



BIOMECHANICS AND PATHOMECHANICS OF SHOULDER

PRIYANKA JADHAV.

Contents



Introduction

Shoulder biomechanics

Shoulder pathomechanics

Summary

Objective

At the end of this lecture one should be able to:

- ❑ Identify different structures in shoulder complex
- ❑ Explain kinetics and kinematics of shoulder complex
- ❑ Describe different pathologies of shoulder complex

Introduction

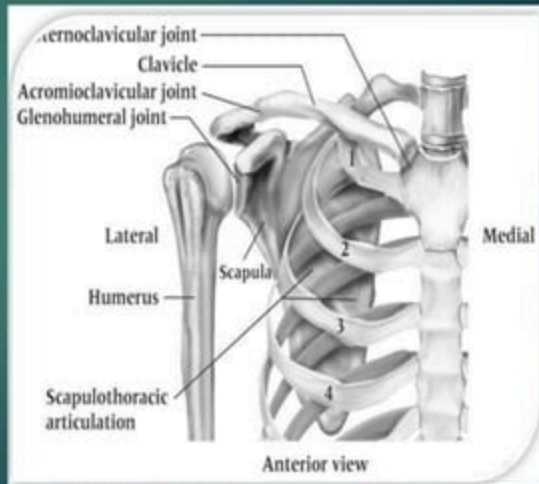
The shoulder girdle connects the upper limb to axial skeleton.

The osseous segments of the shoulder complex are clavicle, scapula and humerus.

These articular structures are designed primarily for mobility.

Five functional joints

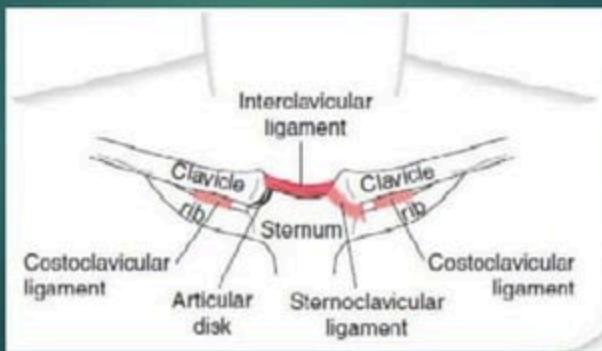
1. Sternoclavicular
2. Acromioclavicular
3. Scapulothoracic joint
4. Glenohumeral joint



Strenoclavicular joint

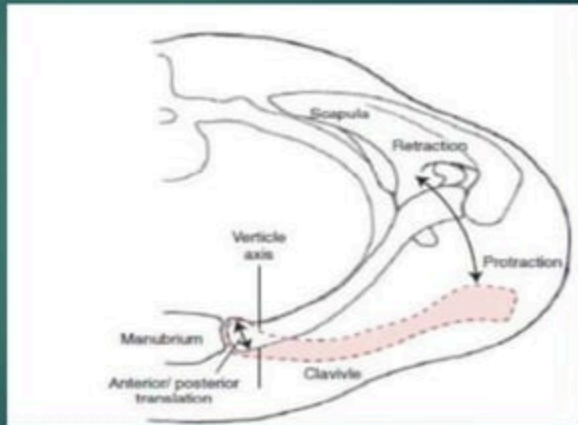
- ▶ Only attachment of upper extremity to axial skeleton
- ▶ Plane synovial joint

Ligaments



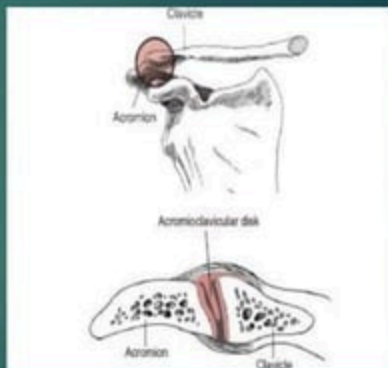
► Movements

1. Protraction – Retraction
2. Elevation – Depression
3. Rotation

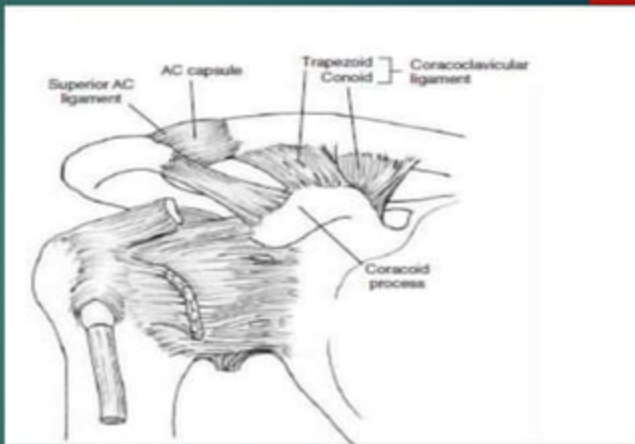


Acromioclavicular Joint

- ▶ Plane synovial joint
- ▶ Formed by articulation of small facets present:
 - At the lateral end of clavicle
 - On median margin of acromion process of the scapula

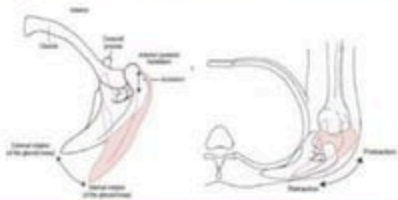


Ligaments

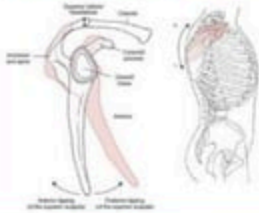


Movements

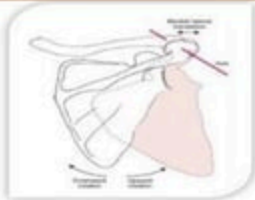
Internal/external rotation



Anterior/posterior tipping



Upward/downward rotation



Scapulothoracic Joint

- ▶ Not true joint
- ▶ Primary role of this joint is to amplify the motion of the GH joint, thus increasing the range and diversity of movement between the arm and trunk
- ▶ With surrounding musculature is act as shock absorber

- ▶ **Motions**

2 translation: elevation-depression

abduction- adduction

3 rotations: downward – upward rotation

Internal – external rotation

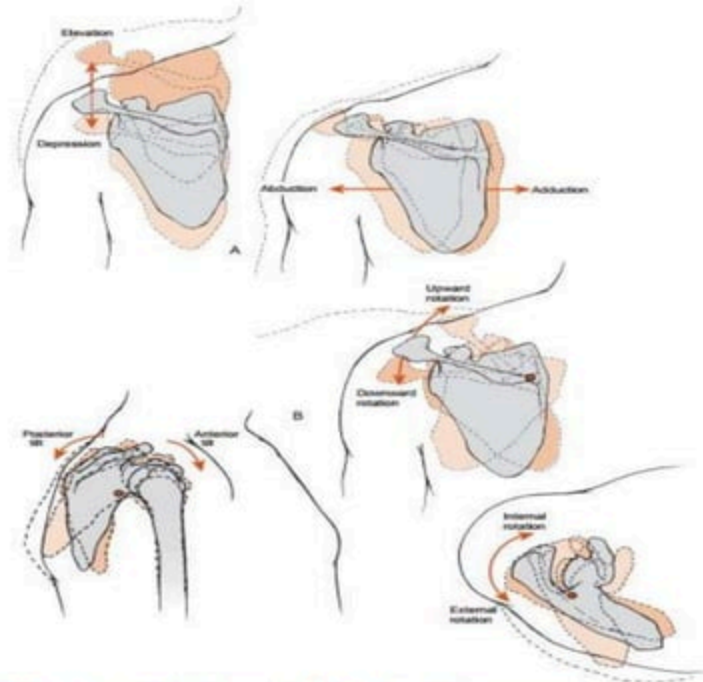


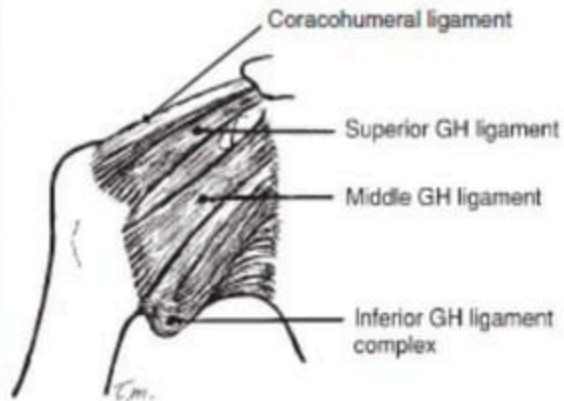
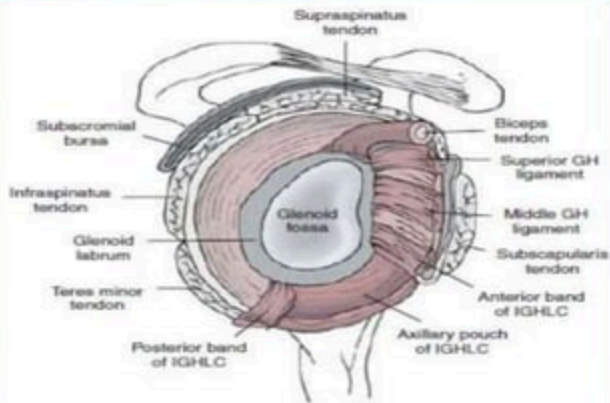
Figure 8.22: Primary motions of the scapulothoracic joint. A. Translations. B. Rotations.

Glenohumeral Joint

- ▶ Ball and socket, synovial joint
- ▶ Articular surface- between head of humerus and glenoid fossa of Scapula
- ▶ 3 degree of freedom



Ligaments



Scapulohumeral Rhythm

During Humeral elevation

- Scapula upwardly rotate
- Posteriorly tip
- Externally rotate
- Elevate
- retracts



Movement of scapula & humerus in arm–trunk elevation

- ▶ Scapula rotates upward
- ▶ Tilt posteriorly about medial- lateral axis
- ▶ Rotate externally about vertical axis

GH:ST

2:1

Sternoclavicular & Acromioclavicular motion during arm-trunk elevation

► Elevation

Upward rotation of scapula + elevation of clavicle

60°

40°



Scapula moves away from clavicle

Shoulder/ Subacromial Impingement syndrome

Results from

- ▶ Persistent or repeated compression of structures within subacromial space
- ▶ Abnormal humeral axial rotation
- ▶ Abnormal scapulothoracic motion during shoulder elevation


Inflammation


Pain



Pathomechanics

Muscles acting on shoulder girdle are:

- ▶ Axiohumeral muscles
- ▶ Axioscapular and Axioclavicular muscles
- ▶ Scapulohueral muscles

Axiohumeral muscles

- ▶ Attach thorax to humerus
- ▶ Thus crosses all four joints of shoulder girdle
- ▶ Role- providing additional strength to shoulder girdle functions

Pectoralis major

- ▶ **Effect of weakness-** decrease strength in medial rotation, adduction, horizontal adduction and depression
- ▶ **Effect of tightness-** limited ROM in shoulder lateral rotation, horizontal abduction also flexion

Seen following thoracic surgery or breast cancer

Lattissimus dorsi

- ▶ **Effect of weakness-** decrease strength in extension, adduction, internal rotation and depression
 - ▶ **Effect of tightness-** limited ROM in shoulder lateral rotation and perhaps abduction
- Increased thoracic kyphosis
- May lead to flexion of upper thoracic spine

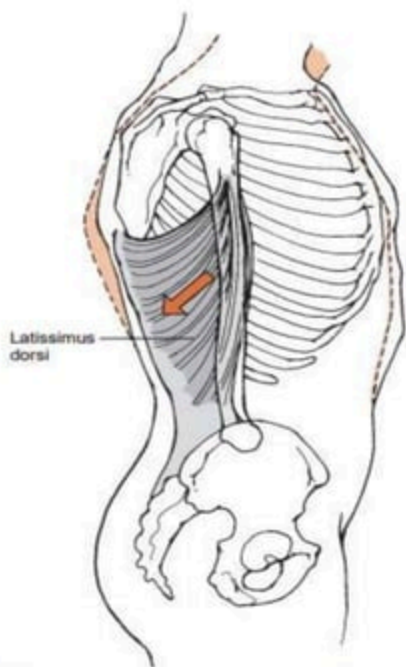


Figure 9.40: Latissimus dorsi tightness. A tight latissimus dorsi may contribute to increased thoracic kyphosis.

Upper extremity weight bearing

- ▶ The GRF in upper extremity weight bearing is in upward direction that tend to elevates shoulder up
- ▶ So shoulder depressors muscles are required to act and depress shoulder so fix it in position



Figure 9.41: Function of the latissimus dorsi and pectoralis major. The latissimus dorsi and pectoralis major help stabilize the shoulder against the upward reaction force from a cane.

Scapulohumeral muscles

- ▶ They provide motion and dynamic stabilization to the GH joint
- ▶ Composed of

Deltoid

Teres major

Corachobrachialis

Supraspinatus

Infraspinatus

Teres minor

Deltoid

Anterior deltoid:

- ▶ Effect of weakness: weakness in shoulder flexion, medial rotation, abduction and horizontal adduction
- ▶ Effect of tightness: limited shoulder range in external rotation and extension

Posterior deltoid:

- ▶ Effect of weakness: Weakness in shoulder extension strength
- ▶ Effect of tightness: Limited shoulder range in flexion adduction



Middle deltoid

- ▶ Effect of weakness: Moderate weakness in shoulder abduction strength and may be flexion strength also.

Rotator cuff muscles

Supraspinatus

- ▶ **Effect of weakness:** weakness in shoulder abduction initiation and strength
- ▶ **Effect of tightness:** unlikely only with surgical repair of rotator cuff so following surgery avoid adduction or medial rotation with hyperextension of shoulder as they stretch the tendon

Subscapularis

- ▶ **Effect of weakness:** Weakness in medial rotation

Anterior instability of shoulder

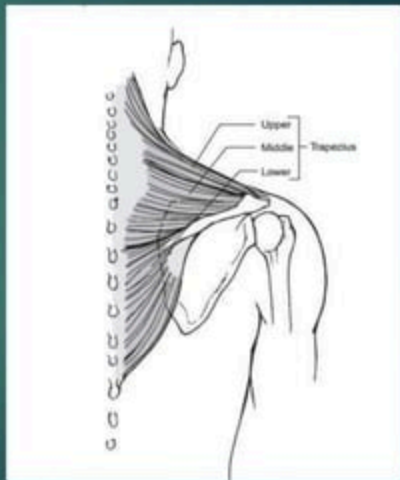
- ▶ **Effect of tightness:** Tightness in lateral rotation

Axioscapular and Axioclavicular muscles

- ▶ Their role is to position scapulae or clavicle by movements of sternoclavicular and scapulothoracic joints with resultant motion of the acromioclavicular joint.
- ▶ They work in team to hold the scapula to the chest wall
- ▶ They are: Trapezius
 - Serratus anterior
 - Levator scapulae
 - Rhomboid major and minor
 - Pectoralis major and minor

Trapezius

- ▶ Its strength is a vector summation of forces from the upper, middle and lower trapezius muscles.
- ▶ As a whole trapezius adduct and upwardly rotate the scapulae.



Balance between upper and lower trapezius muscles

- ▶ The two opposing forces of upper and lower trapezius make “anatomical force couple” which allows scapula to rotate upwardly without being displaced superiorly or inferiorly on thorax

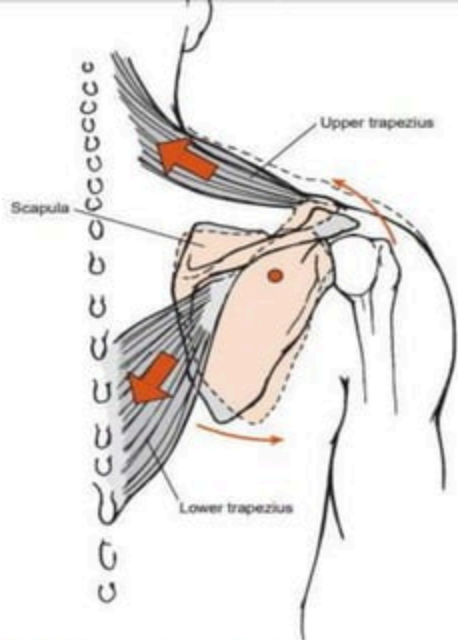


Figure 9.8: Force couple composed of upper and lower trapezius. The elevation and depression pulls by the upper and lower trapezius, respectively, are balanced out while both rotate the scapula upwardly.

Serratus Anterior

- ▶ Effect of weakness: weakness in scapular abduction, upward rotation and to some extent scapular elevation
- ▶ Its weakness appears in push up exercises as medial winging of scapula



Figure 9.11: Medial winging of the scapula due to serratus anterior weakness. The scapula is pushed into adduction and wings medially as an individual pushes forward against a wall in the presence of serratus anterior weakness.

Interaction between trapezius and serratus anterior

Both trapezius and serratus anterior make a force couple with both muscles producing upward rotation of scapula while they counteract each other in abduction and adduction of scapula

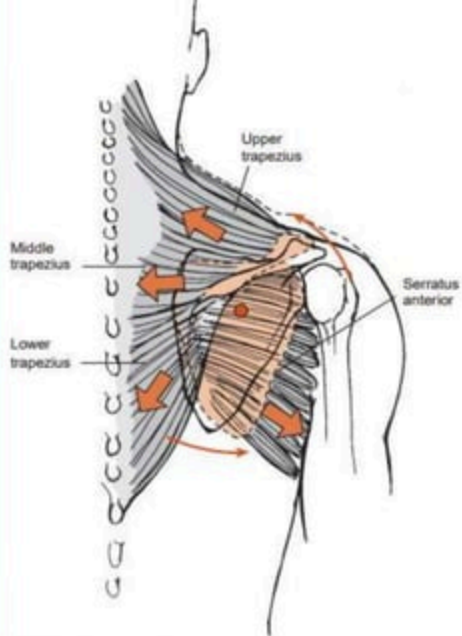


Figure 9.12: Force couple formed by trapezius and serratus anterior. The adduction and abduction pulls of the trapezius and serratus anterior counteract each other while the two muscles produce upward rotation of the scapula.

Medial Winging of Scapula

- ▶ It is a protrusion of medial border of scapula away from the thorax
- ▶ If its caused by
 - weakness in serratus anterior- the protrusion appear in shoulder elevation or resisted shoulder abduction
 - Found at rest of passive movement of shoulder- its sign of restricted ROM at GH joint or posture abnormality

As during activities as reaching for back pocket.



Figure 9.14: Medial winging due to serratus anterior weakness during resisted shoulder flexion. With serratus anterior weakness, the scapula wings medially during shoulder flexion when upward rotation of the scapula is required.

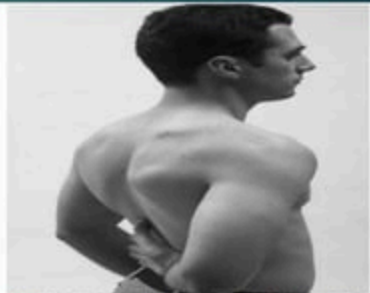


Figure 9.15: Apparent medial winging due to decreased ROM. An individual with decreased medial rotation ROM of the shoulder can use anterior tilting of the scapula to reach behind the back. The scapula appears to be winging; however, this position is not the result of serratus anterior weakness, since the serratus anterior is not required to perform the activity.

Levator scapulae, Rhomboid Major & Minor

- ▶ Weakness of it leads to impairment in activities that need pulling as open doors and rowing
- ▶ Causes adduction and depression of scapulae as reaching as back pocket



Figure 9.15: Function of the levator scapulae and the rhomboid major and minor. Reaching to a back pocket typically requires the rhomboid major and minor and the levator scapulae.

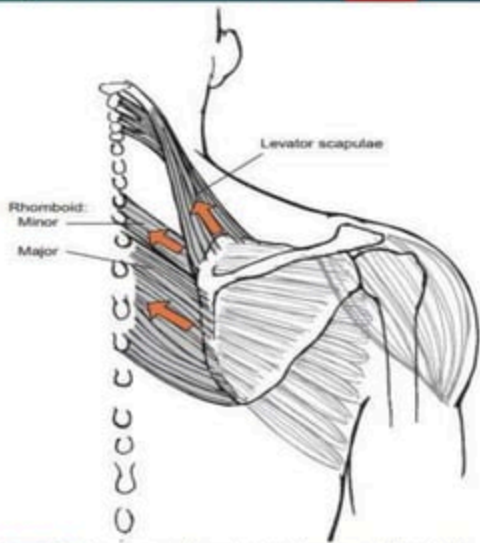


Figure 9.16: Levator scapulae, rhomboid major, and rhomboid minor muscles. The line of pull is approximately the same for the levator scapulae and the rhomboid major and minor.

Pectoralis Minor

Effect of weakness

- ▶ Difficulty in controlling shoulder girdle especially in weight bearing activities
- ▶ In this pectoralis minor exert a downward force on the scapulae to stabilize it against the reaction force of a crutch that is directed upward

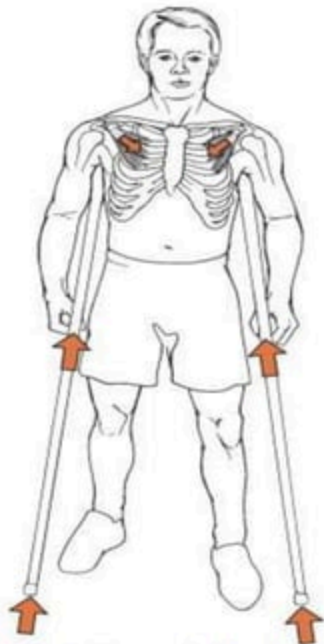


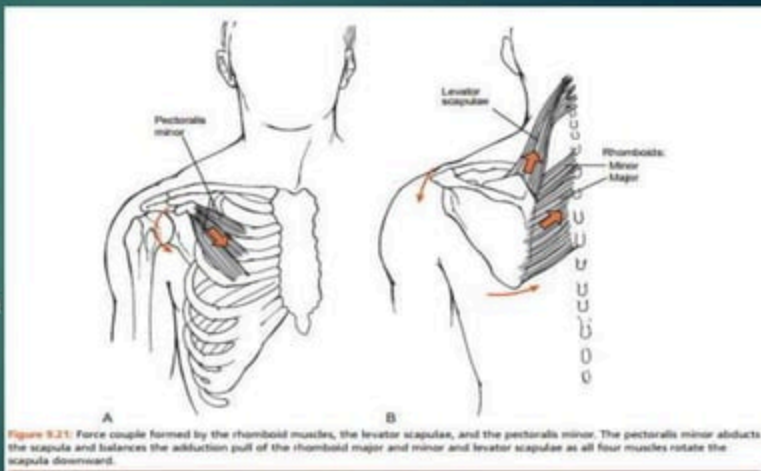
Figure 9.20: Function of the pectoralis minor to depress the shoulder. The pectoralis minor exerts a downward force on the scapula to stabilize it against the reaction force of a crutch that is directed upward and tends to elevate the shoulder.

Effect of tightness

- ▶ Pull scapulae in anterior tilt and causes rounded shoulder
- ▶ As when pectoralis minor contract it pulls the coracoid process anteriorly causing scapula to elevate

Interaction between pectoralis minor and rhomboid muscle

- ▶ There is force couple which is formed by the rhomboids muscles, the levator scapulae and the pectoralis minor
- ▶ The pectoralis minor abduct the scapula and balances the adduction pull of the rhomboids major and minor and levator scapulae as all four muscles rotate scapula downward



References

- ▶ KINESOLOGY: The Mechanics and pathomechanics of human movement, Carol A. Oatis- 2nd Edition
- ▶ Joint Structure and Function, Cynthia Norkin- 4th Edition

Questions

- ▶ Scapulohumeral rhythm (5M)
- ▶ Shoulder pathomechanics (5M)



THANK YOU