Anatomy, Biomechanics, and Pathomechanics of the Shoulder

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ANATOMY of the SHOULDER

**FUNCTIONAL ANATOMY**
- sternum
- clavicle
- scapula
- ribs
- vertebrae
- ilium
- humerus

**CLAVICLE**
- shaped like an italic “f”
- acts as a strut to the UE to resist compressive forces
- medial portion moves the least
- main function is stability

**SCAPULAR ANATOMY**
- thin, flat triangular shape provides a concave surface that can glide easily over the convex thorax with at least 17 muscles that originate or insert

What is the clinical significance of multiple muscle attachments?

Upper Trap
Lever Scapulae
Rhomboid Major
Rhomboid Minor
Middle Trap
Lower Trap
Serratus Anterior
Pec Minor

Deltoid
Supraspinatus
Infraspinatus
Teres Minor
Subscapularis
Teres Major
Biceps
Triceps
Coracobrachialis
SCAPULAR FUNCTIONS

- increases the positions available for the hand in space by varying the original position of the proximal humerus
- provides stability for the upper extremity during functional activities of the hand

proximal stability to allow functional distal mobility

SHOULDER ARTICULATIONS

- sternoclavicular
- acromioclavicular
- scapulothoracic - functional
- glenohumeral

Integrated, functional movement emanating from proximal to distal

sternoclavicular joint

- only skeletal articulation between upper extremity and axial skeleton
- synovial sellar articulation
- Articular surfaces lack congruity
  - 1/2 of the large round head of the clavicle protrudes above the shallow sternal socket

sternoclavicular joint

- Disc
  - completely separates joint
  - attaches to cartilage of 1st rib and capsule
- Capsule - very lax
- Ligaments
  - provide stability
  - interclavicular - costoclavicular - sternoclavicular
  (posterior sternoclavicular is strongest)
sternoclavicular joint ligaments

- Proximal Surface
  - sternal clavicular notch
  - shares cartilage with 1st rib
  - convex vertically (cranial/caudal)

- Distal Surface
  - medial clavicle
  - larger surface with thick fibrocartilage
  - concave AP
  - convex vertically

sternoclavicular joint motion ...

- When the convex vertical surface of clavicle moves:
  - caudally - shoulder elevates
  - cranially - shoulder depresses

- When the concave AP surface of clavicle moves:
  - anteriorly - shoulder protracts
  - posteriorly - shoulder retracts

acromioclavicular joint

- Capsule - lax
- Ligaments - strong
- Role
  - allows scapula to glide and clavicle to rotate
- Motion
  - clavicle elevates 35° and rotates 45-55° during full overhead elevation

ACROMIOCLAVICULAR JOINT

- synovial gliding joint with lax capsule and strong ligamentous support
- Distal Surface
  - acromion (flat or slightly convex)
- Proximal Surface
  - clavicle (flat or slightly concave)
  - clavicle faces inferiorly, posteriorly, and laterally

Acromioclavicular Ligaments

- Acromioclavicular
  - limits 91% of AP translation
- Coracoclavicular
  - limits 77% of superior translation
    - Conoid (medial) is vertically oriented and creates clavicular rotation when taut
    - Trapezoid (lateral) is more horizontally oriented and resists acromion form sliding under the clavicle
Acromioclavicular Ligaments

Coracoacromial
- triangular shape from base at lateral border of coracoid which moves up, laterally, and posterior to the top of the acromion process

Coracoacromial
- forms a protective arch over the GHJ and forms roof of SA space
- Role in stabilizing GH and ACJ?
  - Suspensory function
  - Increased anterior/inferior glide following SAD
- Superior escape syndrome may occur if RC deficiency
  - No pivot point for humeral elevation

Structural Influences
- Prominent coracoid process
  - Impingement of subscapularis between coracoid and lesser tuberosity
- Os acromiale
  - Unfused anterior acromial epiphysis
- Hooked acromion
  - Osteophytes, calcific deposits
  - Morphology Variants

Acromial Morphology and its Relationship to Rotator Cuff Tears

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Acromial Shape Frequency (%)</th>
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<tr>
<td>I</td>
<td>Flat</td>
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</tr>
<tr>
<td>II</td>
<td>Curved</td>
<td>43</td>
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<td>III</td>
<td>Hooked</td>
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Bigliani, Orthop Trans, 1986

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<tbody>
<tr>
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</tr>
<tr>
<td>II</td>
<td>Curved</td>
<td>42</td>
</tr>
<tr>
<td>III</td>
<td>Hooked</td>
<td>26</td>
</tr>
</tbody>
</table>

No evidence of change with aging but acromial spurring does and SA space encroachment does decrease with age

**Acromial Morphology and its Relationship to Rotator Cuff Tears**

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<th>Description</th>
<th>Acromial Shape Frequency (%)</th>
<th>Rotator Cuff Tear Frequency (%)</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Flat</td>
<td>17-32</td>
<td>3</td>
</tr>
<tr>
<td>II</td>
<td>Curved</td>
<td>42-43</td>
<td>24</td>
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<tr>
<td>III</td>
<td>Hooked</td>
<td>26-40</td>
<td>73</td>
</tr>
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Bigliani, Orthop Trans, 1986

**Acromion Morphology**

Acromial morphology has a predictive value in determining the success of conservative measures and the need for surgery.

- 67% satisfactory results with conservative management – medication, injection, and therapy.
- Type I acromions had a disproportionate degree of success.

**Recent Contradictions in the Literature**

- Acromial slope (in all planes) is not useful in classifying patients with shoulder pain and should not be considered a source of pathological change - Moses, et al., J Magn Reson Imaging 2006
- 3D imaging could not adequately distinguish between normals, SIS, and RC tears and osseous acromial impingement is not a primary cause of RC disease - Chang, et al., Radiology 2006

**SCAPULAR LOCATION**

- Tipped 10° forward and 30° anterior to the frontal plane
- Medial border of scapulae essentially parallel to the vertebral column

**Scapular Motion**

- 3 Rotations
- 2 Translations
**Scapulothoracic Joint Motion**

Three Axes of Rotation
- AP upward-downward rotation
- Vertical scapular winging (IR/ER)
- Frontal scapular tipping or tilting

Two Translations
- Elevation - Depression
- Protraction - Retraction

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**Scapular Contributions to Glenohumeral Elevation**

- Upward Rotation
- Internal Rotation
- Posterior Tilt

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**SCAPULAR MOBILITY**

**RANGE of MOTION**

- Up/Downward Rotation: 10-12 cm displacement of inferior angles or 60°
- Protraction/Retraction: 15 cm of movement
- Elevation/Depression: 12 cm of movement

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**Glenohumeral Joint Anatomy**

- "golf ball" (humeral head) on a “tee” (glenoid fossa)
- surface area of humeral head 3-4 times larger than fossa and faces medially, posteriorly, and superiorly

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**Glenohumeral Joint Anatomy**

- humeral head at 130-150° angle to shaft of humerus
- humerus retroverted 20-30° with respect to flex-extension axis of elbow
**Glenoid Fossa Shape**
- pear shaped and shallow
- broader inferiorly than superiorly
- 5° posterior and superior inclination

**Glenoid Version and Tilt**
- 5° superior inclination to provide buttress to inferior subluxation
- 5-10° retroversion to provide buttress to anterior subluxation

**Glenohumeral Closed Pack Position**
"testing position"
the point in the ROM where there is perfect fit, maximal articular contact, and concurrent ligamentous tension
90° Abduction and Ext Rotation

**Glenohumeral Resting Position**
"treatment position"
the point in the ROM where there is perfect fit, maximal articular contact, and concurrent ligamentous tension
Resting position allows for better lubrication, less frictional forces, and more freedom of movement for spin, glide, and roll
50-70° elevation in the scapular plane with mild ER
39° of abduction in the scapular plane of available abduction range

**Glenohumeral Arthrokinematic Motion**

- **Forward Elevation**
  - humeral head slides inferiorly, rolls posteriorly, and spins into IR
  - slide and spin more pronounced than the roll

- **Abduction**
  - humeral head slides inferiorly, rolls superiorly, and spins into ER

- **External Rotation**
  - anterior slide and posterior roll of humeral head
  - the rotator cuff dynamically steers the humeral head during elevation motions

**Joint Geometry vs. Ligamentous Tension**
Is arthrokinematic motion **strictly** determined by joint morphology?

or
Does ligamentous tensions influence arthrokinematics?
Glenoid Labrum Anatomy

- Fibrocartilage ring attached to the rim of the glenoid
- Primary site of insertion of ligaments - capsule
- Inner surface covered with synovium
- Outer surface continuous with capsule and periosteum of scapular neck

Increases depth of fossa to 5mm AP and 9mm superior to inferior from 2.5 mm without the labrum
- Glenoid contact with humeral head = 1/3 without labrum; 2/3 with labrum
- Chock block function

Glenohumeral Capsule Anatomy

- Attaches medially to the glenoid fossa beyond the labrum and circumferentially moves laterally attaching to the humeral neck up to 1/2” down the humeral shaft
- Twice the surface area of the humeral head; lax with inferior recess
- Very loose and redundant; will allow 2-3 cm of joint surface distraction

Shoulder Shirt Sleeve Analogy

- Sleeve size dictates
  - Shoulder mobility
  - Restrictions in range

Coracohumeral Ligament

- Moves downward and laterally from the base of the coracoid to insert onto the greater tuberosity
- Fills the space between the subscapularis and supraspinatus
- Functions to counteract the force of gravity and checks end range ER, flexion, and extension
**Rotator Cuff Interval**

- Combination of CHL and SGHL
  - Prevents inferior translation
  - Stretched in CVAs allowing inferior subluxation when RC inactive
  - Limits ER when arm in dependent position
  - Contracted with adhesive capsulitis

**Glenohumeral Ligaments**

- Three distinct, thickened portions of the capsule on the anterior aspect of the joint
  - Superior Glenohumeral Ligament
  - Middle Glenohumeral Ligament
  - Inferior Glenohumeral Ligament Complex

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**Glenohumeral Ligaments**

<table>
<thead>
<tr>
<th>Portion</th>
<th>Origin</th>
<th>Insertion</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>12:00 glenoid labrum</td>
<td>Lesser tuberosity</td>
<td>Prevent inferior displacement</td>
</tr>
<tr>
<td>Middle</td>
<td>Anterior glenoid fossa</td>
<td>Anterior aspect of anatomical neck</td>
<td>Limits ER up to 90° of Abduction</td>
</tr>
<tr>
<td>Inferior</td>
<td>Ant-post-inferior glenoid</td>
<td>Anterior aspect of anatomical neck</td>
<td>Prevents anterior subluxation in upper ranges of Abduction</td>
</tr>
</tbody>
</table>

**Dependent Position**

- IFGHL
- MGHL
- SGHL
- CCL
- LHB
- CAL

**45° Abduction**

**90° Abduction**
**Shoulder Stability Concepts**

**Static Mechanisms**
- Bony
- Ligamentous
- Joint Pressures/Volumes

GHJ has very little inherent bony stability
- Normal translation of humeral head on glenoid is 50% anterior and posterior
- Should not be more than 6 mm translation from center of rotation during shoulder motion

**Glenohumeral Joint Analogy**
- Concave on convex
- Convex on concave

**Static Shoulder Stability**
- Joint pressures and volumes
  - Negative atmospheric pressure contributes to shoulder stability
  - Adhesion/cohesion: joint surfaces stick together; allowing motion but not separation
    (ex: two slides that stick together with a drop of water)
  - Limited joint volume contributes to shoulder stability
**GHJ intra-articular joint pressure**

- magnitude of the stabilizing pressure is normally 20-30 lbs
- tears in the capsule allow introduction of air or fluid and reduce the force necessary to translate the humeral head by approximately 50%

**Theoretical contributions to shoulder stability**

- NIP (most important)
- Muscular
- Capsular

**Range of motion**

- Dynamic shoulder stability
  - Rotator Cuff
    - Active contraction centers GH articulation and compresses joint surfaces
  - Force Couples
    - Scapular and humeral
  - Neuromuscular Control and Function
    - Increases dynamic ligament tension

**Muscular innervations**

**Axillary Nerve**

- Innervates deltoid and teres minor
- At risk with:
  - Rotator cuff surgery (terminal branches)
  - Anterior instability surgery (adjacent to subacromial and anterior capsule)
  - Posterior instability surgery (emerging from quadrilateral space)
  - Anterior glenohumeral dislocations
  - Proximal humeral fractures

**Functional Screen for Axillary Nerve Innervation**

- Ability to put hand in front pocket
**Long Thoracic Nerve**
- Innervates serratus anterior
- At risk with:
  - Chronic compression or traction
  - Axillary incision approach
  - Neuritis (Parsonage-Turner Syndrome)

**Evaluate for “plus sign”**
- To differentiate dyskinesis from a palsy
  - Elevate to 90° in sagittal plane and observe winging
  - Protract from this position
    - If scapula protracts – dyskinetic
    - If scapula wings – palsy

**Spinal Accessory Nerve**
- Innervates the trapezius
- At risk with:
  - Direct blow
  - Surgical complication
  - Lymph node biopsies
  - Neuritis of unknown origin

**Evaluate for “flip sign”**
- Test for shoulder external rotation strength but monitor medial scapular border
  - If scapula lifts of the thorax (internally rotates) it indicates a spinal accessory nerve lesion where the middle and lower trap can not stabilize the scapula

**Suprascapular Nerve**
- Innervates supraspinatus and infraspinatus
- At risk with:
  - Spinoglenoid ligament ossification

**Suprascapular Nerve**
- Innervates supraspinatus and infraspinatus
- At risk with:
  - Spinoglenoid ligament ossification
  - Protracted scapula
  - Superior or posterior arthroscopic portals
1. Scapulohumeral Rhythm
2. Scapulothoracic Force Couples
3. Obligate Translation
4. Muscular Function

**SCAPULOHUMERAL RHYTHM**

1. distribute elevation motion between two joints permitting a larger ROM with less compromise of stability

2. maintain the glenoid fossa in optimal congruency with the humeral head and decrease shear forces

3. allow muscles that act on the glenohumeral joint to maintain a good length-tension relationship and minimize active insufficiency

**Scapular Movement with Elevation**

- Without scapular movement, the arm can abduct 90° actively and 120° passively
- The difference in ROM is that the deltoid becomes actively insufficient or to short to develop adequate tension without scapular rotation

**2:1 SCAPULOHUMERAL RHYTHM**

- Scapulothoracic joint contributes about 60° to elevation
- Glenohumeral joint contributes about 120° to elevation
  - 120° with flexion
  - 90-120° with abduction
scapulothoracic joint motion formula

30° of sternoclavicular motion + 30° of acromioclavicular motion = 60° of scapulothoracic motion

First 30° of Scapulothoracic motion
- Clavicular elevation through axis at base of spine of scapula

Last 30° of Scapulothoracic motion
- Clavicular rotation through axis at the acromioclavicular joint

SCAPULOHUMERAL RHYTHM

Scapulothoracic Joint Force Couple
- two forces acting in opposite directions to rotate a part about its axis of motion

scapulothoracic joint force couple
- two forces acting in opposite directions to rotate the upwardly rotate the scapula about its AP axis

**UPPER TRAPEZIUS – LOWER SERRATUS**

**LOWER TRAPEZIUS – UPPER SERRATUS**
Scapulohumeral Force Couple

- The lower trapezius is more active in abduction above 90° while the lower digitations of the serratus anterior is more active in forward flexion.
- Once the axis of rotation reaches the AC joint, the lower trap and lower serratus anterior can become much more effective in scapular upward rotation.
- 30-90° powered by upper trap-serratus
- 90-150° powered by lower trap-serratus

So Why is Scapular Function Important?

Literature Supported Evidence
Normal and Pathological Kinematics to Arm Elevation

<table>
<thead>
<tr>
<th>GROUP</th>
<th>HEALTHY</th>
<th>RC DISEASE</th>
<th>ODI INSTABILITY</th>
<th>ACROME CAPSULES</th>
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<tbody>
<tr>
<td>Primary Scapular Motion</td>
<td>Upward Rotation</td>
<td>▼ UR</td>
<td>▼ UR</td>
<td>▼ UR</td>
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<tr>
<td>Secondary Scapular Motion</td>
<td>Posterior Tilting</td>
<td>▼ Post Tilt</td>
<td>Inconsistent evidence</td>
<td>Inconsistent evidence</td>
</tr>
<tr>
<td>Accessory Scapular Motion</td>
<td>Variable Int/Ext Rotation</td>
<td>▼ IR</td>
<td>▼ IR</td>
<td>Inconsistent evidence</td>
</tr>
<tr>
<td>Implications</td>
<td>Maximizes motion; minimizes pain</td>
<td>Contribute to impingement</td>
<td>Contribute to instability</td>
<td>Compensation to allow elevation</td>
</tr>
</tbody>
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Literature Supported Evidence
Biomechanical Mechanisms of Scapular Kinematic Deviations

<table>
<thead>
<tr>
<th>MECHANISM</th>
<th>ASSOCIATED EFFECTS</th>
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<tbody>
<tr>
<td>Inadequate Serratus Activation</td>
<td>Decreased scapular upward rotation and posterior tilt</td>
</tr>
<tr>
<td>Excess Upper Trap Activation</td>
<td>Increased clavicular elevation</td>
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<tr>
<td>Pec Minor Tightness</td>
<td>Increased scapular internal rotation and anterior tilt</td>
</tr>
<tr>
<td>Posterior GH tightness</td>
<td>Increased scapular anterior tilt</td>
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<tr>
<td>Thoracic Kyphosis</td>
<td>Increased scapular internal rotation and anterior tilt</td>
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<tr>
<td></td>
<td>Decreased scapular upward rotation</td>
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Does the humeral head depress?

only when it shouldn’t …
the cuff minimizes superior translation during active elevation
Glenohumeral Elevation Force Couple

- **Elevators - Compressors:**
  - Deltoid
  - Pectoralis
  - Supraspinatus
  - LH of Biceps

- **Depressors: (Elevation Resisters)**
  - Subscapularis
  - Infraspinatus
  - Teres Minor

Rotator Cuff Cross Sectional Volume

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<tr>
<th>Muscle</th>
<th>Percentage</th>
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<tr>
<td>Subscapularis</td>
<td>53%</td>
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<tr>
<td>Supraspinatus</td>
<td>14%</td>
</tr>
<tr>
<td>Infraspinatus</td>
<td>22%</td>
</tr>
<tr>
<td>Teres Minor</td>
<td>10%</td>
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*Keating, JBJS, 75B: 1993*

Rotator Cuff Elevation Force Couple

- Rotator cuff is active throughout elevation ROM and functions to resist excessive humeral head elevation and decrease subacromial impingement.
- RC mm action decreases at higher ranges of elevation as their is less need for depression of the humeral head.
- At higher ranges of elevation, gravity and the adductors provide humeral head depression.

EMG Action Potential of Rotator Cuff through Elevation Range

- Supraspinatus: dominant vector is compression. 63% of total force.
- Infraspinatus, Subscapularis: mean vector of IST is angled 50° inferior to the face of the glenoid. 80% of total force.
- Deltoid: dominant vector is superior. 89% of total force.
**Deltoid Muscle**

- 40% of the x-sectional mass
  - Cross section of 18.2 cm²
- Changing vector action
  - Line of pull at rest produces superior shear and 45% of compressive force
  - At 90° - line of pull produces compression

**Challenging Traditional Thought**

**Convex-Concave Morphology vs. Capsular Obligate Translation**

**Premise**

- The relationship of the humeral head to the glenoid fossa should remain relatively constant throughout the ROM
- After an initial superior glide during elevation, the humeral head should essentially spin on the glenoid fossa

**Evidence**

- Howell, JBJS, 1988 radiographically demonstrated that the humeral head translated 4 mm posteriorly when the arm was position at 90° of abduction, full ER, and maximum horizontal abduction in normal shoulders
- Howell, JBJS, 1988 conversely found that in subjects with anterior instability, the humeral head translated anteriorly when in the same position of 90° abduction, full ER, and maximum horizontal abduction

**Convex-Concave Morphology vs. Capsular Obligate Translation**

**Evidence**

Harryman, JBJS, 1990 analyzed the biomechanics of the GHJ on cadaveric specimens and noted a posterior translation of the humeral head with ER and an anterior translation with IR with the arm at the side.

This phenomena increased significantly when the posterior capsule was tightened.

**Clinical Examples: Adhesive Capsulitis**

Obligate translation

 Tight anterior capsule structures causing obligate posterior translation and possible posterior pain with end range mobilization.
Tight posteroinferior capsule causing early and excessive anterosuperior translation and closing the subacromial space

**Clinical Examples**

**Subacromial Impingement**

One more clinical example: roll back phenomena in throwers

- G.I.R.D (IR ROM deficit of > 25°) with tight posterior capsule and acquired IGHL laxity does not allow normal posterior translation creating internal impingement

**Convex-Concave Morphology vs. Capsular Obligate Translation**

**Interpretation**

- Translation direction is dictated by the capsuloligamentous complex. During arm movements, the passive restraints act not only to restrict movement but also to reverse humeral head movements at the end range of motion
  - Humeral head moves in the direction of least resistance
  - When this phenomena is lost - abnormal translation is present
- Asymmetrical capsular tightness will cause obligate translation away from the side of tightness

**Typical Arthrokinematics**

| Early ER | Anterior glide with Posterior rotation |
| ER approaching end range | Asymmetrical tension builds – taut anteriorly; lax posteriorly |
| End range ER | Head re-centers by gliding posteriorly |

**Manual Therapy Epub – Brandt, 2006**


- Questioning the concept of Kaltenborn’s convex-concave rule
  - Systematic review of the literature indicates that not only passive, but active control subsystems should be considered when determining appropriate direction of humeral head translation

**Muscular Function of the Shoulder**

- Deltid
- Subscapularis
- Infraspinatus
Muscular Function of the Shoulder

**Axioscapular**
Anchor Stabilize & Rotate

**Scapulohumeral**
Center Steer and Compress

**Axiohumeral**
Position Move

- Axioscapular Mms: serratus, traps, rhomboids, levator, pec minor
- Scapulohumeral Mms: SITS rotator cuff muscles, deltoid
- Axiohumeral Mms: pecs, lats, teres major

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EMG Analysis of Glenohumeral Muscles

Flexion
supraspinatus, anterior deltoid

Scaption
subscapularis, supraspinatus, ant/middle deltoid

Horz Abd - ER
infra-spinatus, teres minor, post/middle deltoid

Push Up
latissimus, pec major

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EMG Analysis of Scapulohumeral Muscles

Flexion
upper serratus, lower trap

Scaption
lower serratus, lower trap

Rowing
upper/lower trap, levator scapulae, rhomboids

Horz Abd
middle trap, levator scapulae, rhomboids

Push Up +
lower serratus

Shrug
levator scapulae, upper trap

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Another Systematic Review of Periscapular EMG Activity

1. Prone Extension
2. Overhead Arm Raise (Superman)
3. Inferior Glide
4. Lawnmower
5. Isometric Low Row
6. Wall Slide

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“Therapeutic Ten”

- Standing Flexion
- Standing Scaption
- Standing Shrugs
- Standing Short Arc Military Press
- Prone Row
- Prone Horz Abduction
- Int. Rot. or Mod. D2 Ext Diagonal
- External Rotation
- Dips
- Push-Up +

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Elite Elastic Eight

1. Seated Short Arc Military Press
2. Seated Narrow Row (IR)
3. Seated Mid-Wide Grip Row
4. Standing Boxer Punch
5. Standing Dynamic Hug
6. Standing Shrug-Retraction
7. Standing ER Retraction
8. 0-90° Scapular Plane ER
What's so great about scapular plane elevation?

- Better clearance
- No humeral rotation required
- Symmetrical anterior/posterior capsular tension
- Length/tension relationships optimized
- Path of least resistance

Shoulder Pathoanatomy

- Relationship between various shoulder pathologies

Glenohumeral Instability

Methods of Classification

- Frequency
  - Acute
  - Fixed
  - Recurrent

- Degree
  - Subluxation
  - Dislocation

- Etiology
  - Atraumatic
  - Microtraumatic
  - Macrotraumatic

- Direction
  - Anterior
  - Posterior
  - Inferior
  - Bi/Tridirectional

TUBS vs. AMBRI

These two acronyms represent each end of the instability spectrum.

TUBS (Most Patients)
- Traumatic (acute dislocation)
- Unilateral anterior or posterior
- Bankart lesion
- Surgery (or sling)

AMBRI
- Atraumatic or recurrent
- Multidirectional
- Bilateral
- Rehabilitation
- Inferior capsular shift

Inferior capsular shift: these two acronyms represent each end of the instability spectrum there are overlapping gradations of instabilities between these extremes

“Torn - worn - born loose”

Bankart Lesion

- Periosteum and capsule of IGHL and anterior labrum complex detach from scapular neck and adhere to the overlying subscapularis tendon
- Anterior capsular avulsion of IGHL between the 3:00 and 5:00 positions
cadaveric transverse section just inferior to the humeral head equator

Normal Anatomy  Bankart Lesion

Essential Lesion
- no detachment, but stretching of inferior glenohumeral ligament leaving
- an attenuated, baggy capsule with a stretched or traumatized subscapularis tendon

Hill Sachs Lesion
- compression fracture of posterior humeral head as it slips over the sharp edge of the anterior lip of the glenoid fossa

Clinical Features of Anterior Dislocation
- Abnormal shoulder contour
  - prominent lateral acromion
  - “flat” deltoid
  - “fullness” anteriorly and inferiorly
- Arm “locked in place” – slightly abducted and ER and unable to internally rotate
- Decreased sensibility
  - axillary nerve damage -15%

Recurrence Contributing Factor
- The changing ratio of Type I to Type III collagen synthesis
- Type III collagen is much more elastic and synthesized in much greater proportion when younger.

Recurrence Contributing Factor
- The changing collagen ratio is so reliable it can be used to determine the chronological age of an individual
- The higher proportion of Type I collagen in older adults explains their propensity for motion loss following trauma and their decreased dislocation recurrence rate
Posterior GHJ Instability

- **Mechanism of Injury**
  - Direct anterior blow
  - Fall on outstretched hand

- **Clinical Features**
  - Abnormal shoulder contour
  - Loss of ER & abduction
  - Excessive posterior glide in load & shift
  - Lesser tuberosity fracture

- **Pathology**
  - Stretched post capsule
  - Detached posterior glenoid and capsule
  - Reverse Hill-Sach’s lesion
  - Stretched or avulsed subscapularis tendon

Multi-Directional Laxity

- **Mechanism of Injury**
  - Atraumatic
  - Gradual, insidious
  - “Born loose”

- **Pattern of Instability**
  - A-P-I subluxation
  - Anterior or posterior may predominate, but always has an inferior component

Multi-Directional Laxity

- **Clinical Findings**
  - Overuse history with significant episode of trauma
  - Minimal pain complaint
  - Can usually demonstrate instability
  - + sulcus test & general ligamentous laxity
  - Usually > 30 years old

- **Pathology**
  - Inferior capsular redundancy

Impingement Syndrome

- “Very little room for error”

- 9-10 mm clearance with arm at side
- 6-7 mm clearance with arm in flex/IR

Subacromial Impingement Syndrome

Pathological changes underneath the coracoacromial arch

Compression of supr humeral structures against the anteroinferior aspect of the acromion and coracoacromial ligament

Neer, 1972
Combination of intrinsic and extrinsic factors

Intrinsic tension overload and intratendinous degeneration as a result of limited vascularity and external compression

Mehta, 2003

Systematic Review challenges many of Neer’s original conclusions

1. Evidence suggests that coracoacromial arch contact is not in the area that most commonly causes rotator cuff tears
2. Evidence suggests coracoacromial arch contact is normal in cadaveric and asymptomatic subjects
3. Evidence suggests that spurs on the anterior aspect of the acromion are normal traction entheseophytes and normally do not encroach on the underlying rotator cuff
4. Successful treatment of SAS does not require surgical alteration of the acromion and/or coracoacromial arch as evidence by the effective management with physical therapy and injections


Anterior Compressive Impingement

Type I

- direct compression of tissue
- “weekend warrior” usually over 30
- usually secondary to hypomobility

Posterior Compressive “Internal” Impingement

Type II

- Supra and infraspinatus rub on the posteroslateral glenoid and labrum
- Acquired anterior instability resulting in secondary impingement
- young overhead athlete usually < 30
- usually secondary to hypermobility
- labrum and undersurface of rotator cuff

Stages of Compressive Impingement

SLAP Lesions

Superior Labrum Anterior-Posterior

- detachment lesion of the superior aspect of the glenoid margin at the insertion of the LH of the biceps
- Increases strain on IGHL by 100-120%
- MOI
  - throwing athletes
  - falls; direct blows; unexpected traction loads on the biceps
**SLAP Lesion Classifications**

- **Type I**: degenerative or shredded labrum; normal bicep tendon anchor
- **Type II**: superior separation; best tested for by relocation test
  - under 40 associated with Bankart lesion
  - over 40 associated with supraspinatus tear or osteoarthritis
- **Type III**: labrum separated for biceps; bucket handle type tear
- **Type IV**: both labrum and biceps separated from glenoid rim

**SLAP Surgical Indications**

- **Type I**: debridement if symptomatic
- **Type II**: debridement and fixation repair
  - sutures or suretac anchor
- **Type III**: rare
  - debridement or excision
- **Type IV**: rare
  - repair and/or bicep tenodesis

Only 5-20% of total SLAP lesions are Type III or IV and usually occur with a dislocation.

**RC Pathology**

- **Prevalence of RC pathology correlates with increasing age in patients with shoulder complaint**

**How Common are Rotator Cuff Tears?**

- **Average Age**
  - 49: no cuff tear
  - 59: unilateral cuff tear
  - 68: bilateral cuff tear

Yamaguchi, DBS, 2006

**Do you always know that your rotator cuff is torn?**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Full Thickness</th>
<th>Partial Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>14%</td>
<td>20%</td>
</tr>
<tr>
<td>&gt; 60</td>
<td>28%</td>
<td>28%</td>
</tr>
<tr>
<td>40-59</td>
<td>4%</td>
<td>24%</td>
</tr>
<tr>
<td>&lt; 40</td>
<td>0%</td>
<td>4%</td>
</tr>
</tbody>
</table>

- 50% of asymptomatic tears become symptomatic
- Tear size increases in 50% of symptomatic and 22% of asymptomatic
- The risk for RC tears doubles if you have a sibling that has experienced a full-thickness tear (as compared to a spouse) indicating a genetic predisposition


**What do we need to know to get started?**
Post-Operative Considerations

How large was the tear?

Linear Size of the Defect
- small: < 1 cm
- Medium: 1-3 cm
- large: 3-5 cm
- massive: > 5 cm

number of tendons involved or diameter cm of involvement

consideration give to the size of the individual

Post-Operative Considerations

What was the nature of the tear?

Thickness of the Tear
- full vs. partial thickness
- bursal surface partial thickness
- articular surface partial thickness
- PASTA – partial articular supraspinatus tendon avulsion
- intratendinous

Shape of the Tear
- transverse vs. linear (longitudinal)
- Crescent – do not retract
- U-shape – retract medially
- L-shape

How was the tear fixed?

Surgical Approach and Technique
- Arthroscopic SA Decompression without Tendon Repair
- Open Anterior Acromioplasty and Tendon Repair
- Arthroscopic SA Decompression with Mini-Open Tendon Repair
- Arthroscopic SA Decompression and Tendon Repair

Gold Standards

Post-Operative Considerations

Surgery Specifics?

- Additional Procedures
  - Bursectomy
  - Acromioplasty but maintain coracoacromial ligament
    - Raise the roof
  - Mumford
    - distal clavicle resection
  - MUA
- Osteoarthritic Change

- Method of Fixation
  - single vs. double row
    - suture anchors
    - transosseous tunnels
    - stitching technique
- Incision Size
  - Mini Open 3-4 cm
  - Arthroscopic 1 cm
- PRP Augmentation
  - Numerous studies have failed to show outcome benefit
Post-Operative Considerations

Surgery Specifics?

- Orthobiological implant providing a scaffold to reinforce soft tissue repair
- May augment repairs at higher risk of failure

Adhesive Capsulitis

A common pathology that is difficult to define, difficult to treat, and difficult to explain

Prevalence of 2–5% in a normal population

Definition

(consensus of literature review)

A progressive condition of uncertain etiology in which there is a spontaneous onset of pain and a gradual loss of active and passive shoulder motion

adhesive capsulitis pathology

- irritation of glenohumeral synovium with chronic capsular inflammation
- capsular fibrosis and perivascular infiltration of adhesions into the lax folds of the anterior and inferior capsule

Bottom line: AC is an aggressive inflammatory process

adhesive capsulitis pathology

- obliteration of joint cavity (20-30 ml decreased to 5-10 ml)
- contracted rotator cuff interval and CHL
- thickened contracted capsule holding the HH tightly on the glenoid fossa
- rotator cuff contracture
Capsular “Shrink Wrap”

Adhesive Capsulitis
"Frozen Shoulder"

Thank you