the axillary fold of the capsule and adhesion of the associated ligaments
- Capsular pattern: PROM limited in **ER**>**abd**>**IR**

Stages:

- Painful or freezing (10-36 weeks)
  - Spontaneous onset of severe pain
  - Disrupts sleep
  - Tendency is to rest arm which contributes to stiffness
- Stiffening or frozen (4-12 months)
  - Restricted ROM in capsular pattern
- Thawing (5-26 months)
  - Gradual recovery of ROM
  - May not achieve full ROM

Specific patterns of restriction

- Tight posterior capsule:
  - limited IR and cross body adduction
- Tight subscapularis:
  - ER limited more at 0* vs. 45-90*
- Tight MGHL and IGHL/Capsule:
  - ER limited more at 45-90* vs. 0*
- Tight inferiorly:
  - decreases elevation

(Turkel et al, 1981)

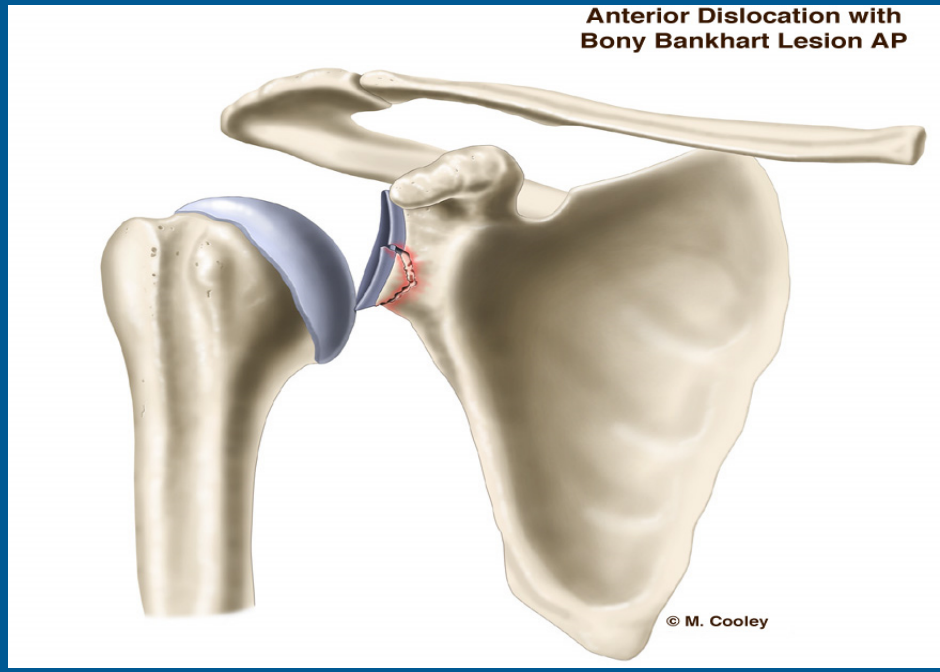
Shoulder Instability

- Definition: Inability to maintain the humeral head centered in the glenoid cavity
- A component of the stabilizing matrix has become dysfunctional (usually labrum)
- Direction of Instablility
  - Anterior
  - Posterior
  - Inferior
  - Multidirectional
  - Anterior-inferior is most common (Bankart)

Shoulder Instability
Clinical Presentation

History

- TUBS: traumatic, unilateral, bankart, surgery
  - Specific traumatic event causing dislocation
  - Usually labroligamentous complex lesion (Bankart)
  - Require surgery: only 14% rehab successfully
  - Bankart repair



Shoulder Instability
Clinical Presentation

History

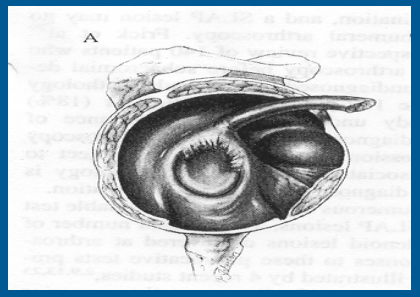
- AMBRI: atraumatic, multidirectional, bilateral, rehabilitation, inferior shift
  - No clear cut history of dislocation
  - Multiple planes of instability in both shoulders
  - Rehab: 85% successful
  - If rehab is not successful require inferior capsular shift (tightening of the inferior capsule)
  - Can typically dislocate voluntarily

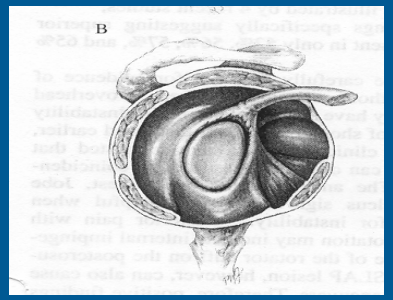
Shoulder Instability
Clinical Presentation

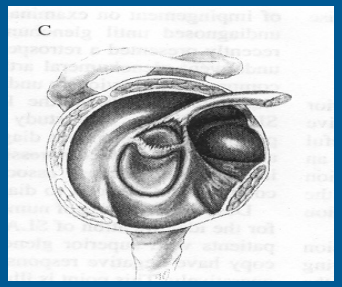
- Special tests
  - Apprehension test (AB with ER)—anterior instability
  - Jobe relocation test (posterior glide before pushing into ER – symptom relief)—anterior instability
  - Load and shift test (stabilize scap – push forward / pull back)—anterior and posterior instability
  - Sulcus test— (pull downward) - inferior instability

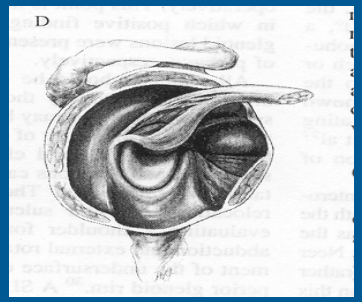
Labral Tears: SLAP Lesions

- Injury to the superior labrum anterior to posterior
- Pain in anterior shoulder- involves long head of biceps
- Injury hear can allow the humeral head to migrate superior and cause compression of the supraspinatus









SLAP Lesions
Clinical presentation

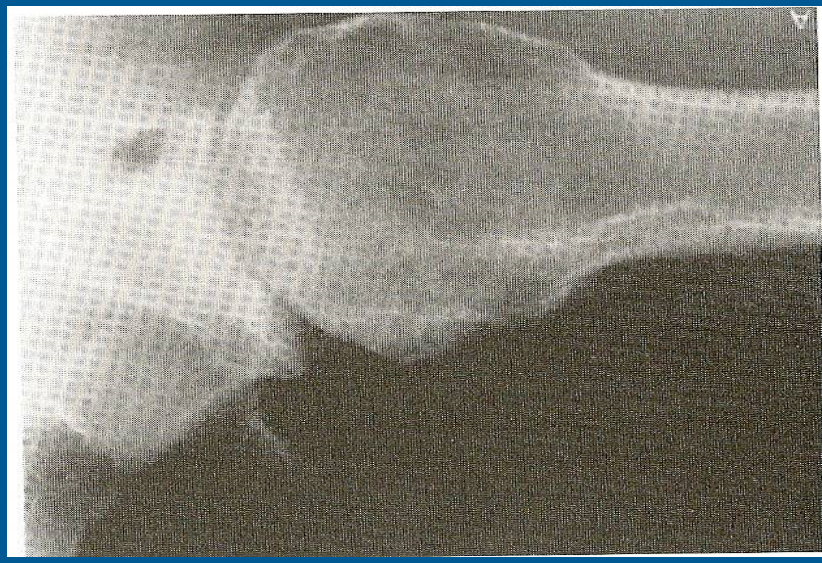
- History
  - Traumatic event
  - Compressive force applied to shoulder ie: fall on an outstretched arm that is abducted and slightly flexed (most common)
  - Traction injuries
  - May also occur in the presence of shoulder instability; very common with overhead athletes especially throwing athletes
- Subjectively c/o deep pain, popping and clicking
- Special tests
  - O'Brien's test
  - Load and Shift test
  - Kibbler test
  - Pain at biceps groove

Fractures of the Humerus

- Description related to the anatomy invovled
  - Lesser tuberosity
  - Greater tuberosity
  - Neck of humerus
  - Shaft of humerus

Glenohumeral Arthritis

- Causes
  - OA
  - Avascular necrosis
  - Dislocation arthropathy
  - RA
  - Post-traumatic arthritis
  - Septic arthritis
  - Cuff tear arthropathy
  - Malunion or nonunion of proximal humerus fracture



Glenohumeral Arthritis

- Symptoms
  - Progressive stiffness and loss of motion
  - Complain more of limited function and difficulties with ADL's
  - Generally have restricted PROM with normal strength
  - May have night pain generally positional

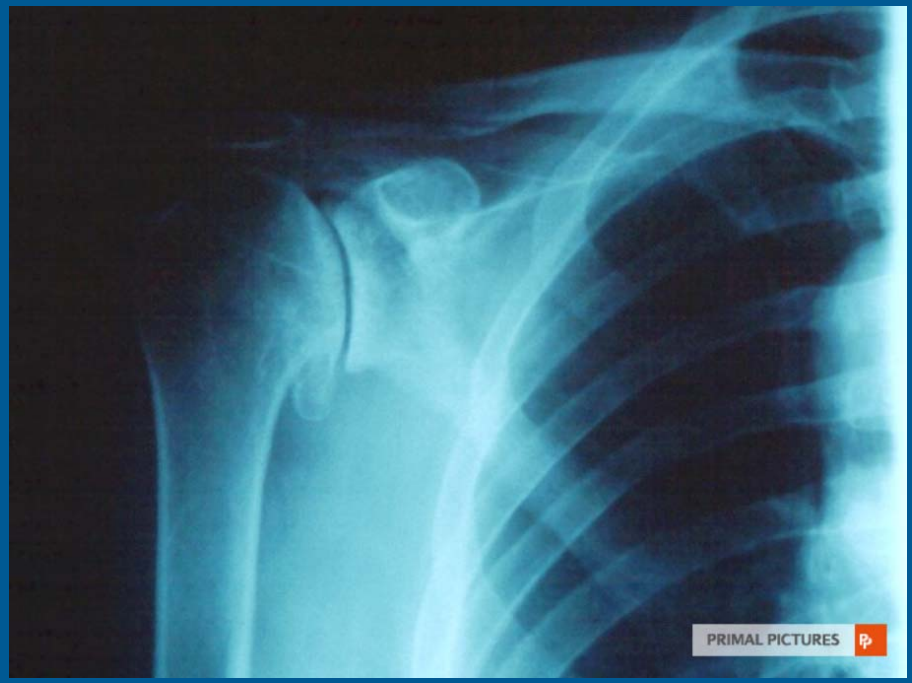


TABLE 14-17 Range of Motion Necessary at the Shoulder for Functional Activities[322,505]

Activity	Necessary Range of Motion
Eating	70–100° horizontal adduction 45–60° abduction
Combing hair	30–70° horizontal adduction 105–120° abduction 90° external rotation
Reach perineum	75–90° horizontal abduction 30–45° abduction 90° or greater internal rotation
Tuck in shirt	50–60° horizontal abduction 55–65° abduction 90° internal rotation
Position hand behind head	10–15° horizontal adduction 110–125° forward flexion 90° external rotation
Put an item on a shelf	70–80° horizontal adduction 70–80° forward flexion 45° external rotation
Wash opposite shoulder	60–90° forward flexion 60–120° horizontal adduction

Mark Dutton Text, pg.445

Reflections

- 1. What did you know before this learning module?
- 2. What did you learn form this material?
- 3. Have you treated a patient with this diagnosis? If so, What would you do different? What would you do again?
- 4. Has any of this information changed your way of thinking?
- 5. What more would you like to know about this topic?
- 6. What do you understand now that you did not understand last week?
- 7. How do you know this information is correct?
- 8. What kind of resources might you use in the future?
- 9. Does what you have learned raise new questions?
- 10. Could you explain these concepts?

References Shoulder

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