- Instability of the Glenohumeral Joint - Pathophysiology and Classification

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Glenohemeral stability:

- Complex interactions between static and dynamic factors
- Strength and coordination of the rotator cuff and periscapular muscles
- Integrity of the capsuloligamentous complex and the glenoid labrum articular surface

• Glenohumeral stability at rest: Adhesion-cohesion, glenoid suction cup, limited joint volume

• Glenohumeral stability in the midrange of motion: The combined force of the rotator cuff and scapular muscles: Net humeral joint reaction force

• Glenohumeral stability at extremes of motion: Ligamentous glenohumeral stabilization

Static restraints

1. Bony architecture

• Articular version

- The scapula faces 30 degrees anteriorly, tilt 3 degrees upward.
- 75% of persons: 7 degrees glenoid retroversion
- 25%: 2~10 degrees glenoid anteversion
- Humerus: 130~140 degrees of neck-shaft angle
  30 degrees retroversion

• Articular conformity

- Surface area mismatch: Humeral head has surface area that is 3 times that of glenoid.
- Only 25~30% of the humeral head is in contact with the glenoid surface.
- The cartilage of glenoid is thicker peripherally.
- The cartilage of humeral head thicker centrally.
- The articular surface of glenoid and humeral head match almost perfectly.
- Similar to a ball and socket joint

2. Glenoid labrum

- The relative lack of depth and surface area of the boy glenoid is compensated by the fibrous labrum acting to maintain normal glenohumeral biomechanics.

- 75% increase of surface area contact
- Deepen the concavity of glenoid by 50%
- Act as a "chock-block"
- Resection of labrum reduced resistance to translation by 20%.
- Act as an anchor point for the capsuloligamentous structures

3. Negative intra-articular pressure

- Glenohumeral suction cup stabilization mechanism
- High osmotic pressure in the interstitial tissues
- Pressure: - 42 cm H_2O in the adducted and relaxed shoulder
- Important when the rotator cuff is not contracting
- Loss of negative pressure leads to 55% increase of anterior translation.

4. Adhesion-cohesion

- Less than 1ml of joint fluid
- Viscous and intermolecular forces help to create this adhesion-cohesion effect.
- This is a stabilizing mechanism that permits sliding motion while limiting them from being pulled apart.

5. Capsuloligamentous structures

1) Rotator interval

- Superior glenohumeral ligament and Coracohumeral ligament
- Limit the inferior dislocation and external rotation in adducted position

2) Middle glenohumeral ligament

- Limit the inferior displacement in adducted position
- Limit the anterior displacement and external rotation in mid-range of abduction

3) Inferior glenohumeral ligamentous complex

- Anterior and posterior bands: thick anterior band
- Thinner axillary pouch
- Primary restraint in 90 degree abduction and external rotation
- Main stabilizer to both anterior and posterior stress in over 45 degrees of abduction
- Restraint to external rotation in neutral and abducted position
- Functions as a "hammock" to support the humeral head as it undergoes reciprocal tightening-loosening with abduction or rotation as the orientation of the complex changes.

4) Posterior capsule

- Thinnest region of the joint capsule
- Limit posterior translation in forward-flexed, adducted and internally rotated position

6. Rotator cuff as a static stabilizer

- Passive tension within the rotator cuff appears to have some static role.
- The "posterior mechanism of dislocation" occurs in older patients who sustain supraspinatus and infraspinatus tendon tears, with or without capsular injury, in association with anterior dislocation.
- Rupture of the subscapularis has also been noted in patients with recurrent dislocation who are older than 35 years of age.

Dynamic factors

1. rotator cuff

- Concavity-compression mechanism
- Coordinated rotator cuff contraction/steering effect

2. Ligament dynamization

- Conceptually, active shoulder motion may "dynamize" the capsule and ligaments, thereby becoming a stabilizing factor in the mid-range of rotation when they are relatively lax.

3. Long head of biceps brachii

- Stabilize the joint anteriorly in internal rotation
- Stabilize the joint posteriorly in external rotation
- Anteroposterior translation decreases with biceps loading
- Superoinferior translation also decreases with biceps loading
- Secondary stabilizing function for failed primary static restraints

4. Scapular rotators

- Trapezius, rhomboids, latissimus dorsi, serratus anterior, and levator scapulae
- "scapulohumeral rhythm" : glenohumeral motion:scapulothoracic motion = 2:1
- The role is to provide a stable platform beneath the humeral head during shoulder motion.
- These muscles allow the glenoid to adjust to changes in arm position.
- Deltoid and pectoralis major also play some role in stabilizing the glenohumeral joint.

5. Proprioception

- This afferent feedback may mediate a protective mechanism against capsular failure and instability by activating reflex muscular contraction.
- Several studies found decreased proprioception in shoulder with instability.

Pathoanatomy

1. Bankart lesion

- Detachment of capsulolabral complex from the glenoid rim and scapular neck
- Originally described as the "essential lesion"
- But simulation in cadaveric study resulted in minimal increase of anterior translation.
- 97% of first-time traumatic anterior dislocation: Bankart lesion without capsular injury
- But most patients with recurrent anterior dislocation present with additional pathology.

* It is now believed that recurrent complete dislocation requires an additional pathoanatomic component.

2. Capsular injury

1) Traumatic intrasubstance injury

- In one study, 55% of acute anterior dislocation showed capsular rupture arthrographically.
- Associated with rotator cuff tear in older patients

2) Humeral avulsion

- HAGL: humeral avulsion of the glenohumeral ligament
- Appears as a thickened, rolled edge of capsular defect
- Typically found in inferior pouch
- Associated with subscapularis tear

3) Repetitive injury

- Overhead athletes
- The cumulative effect of repetitive subfailure strain causes irreversible stretching of IGHL followed by instability.

3. Capsular laxity

- Intrinsic capsular laxity
- Inherited disorders of collagen

4. Humeral bone loss

- Hill-Sachs lesion is present in more than 80% of anterior dislocations and 25% of anterior subluxations.
- If Hill-Sachs lesion involves more than 30% of the humeral articular surface, it may contribute to recurrent anterior instability even with capsular repair.

5. Glenoid bone loss

- Bony Bankart lesion
- Compromise of 25% or more of the glenoid surface warrants bony reconstruction
  Ex) Coracoid transfer (Latarjet procedure)
- Defect smaller than 20%: repairing the capsule and labrum back to the edge of the intact glenoid

6. Articular version abnormalities

- Glenoid dysplasia
- Excessive glenoid retroversion: posterior instability

Classification

* Classification based on four factors

1. Degree

A. Dislocation
B. Subluxation
C. Subtle

2. Frequency

A. Acute (primary)
B. Chronic
  1) Recurrent
  2) Fixed

3. Etiology

A. Traumatic
B. Atraumatic
  1) Voluntary (muscular)
  2) Involuntary (positional)

C. Acquired (microtrauma)
D. Congenital
E. Neuromuscular

4. Direction

A. Unidirectional
    1) Anterior
    2) Posterior
    3) Inferior
B. Bidirectonal
    1) Anteroinferior
    2) Posteroinferior
C. Multidirectional

• Classification by Matson et al
A. TUBS: traumatic, unidirectional, Bankart, surgery
B. AMBRII: atraumatic, multidirectional, bilateral, rehabilitation, inferior capsular shift, interval closure

• Classification by Gerber et al
- Class A: Static instability
    - Class A1: Static superior subluxation
    - Class A2: Static anterior subluxation
    - Class A3: Static posterior subluxation
    - Class A4: Static inferior subluxation
- Class B: Dynamic instability
    - Class B1: Chronic locked dislocation
    - Class B2: Unidirectional instability without hyperlaxity
    - Class B3: Unidirectional instability with hyperlaxity
    - Class B4: Multidirectional instability without hyperlaxity
    - Class B5: Multidirectional instability with hyperlaxity
    - Class B6: Unidirectional or multidirectional instability with voluntary reduction
- Class C: Voluntary dislocation

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