STATIC AND DYNAMIC STABILITY OF THE GLENOHUMERAL JOINT

Presented by: Archana K

Assistant professor

SNS COLLEGE OF PHYSIOTHERAPY

Introduction

- The glenohumeral joint is a ball and socket type of joint, the articulation is composed of head of the humerus and the glenoid fossa.
- The humeral head is larger compared to the glenoid fossa.
- The joint has compromised its stability for the mobility.
- These two factors make the glenohumeral joint highly incongruent.
- The bony components alone cannot maintain the joint stability.

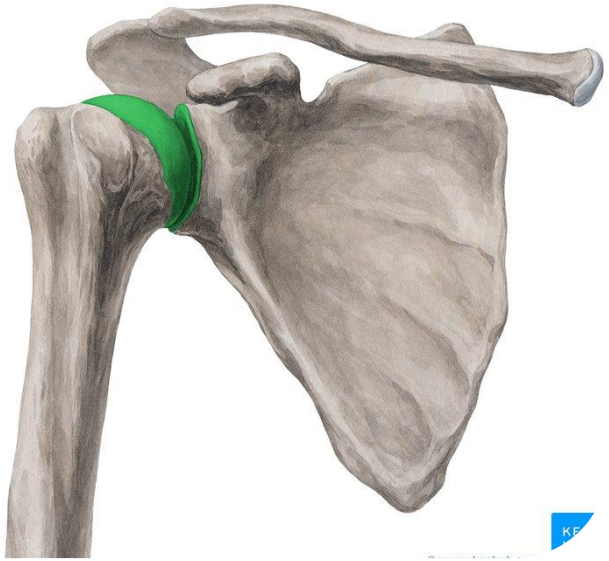


Fig:1
Source:https://www.kenhub.com/en/library/anatomy/the-shoulder-joint

STATIC STABILIZATION

(stabilization at rest)

- Stability is required when the head of the humerus is resting on the glenoid fossa as the gravitational force imparts the caudally directed translatory force on the humerus.
- If the gravitational force is not balanced it can pull the humeral head downward causing the inferior translation of the GHJ or subluxation.
- The structures of rotator interval capsule (superior capsule, superior glenohumeral ligament and coracohumeral ligament) are taut when the arm is at the side producing the necessary force to balance the gravitational force.

The resultant vector formed from the gravity and rotator interval capsule capsule vectors creates a force that compress the humeral head into the glenoid fossa and prevents the inferior humeral head translation.

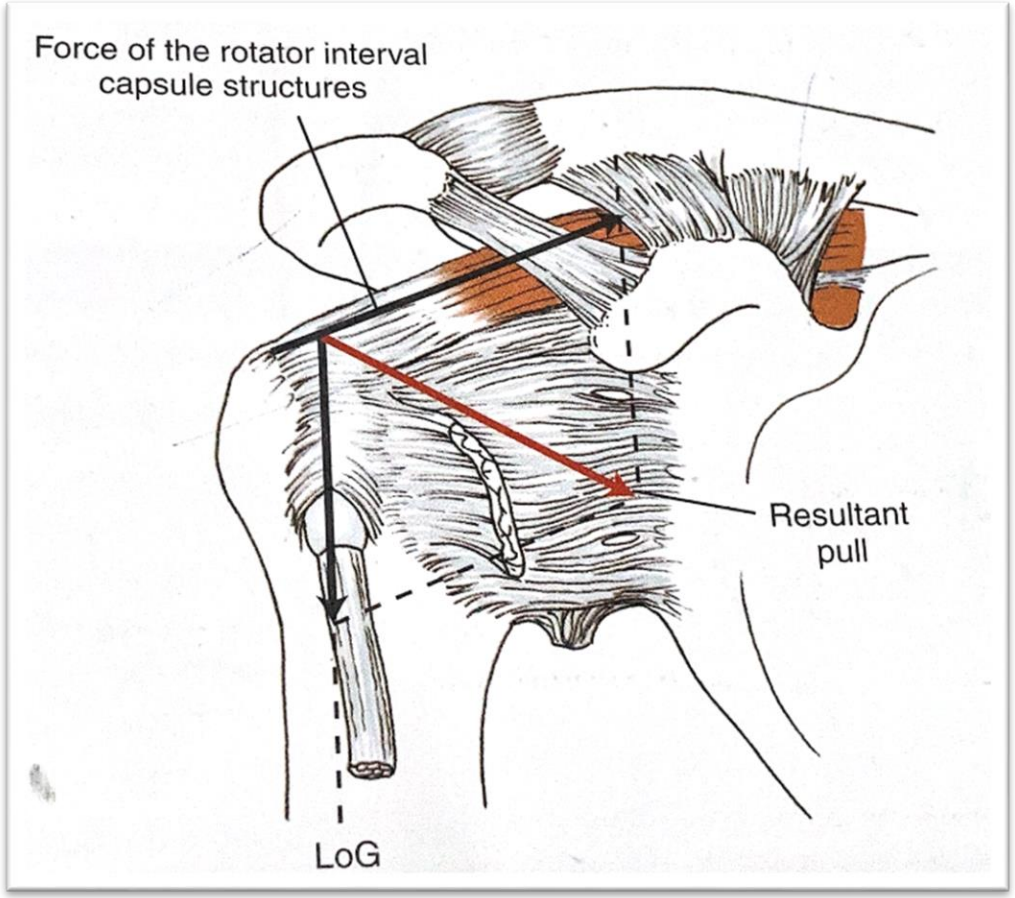


Fig:2
Source: Levangie, P. and Norkin, C., 2007. Joint Structure And Function. 5th ed. Philadelpha: F.A. Davis

- In addition to passive tension from the rotator interval capsule, two other mechanisms help provide static stability to the GHJ.

2)The capsule:

- Around the joint is airtight and there is **negative intra-articular pressure**.
- This **negative intra-articular pressure** creates a vacuum that hold the humeral head and provides stabilization.
- Loss of intra articular pressure occurs when there is tear in glenoid labrum- results in inferior translation of humeral head.

3) The degree of glenoid inclination:

- A slight upward tilt of the glenoid fossa will produce a partial boney block against the humeral inferior translation.
- When these passive forces are inadequate for GHJ stabilization, as may occur in the heavily loaded arm, the supraspinatus is required to provide active assistance. The supraspinatus tendon has attachments to the rotator interval capsule.
- Any paralysis or dysfunction in the supraspinatus may lead to gradual inferior subluxation of the GHJ.

DYNAMIC STABILIZATION

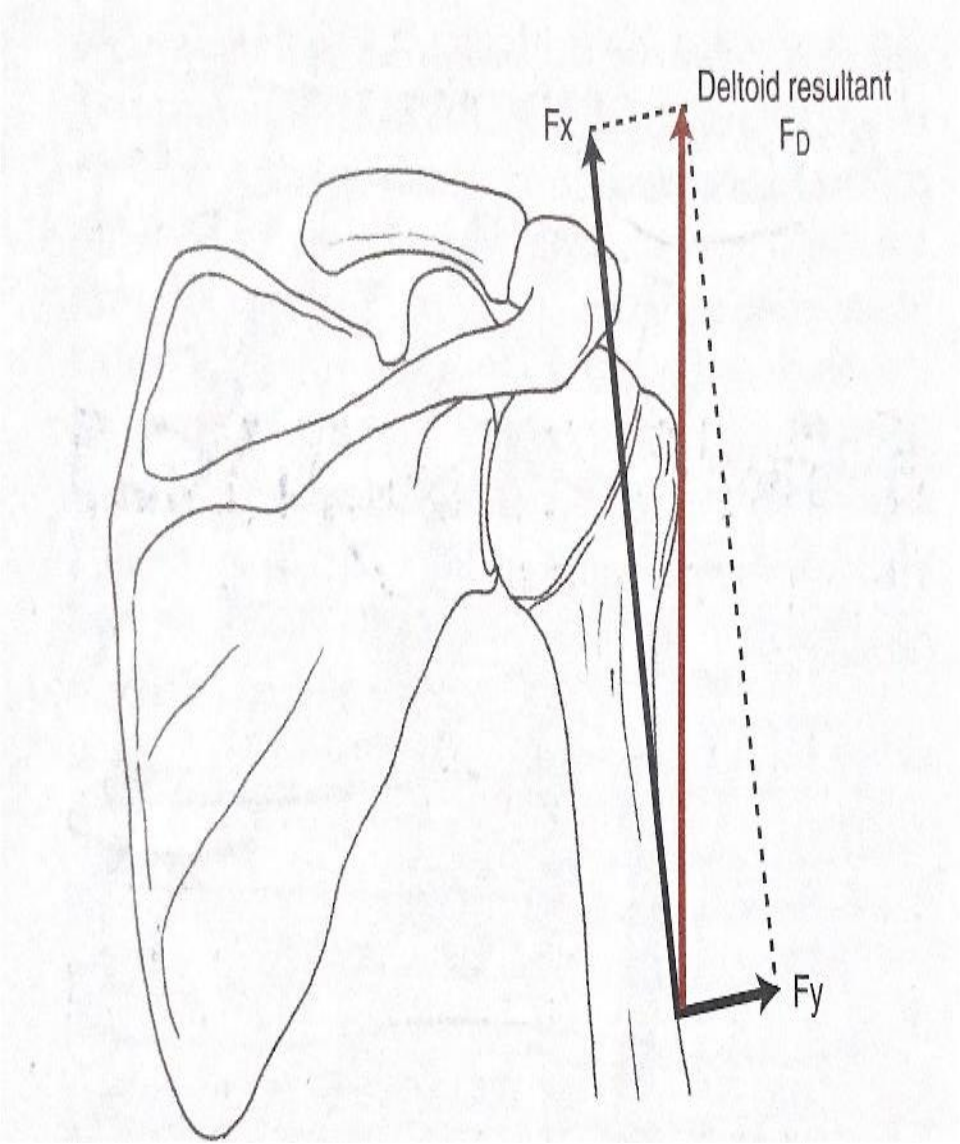
(stabilization during the motion)

The Deltoid and Glenohumeral Stabilization

- Deltoid muscle along with supraspinatus is a prime mover for glenohumeral abduction.
- The anterior deltoid is also considered the prime mover in glenohumeral flexion.
- The action line of all 3 segments of deltoid follows the line of pull of middle deltoid.

- When force vector of **deltoid** (**F_D**) is resolved in to :
  - Parallel component (**F_X**)- Parallel to humerus
  - Perpendicular component (**F_Y**)- perpendicular to humerus.
- As the parallel component directed superiorly is larger than perpendicular component, **the force of contraction of deltoid causes superior translation of humeral head.**

- The action line of all three segments of the deltoid follows the line of pull of the middle deltoid.
- The resultant (F_D) resolves into a very large translatory component (F_X) and a small rotatory component (F_Y) so that an isolated contraction of the deltoid would cause the deltoid to produce more superior translation than rotation of the humerus.
- The inferior pull of gravity cannot offset the Fx component of the deltoid, because the resultant force of the deltoid must exceed that of gravity before any rotation can occur.



- The **large superiorly** directed force of deltoid if **unopposed** would cause the humeral head to **impact the coraco acromial arch** before full abduction had occurred.
- As a result, the deltoid cannot independently abduct the arm.
- **Rotator cuff** work synergistically with the deltoid for it to work effectively to produce the desired rotation (abduction).

The Rotator Cuff and Glenohumeral Stabilization

- The supraspinatus, infraspinatus, teres minor and subscapularis muscles and tendons compose the rotator cuff (SITS muscles).

- These muscles have lines of action that significantly contribute to the dynamic stabilization of the glenohumeral joint.

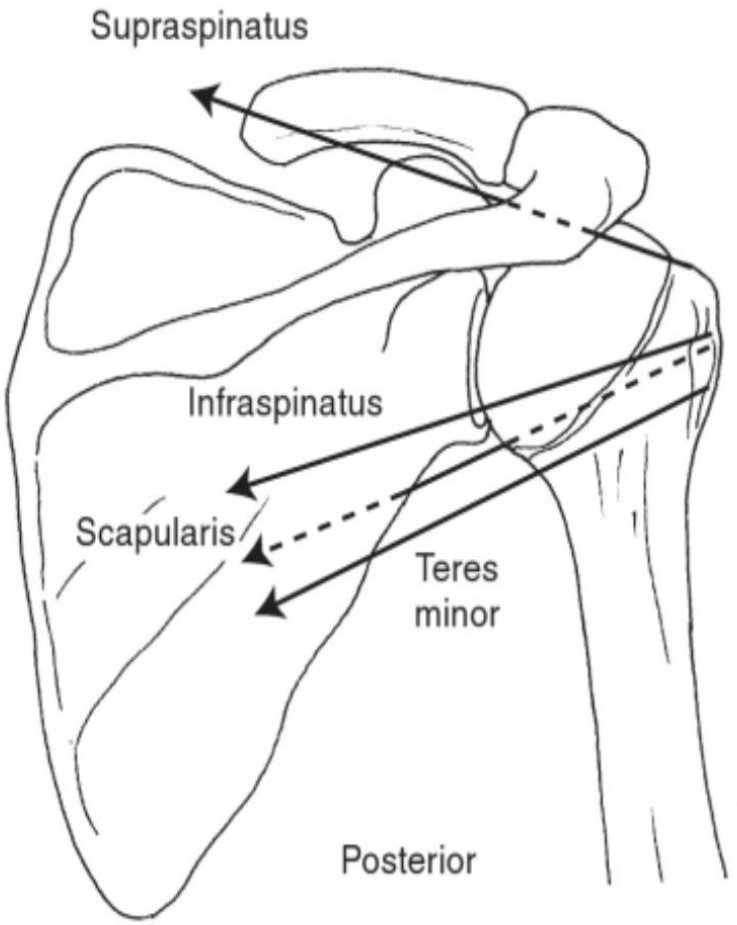


Fig:3
Source: Levangie, P. and Norkin, C., 2007. Joint Structure And Function. 5th ed. Philadelpha: F.A. Davis

- The **infraspinatus, teres minor and subscapularis (ITS)** muscles individually and together have a **similar line of pull**.
- When resultant force vector is resolved in to perpendicular (Fy) and parallel component (Fx).
- The perpendicular component (Fy) -**compresses** the humeral head as well as rotates .
- the parallel component (Fx)-**directed inferiorly**. So it helps **offset the superior translatory pull of the deltoid.**

- **The action of the deltoid and the combined actions of the infraspinatus, teres major and subscapularis muscles approximate a force couple which helps in rotation of the humeral head around a relatively stable axis of rotation with minimal translation.**

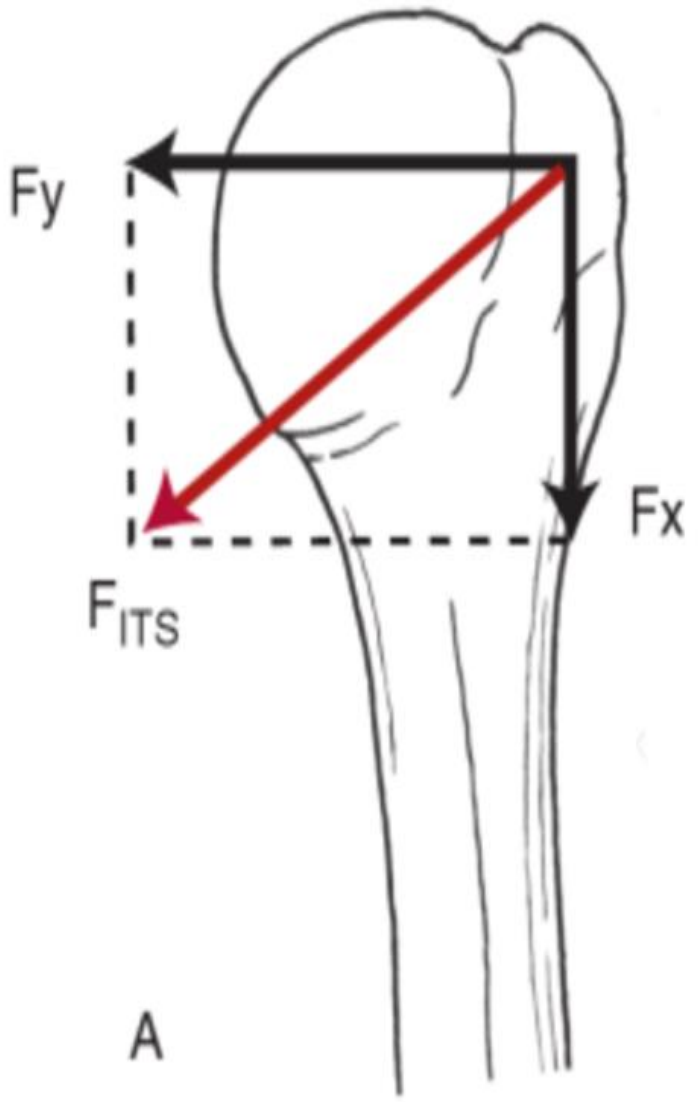


Fig:5
Source: Levangie, P. and Norkin, C., 2007. Joint Structure And Function. 5th ed. Philadelpha: F.A. Davis

The supraspinatus and Glenohumeral Stabilization

- Although the supraspinatus muscle is a part of the rotator cuff, the line of action of the supraspinatus muscle, is not similiar to the action lines of the other three rotator cuff muscles.
- It has a superior translatory component rather than the inferior component as in other rotator cuff muscles.
- It is an effective stabilizer of the glenohumeral joint as its line of action lies father from the glenohumeral joint axis.

- The supraspinatus has a superiorly directed parallel translatory component (Fx) and a perpendicular component (Fy).
- perpendicular component (Fy) is **more compressive** than that of the other rotator cuff muscles and can **independently produce full range of abduction** along with stabilization of GH joint.

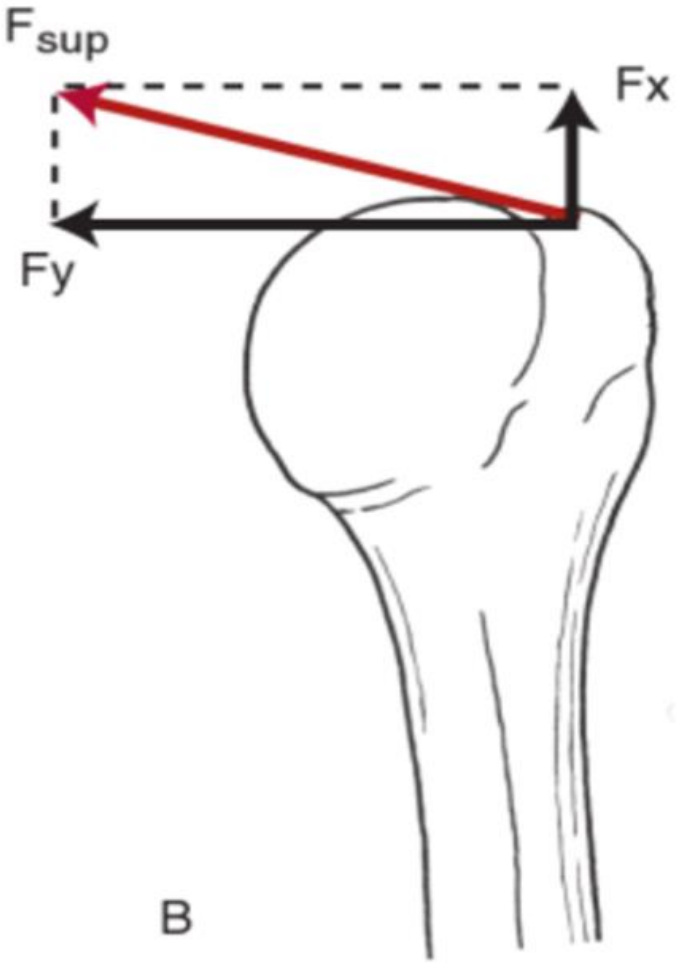


Fig:6
Source: Levangie, P. and Norkin, C., 2007. Joint Structure And Function. 5th ed. Philadelpha: F.A. Davis

The Long Head of the Biceps Brachii and Glenohumeral Stabilization

- The long head of the biceps brachii runs superiorly from the anterior shaft of the humerus through the bicipital groove between the greater and lesser tubercles to attach to the supraglenoid tubercle and superior labrum.
- It enters the glenohumeral joint capsule through an opening between the supraspinatus and subscapularis muscles, where it penetrates the capsule.

The long head of biceps brachii

•Because of its position at the superior capsule and its connection to structures of the rotator interval capsule, is sometimes considered to be part of the reinforcing cuff of the GHJ. Also helps in centering of the humeral head.

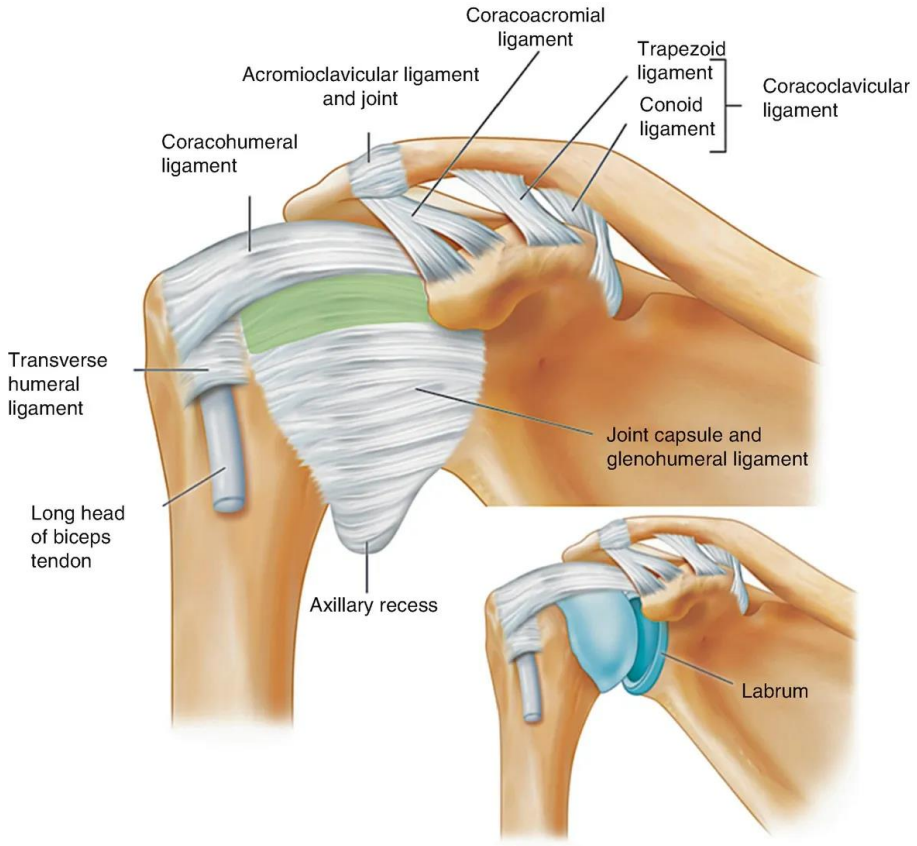
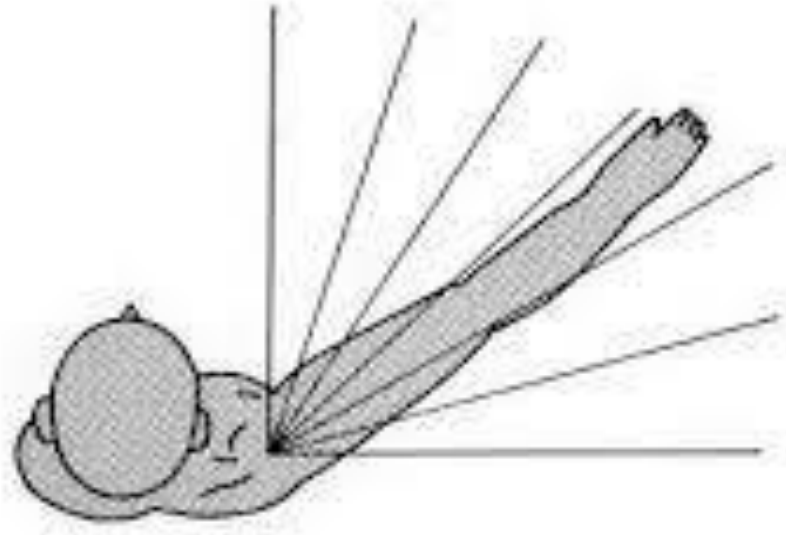
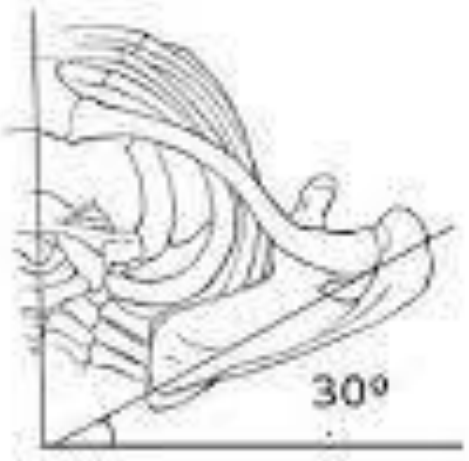


Fig:7
Source: https://aneskey.com/19-shoulder/

Plane of scapula

- Also known as **scaption.**
- The plane were scapula lies.
- It is in between sagittal and frontal plane.
- It is about 30 degree to frontal plane .functional movements takes place in this plane





Muscles of elevation

- **Upper trapezius** cause elevation of clavicle and **serratus anterior** cause protraction and upward rotation of scapula during arm elevation.
- Serratus anterior- has a large moment arm and is the prime mover.
- Lower trapezius is the prime stabilizer and prevent excess lateral rotation of scapula.

Deltoid:

- Anterior deltoid is prime mover for flexion, it assist flexion after 15 degree of GH flexion.
- Length tension relationship of deltoid depends on the optimal position of scapula.
- When scapula is not able to upwardly rotate , there will be loss of tension in deltoid that result in decreased glenohumeral abduction

- If scapular upward rotators- serratus anterior and trapezius is weak, **middle and posterior deltoid** will act on the scapula and result in downward rotation of scapula
- The net effect of abduction by deltoid in the presence of trap and serratus paralysis result in limited range of 60-75 degree.

- Supraspinatus muscle:
- When deltoid is paralysed supraspinatus alone can abduct arm because it has larger moment arm, but the motion will be weaker.
- Isolated paralysis of supraspinatus can cause loss of strength in abduction.

- When trapezius is intact and serratus anterior muscle is paralysed, full active abduction is possible but flexion will be difficult.
- Bcz trap is more active in abduction than flexion.

- If serratus anterior is paralysed – strength of flexion and range will be dimnished.

- Shoulder impingement and shoulder shrug during elevation of arm can occur due to:
- Increased trapezius activity
- Diminished serratus muscle activity
- Less upward rotation of scapula

- muscles of depression: latissimus dorsi and pectoralis minor muscle combine to form depression of shoulder.