

Shoulder Anatomy and Biomechanics

Movements

Sagittal plane

- Flexion (180°)
- Extension (60°)

Coronal plane

- Abduction (180°)

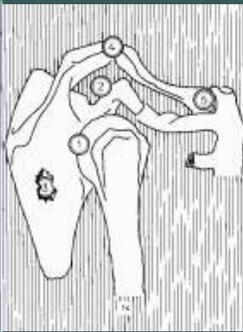
Transverse plane

- Internal rotation (80°)
- External rotation (90°)

Horizontal abduction / adduction

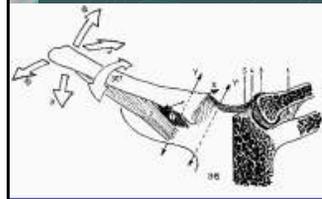
- Abduction (90°)
- Adduction (30°)

Five Functional Joints



1. Glenohumeral Joint
2. Subacromial
3. Scapulothoracic
4. Acromioclavicular
5. Sternoclavicular

Sternoclavicular Joint



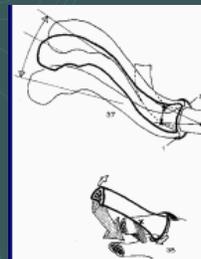
- The only true bony attachment of the upper extremity to the trunk.
- Synovial, saddle shaped joint

Sternoclavicular Joint



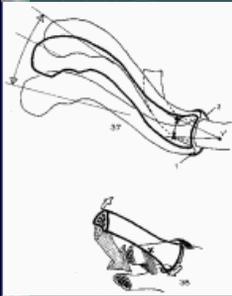
- Disc that attaches to the first rib
- **Ligaments:**
 - Interclavicular Ligament
 - Costoclavicular Ligament (subclavius muscle)
 - Posterior Ligament
 - Sternoclavicular

Sternoclavicular Joint



- Three degrees of freedom
- Movements in horizontal plane:
 - Protraction (30°) limited by costoclavicular and post. capsule
 - Retraction (30°) limited by costoclavicular and ant. capsule

Sternoclavicular Joint



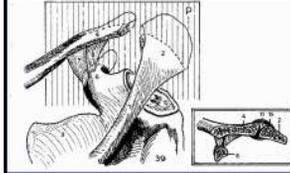
Movements in the frontal plane:

Elevation (60°) limited by costoclavicular

Depression (5°) limited by first rib

Axial Rotation created by ligamentous attachments

Acromioclavicular Joint



Synovial sliding joint allows three degrees of movement

There is a disc present until the second decade.

Acromioclavicular Joint



Ligaments:

Medial - Coracoclavicular;
Conoid

Lateral - Trapezoid

Acromioclavicular

Coracoacromial: coracoid process to acromion process

Closed packed position is when the humerus is abducted to 90°.

Acromioclavicular Joint

Movements

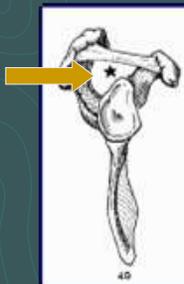
- Axial rotation of the clavicle (spin)
- Angulation between scapula and clavicle

Biomechanics of Scapular Rotation

Scapulo-thoracic motion occurs as part of a closed kinetic chain involving the:

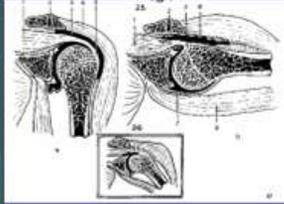
- A-C joint
- S-C joint

Subacromial Space



Structures Within Suprahumeral Space

1. Long head of biceps
2. Superior capsule
3. Supraspinatus tendon
4. Upper margins of subscapularis & infraspinatus tendons
5. Subacromial bursa
6. Inferior surface of the A-C joint



Subacromial Space

Clinical Relevance

- Avoidance of impingement during elevation of the arm requires
 - External rotation of humerus to clear greater tuberosity
 - Upward rotation of scapula to elevate lateral end of acromion

Subacromial Space

- Primary Impingement
 - Structural stenosis of subacromial space
- Secondary Impingement
 - Functional stenosis of subacromial space due to abnormal arthrokinematics

Glenohumeral Joint

- Synovial ball and socket joint
- Three degrees of freedom
- Stability provided by
 - Passive restraints
 - Active restraints

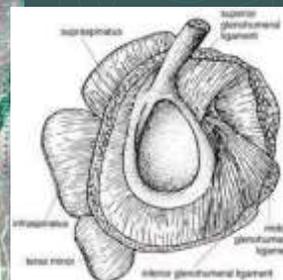
Glenohumeral Motion

Passive Restraints:

1. Bony geometry
2. Labrum
3. Capsuloligament-ous structures
4. Negative intra-articular pressure



Glenohumeral Ligaments



- SGHL
- MGHL
- IGHL
 - Anterior band
 - Posterior band
 - Axillary band

Capsuloligamentous Structures

Coracohumeral Ligament

- anterior band
- posterior band



Restraints to External Rotation

Dependent on arm position

- 0° - SGHL, C-H & subscapularis
- 45° - SGHL & MGHL
- 90° - anterior band IGHL



Restraints to Internal Rotation

Dependent on arm position

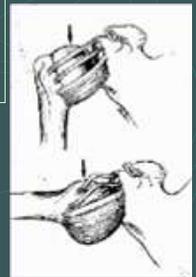
- 0° - posterior band of IGHL
- 45° - anterior & posterior band of IGHL
- 90° - anterior & posterior band of IGHL



Restraints to Inferior Translation

Dependent on arm position

- 0° - SGHL, C-H
- 90° - IGHL



Glenohumeral Motion

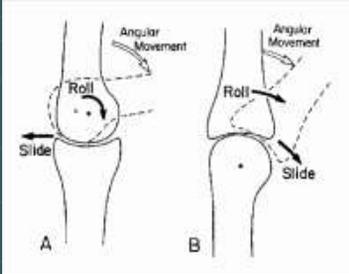
Scapular Plane:

- Flexion/extension - 120°
- Abduction/adduction - 120°
- External/internal rotation
- Horizontal abduction/adduction

Arthrokinematics of the Glenohumeral Joint



Glenohumeral Motion Concave-Convex 'Suggestion'



Glenohumeral Motion Arthrokinematics



Glenohumeral Motion

Capsular Tightness:

Results in abnormal arthrokinematics

Glenohumeral Motion

Normal Arthrokinematics:

Combines rotation and translation to keep the humeral head centered on the glenoid

Scapulohumeral Muscles

Prime Movers:

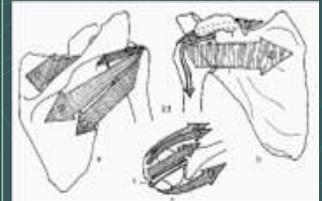
- Deltoid
- Pectoralis major
- Latissimus Dorsi
- Teres Major
- Biceps
- Coracobrachialis
- Triceps



Scapulohumeral Muscles

Rotator Cuff ms:

- Subscapularis
- Supraspinatus
- Teres Minor
- Infraspinatus



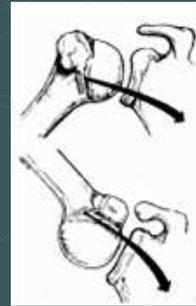
Rotator Cuff Function

- Approximates humerus to the glenoid
- Supraspinatus assists deltoid in abduction
- Subscapularis, infraspinatus & teres minor depress the humeral head



Subscapularis

- **Effective** restraint to ER with arm at the side
- **Ineffective** restraint to ER with the arm abducted to 90°



Rotator Cuff Function

- Biceps tendon force increases the torsional rigidity to ER
- No effect on strain of the IGHL
- Effect lost with a SLAP lesion

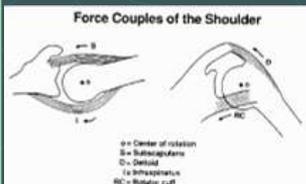


Biceps becomes more important as an anterior stabilizer as capsuloligamentous stability decreases

Itio et al, JBJS 1994
Grousman et al, 1988

Force Couples Acting on the Glenohumeral Joint

- Transverse plane – anterior vs posterior RC
- Coronal plane – deltoid vs inferior RC



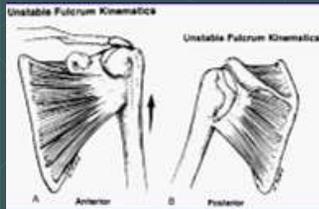
Rotator Cuff Tear Supraspinatus

- Essential force couples maintained
- Normal strength & function possible



Rotator Cuff Tear Supraspinatus/Posterior Cuff

- Essential force couples disrupted
- Weakness with ER
- Little elevation possible



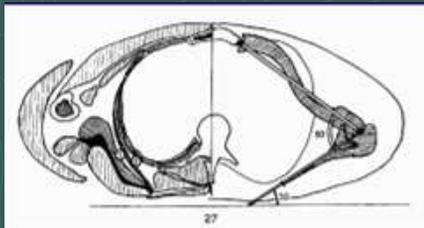
Rotator Cuff Tear

Massive Tear

- Essential force couples disrupted
- Weakness with IR & ER
- Little active elevation possible

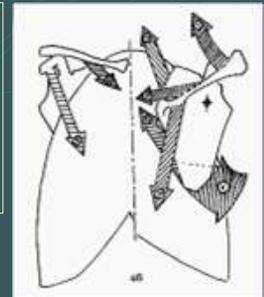


Scapulothoracic Joint



Scapulothoracic Muscles

- Trapezius
- Serratus Anterior
- Rhomboids
- Levator Scapulae
- Pectoralis minor
- Subclavius



Scapulothoracic Motion

- Elevation/depression
- Protraction/retraction
- Upward/downward rotation



Force Couples at Scapulothoracic Joint

- Serratus anterior produces antero-lateral movement of the inferior angle
- Upper trapezius pulls scapula medially
- Forces Couples for abduction
 - 0-90° Deltoid and supraspinatus
 - 90-150° Trapezius (Upper and Lower), Serratus anterior, deltoid
 - 150-180° As above plus contralateral spinal muscles

Scapulohumeral Rhythm

- Total elevation
 - 120° at GH joint
 - 60° at ST joint



- 2:1 ratio for GH/Scapula movement
- Most GH motion occurs within the first 90° of humeral elevation
- Scapula movement occurs toward the end of motion.
- SC rotation and elevation also contribute at the end of motion

Force Couple for Flexion

- 0-60° Anterior deltoid, coracobrachialis, pectoralis major
- 60-120° Trapezius (upper & lower), serratus anterior
- 120-180° Lower trapezius, serratus anterior, contralateral spinal muscles

Scapular Rotation

Phase 1

- Upper & lower portions of trapezius & serratus anterior produce an upward rotatory force on the scapula
- Motion at the A-C joint prevented by the coracoclavicular ligament
- Rotation of the scapula occurs as elevation of the clavicle occurs at the S-C joint



Scapular Rotation

Phase 2

- Further motion at the S-C joint is prevented by the costoclavicular ligament
- Continued upward rotation of the scapula pulls on the costo-clavicular ligament causing posterior rotation of the clavicle
- Posterior rotation of the clavicle allows further rotation of the scapula



Scapular Rotation

- Necessary to:
 - Enhance glenohumeral stability
 - Elevate acromion to avoid impingement
 - Maintain effective length tension relationship of scapulohumeral muscles