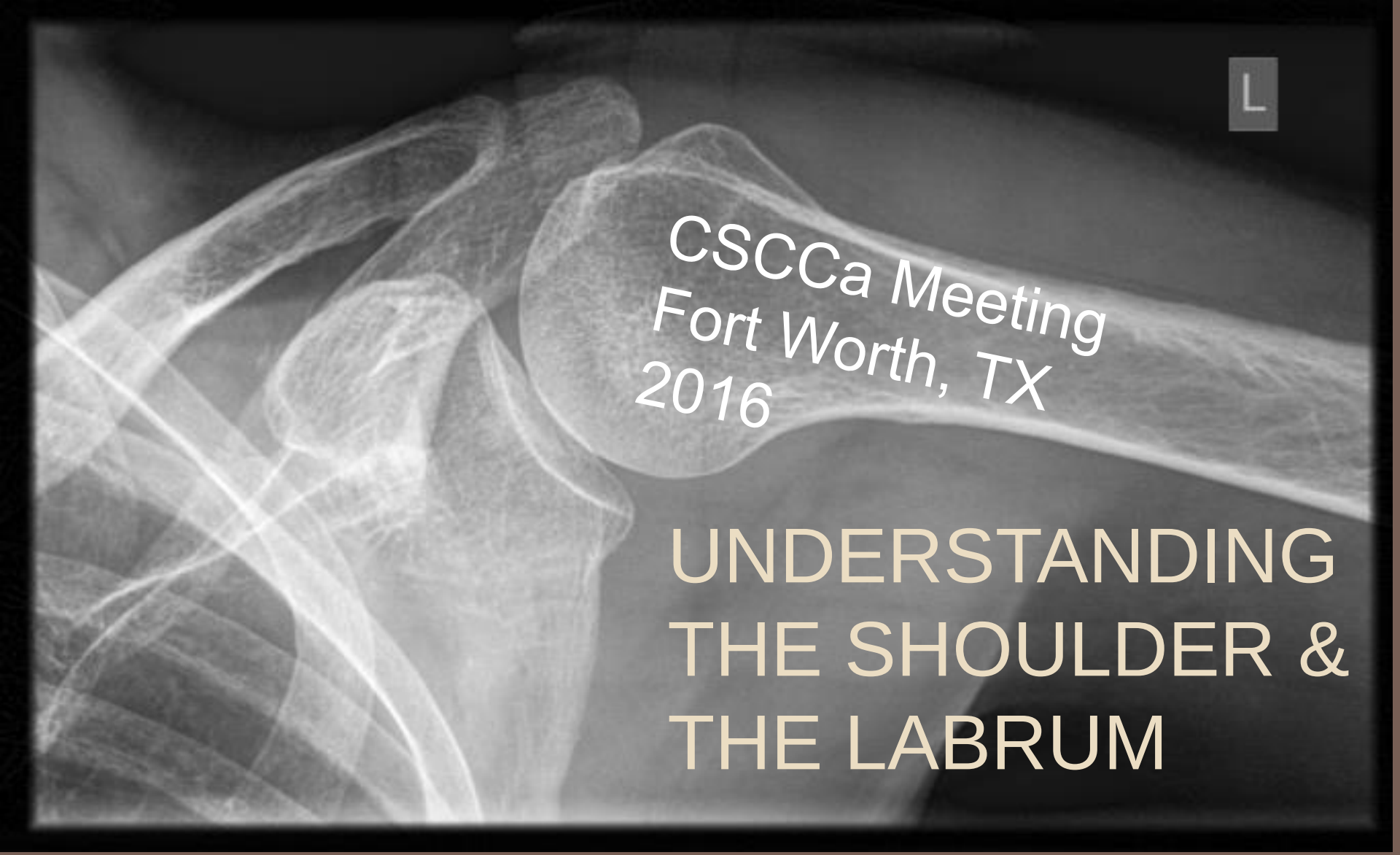


CSCCa Meeting
Fort Worth, TX
2016

UNDERSTANDING THE SHOULDER & THE LABRUM

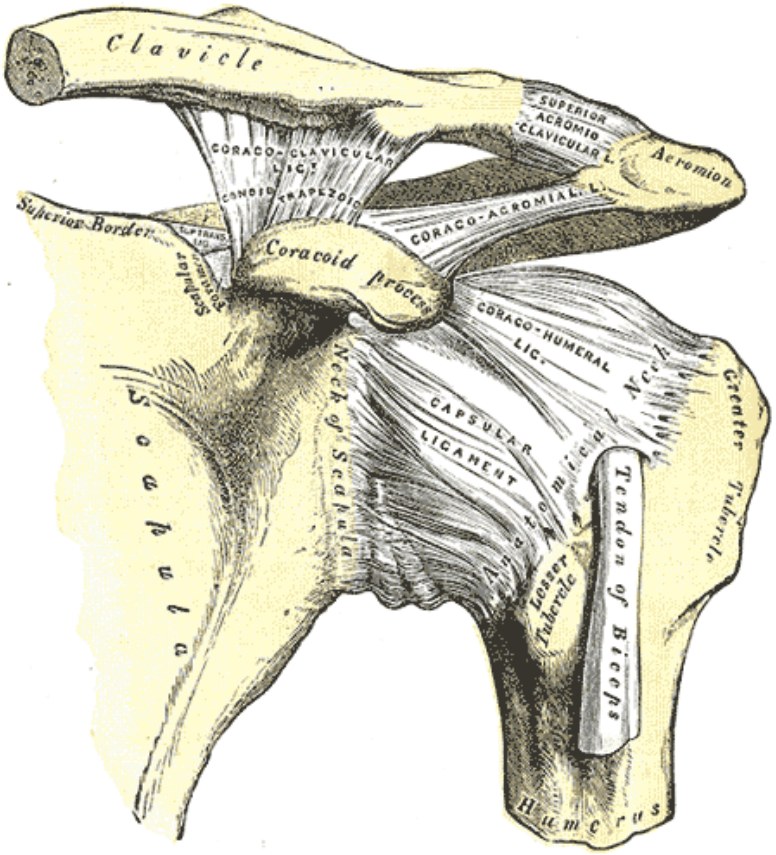
J. Brent Feland, MSPT, PhD

Anatomical Review

- The shoulder joint
  - Glenohumeral (glenoid fossa and humeral head)– ball in socket
- The shoulder girdle
  - Acromioclavicular joint– gliding joint
  - Sternoclavicular joint– saddle joint
  - Scapulothoracic interface- not classified as a joint but the movement is vitally important for normal shoulder joint motion.

Shoulder Capsule

- Capsule is approximately 2x larger than the humeral head.
- Inferior portion is the weakest and is stretched out in order to stretch over humeral head in full abduction or flexion.



"Gray326" by Henry Vandyke Carter - Henry Gray (1918) Anatomy of the Human Body (See "Book" section below)Bartleby.com: Gray's Anatomy, Plate 326. Licensed under Public Domain via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Gray326.png#/media/File:Gray326.png

General Anatomy Review

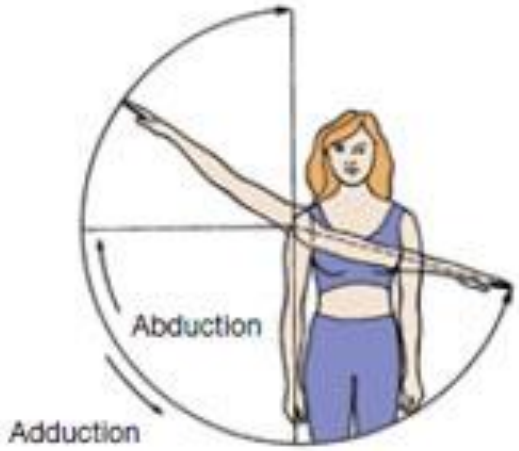
Joint Motion

Muscles

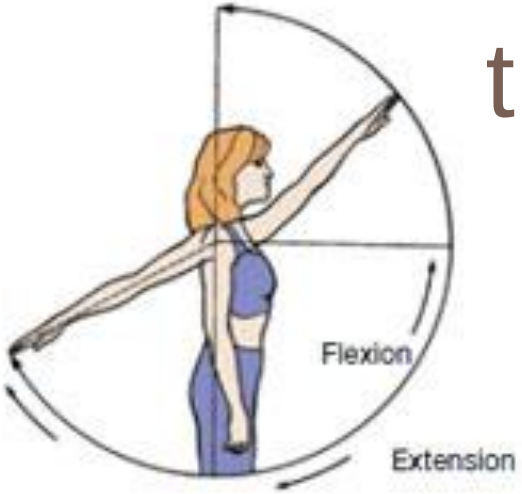
Rotator Cuff

Humeral torsion

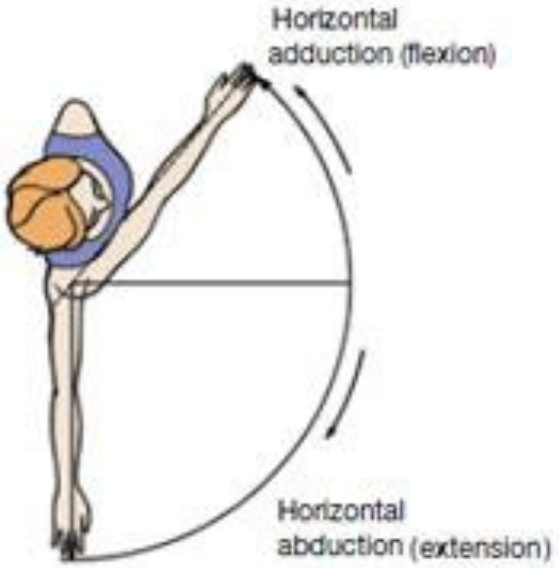
Motions at the Shoulder



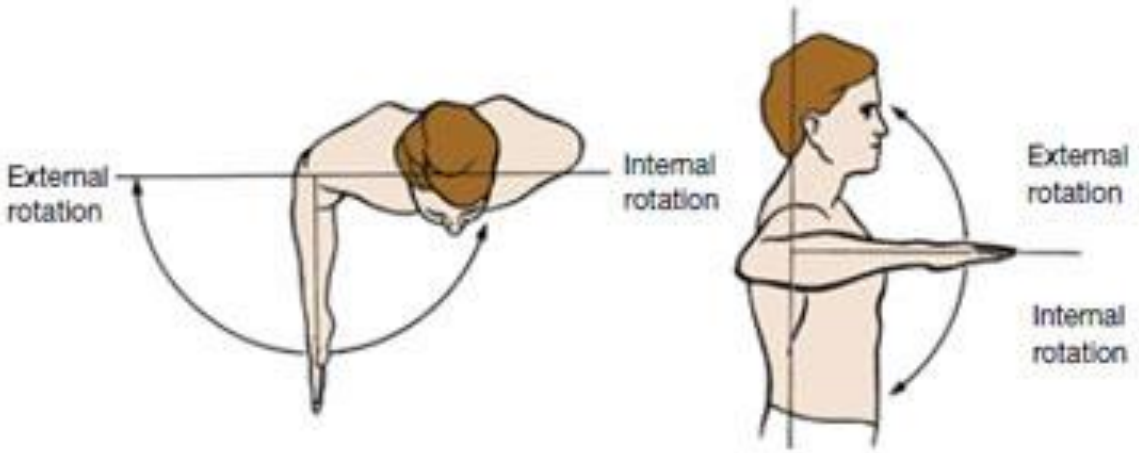
Abduction & Adduction



Flexion & Extension



Horizontal Abduction & Adduction



Internal & External Rotation

Muscles Crossing the Shoulder Joint

- Deltoid
- Supraspinatus
- Infraspinatus
- Teres minor
- Teres major
- Pectoralis major
- Subscapularis
- Biceps (long head)
- Triceps (long head)
- Coracobrachialis
- Latissimus Dorsi (when shoulder is fully flexed)

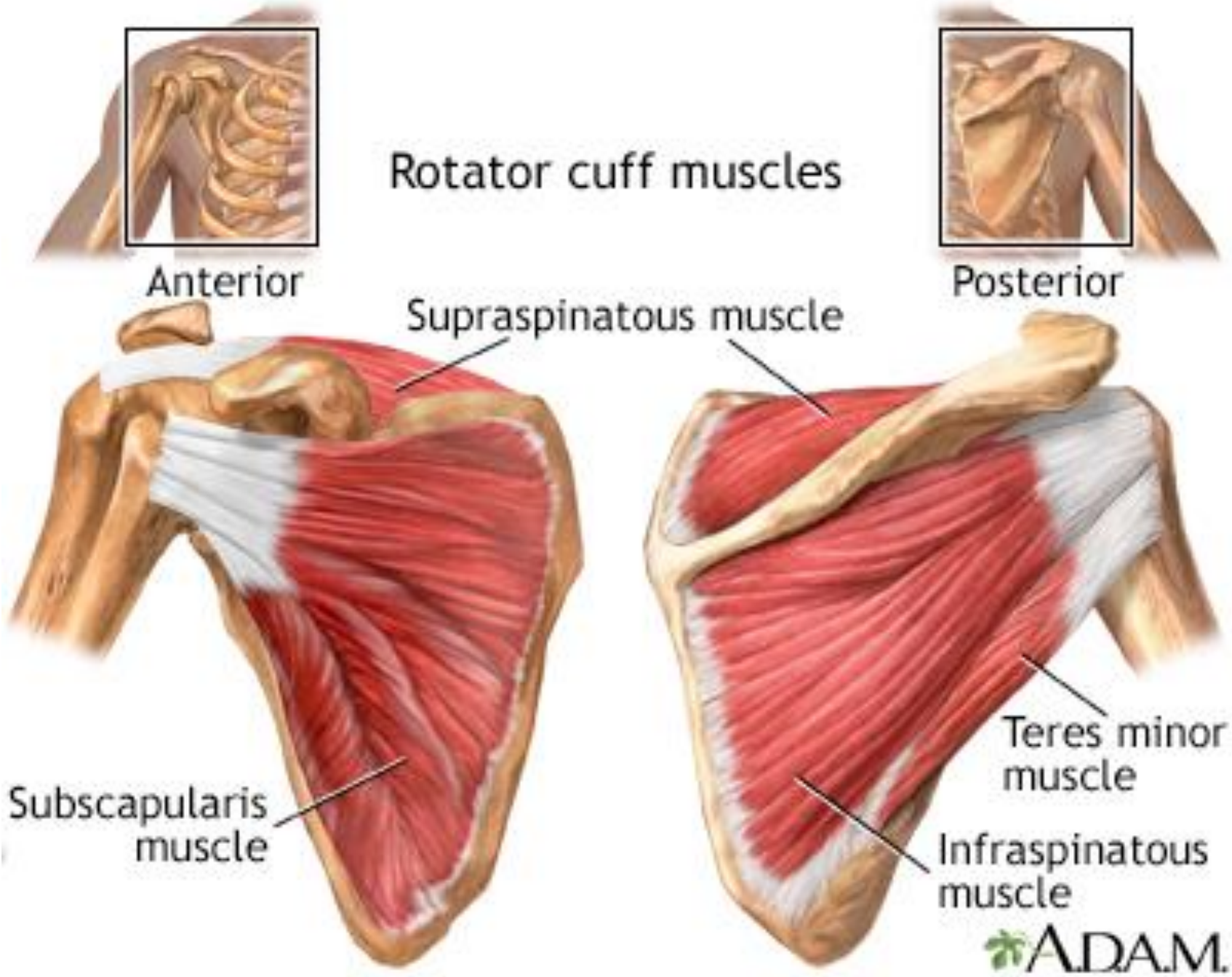
Muscles attaching to Scapula

- Deltoid
- Trapezius
- Supraspinatus
- Infraspinatus
- Teres minor
- Teres major
- Subscapularis
- Serratus Anterior
- Latissimus Dorsi
- Rhomboids
- Pectoralis minor
- Coracobrachialis
- Biceps (long head)
- Biceps (short head)
- Triceps (long head)
- Levator Scapulae
- Omohyoid (inferior belly)

The Rotator Cuff Muscles

- Supraspinatus
  - Abduction
- Infraspinatus
  - External rotation
- Teres Minor
  - External rotation
- Subscapularis
  - Internal rotation

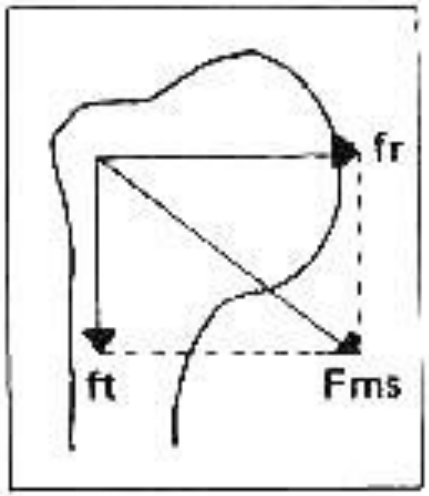
- Greater tubercle of the humerus
  - S.I.T. (supraspinatus, infraspinatus, and teres minor)
- Lesser tubercle of the humerus
  - subscapularis

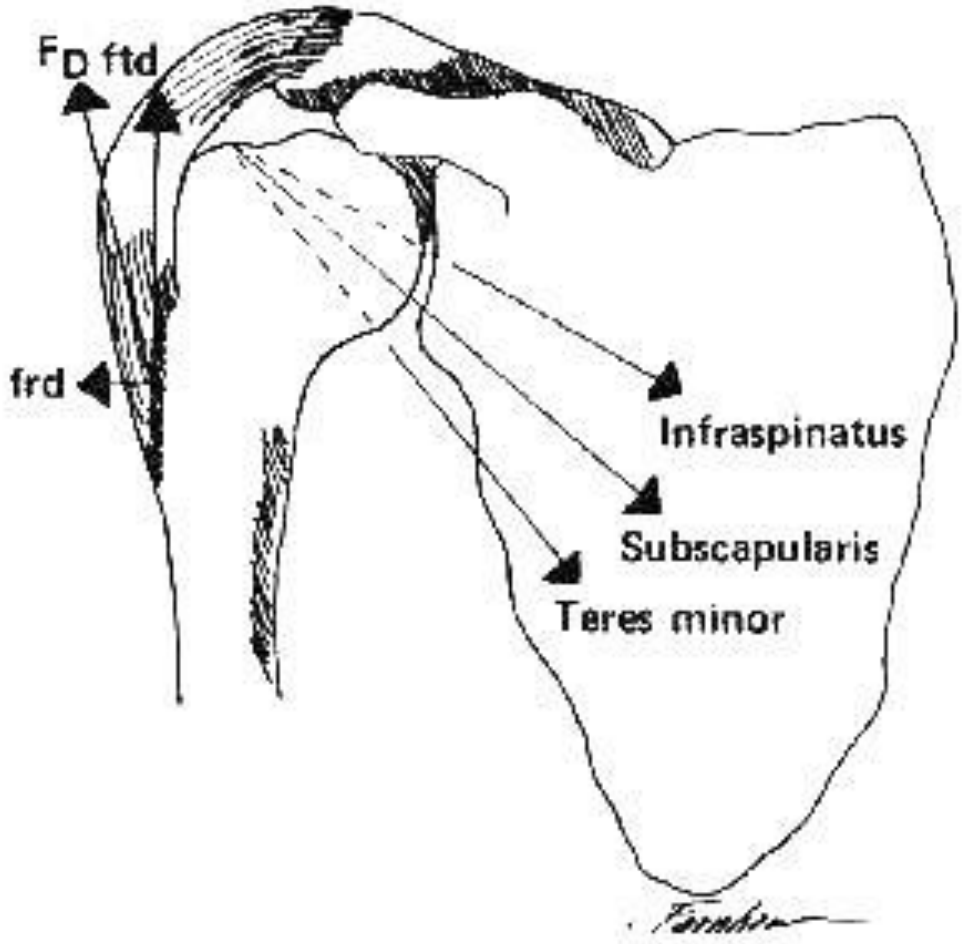

Rotator cuff muscles
Anterior
Posterior
Supraspinatous muscle
Subscapularis muscle
Teres minor muscle
Infraspinatous muscle
A.D.A.M.

Rotator Cuff Muscles

- Why is it called the “rotator cuff”
- Of all the muscles that cross the shoulder joint, these are the only 4 whose tendons blend with the joint capsule. And thus, strengthen the “cuff” of the shoulder.
- The “cuff” is the shoulder joint capsule

GH Dynamics





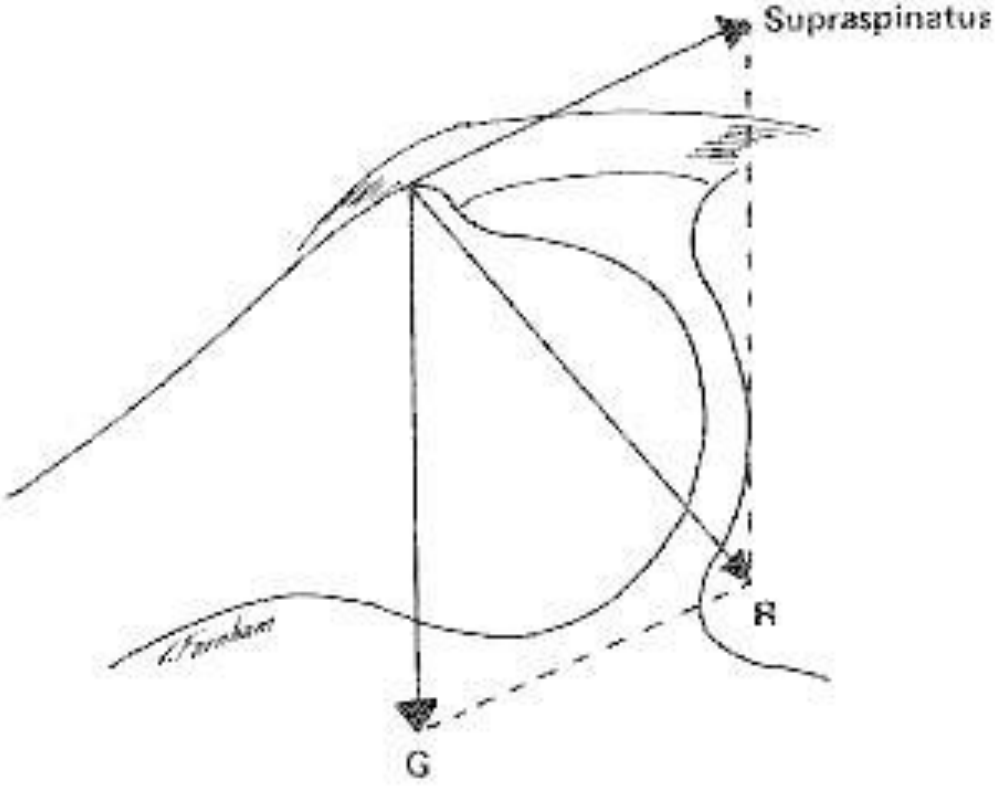
Picture from Norkin and Levange book, Joint Structure and Function: a comprehensive analysis. 2nd ed. 1992. F.A. Davis.

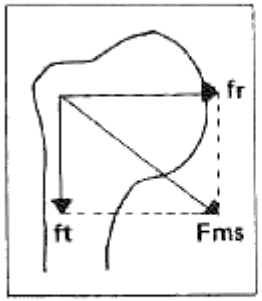
Deltoid Action

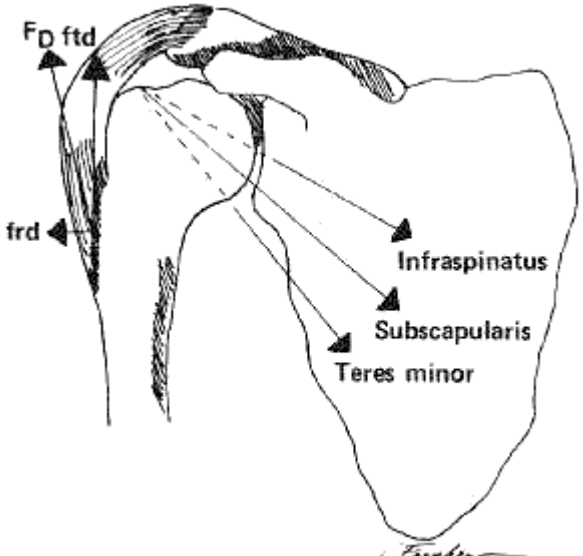
- With the arm hanging at your side, the deltoid will cause the humerus to simply glide upward.
- This jams the humerus into the acromion and impinges the soft tissue
- Needs to be abducted 20-30^0 before it is able to produce a rotary force and actually abduct the arm

Rotator Cuff

- *Supraspinatus*
  - Superior translation, compression, abduction
- *Infraspinatus, Teres minor, Subscapularis*
  - Helps pull humerus inferiorly and offset the superior pull of deltoid







Picture from Norkin and Levange book, Joint Structure and Function: a comprehensive analysis. 2nd ed. 1992. F.A. Davis.

Reminder - Impingement

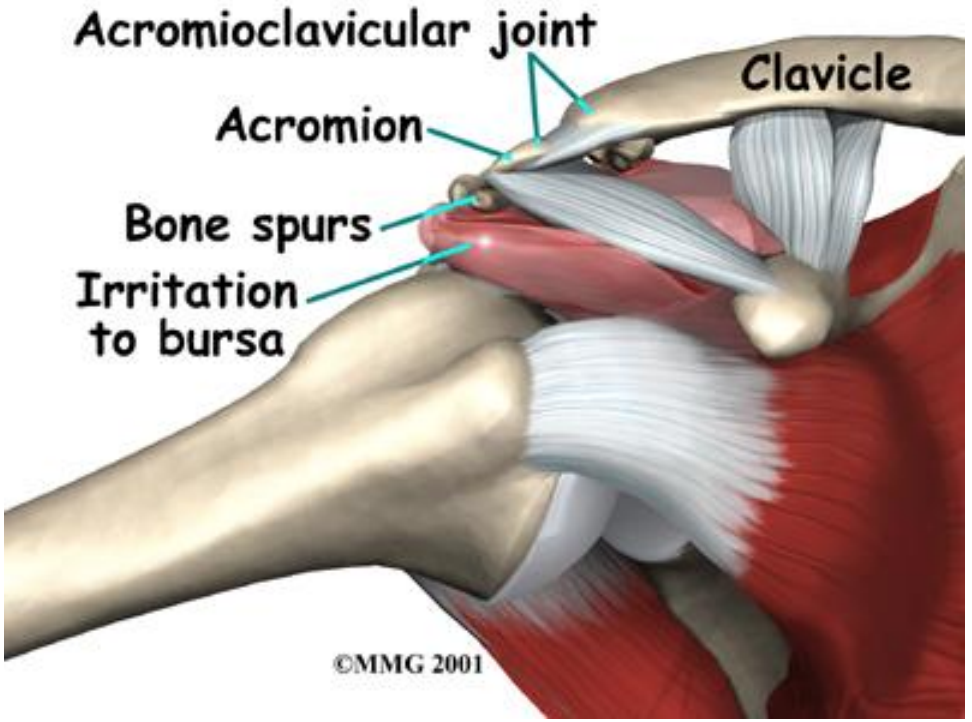
- Most rotator cuff problems are due to repeated impingement which leads to wear and tear of the tendons. In general, we refer to two types of impingement.

Internal vs External Impingement

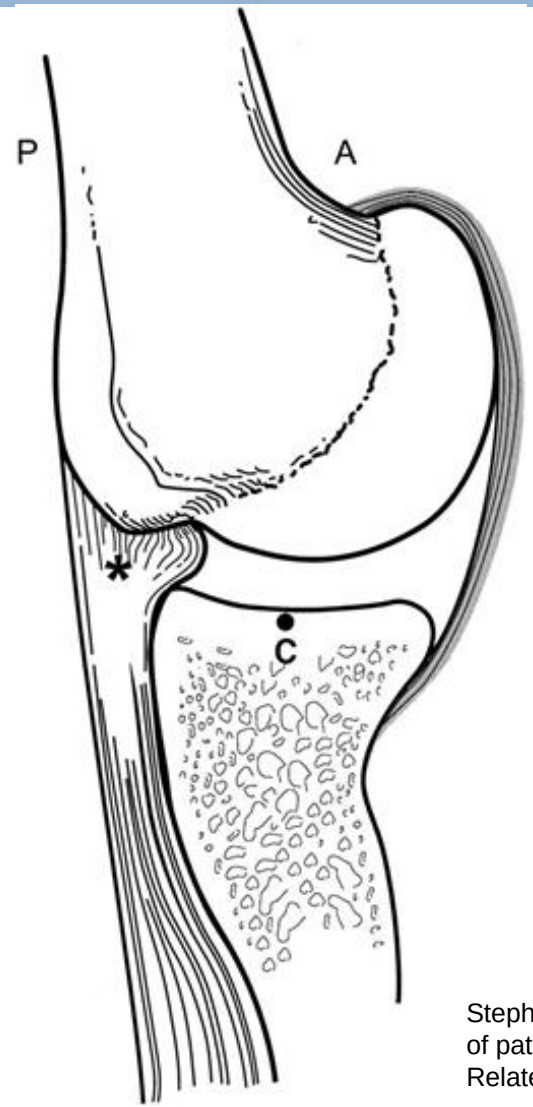
- General Description
- *External Impingement* is a common form of impingement in the everyday population. Simply means that soft tissue is being impinged (pinched) between the humerus and the acromion. Includes tissue that is “external” to the capsule.
- *Internal Impingement* is pinching the rotator cuff tendons on the posterior glenoid within the capsule. More common in throwers.

External Impingement

- Majority of this is found between the greater tubercle of the humerus and the acromion, but can also be just anterior to acromion where the coracoacromial ligament is also.
- Supraspinatus most commonly at risk



Internal Impingement



- In abduction and external rotation of the shoulder, the greater tuberosity abuts against the posterosuperior glenoid, entrapping the rotator cuff between the 2 bones. (*) This has been dubbed internal impingement. (A, anterior; P, posterior; C, glenohumeral center of rotation.)

Stephen S. Burkhart, Craig D. Morgan, W.Ben Kibler. The disabled throwing shoulder: Spectrum of pathology part I: Pathoanatomy and biomechanics. Arthroscopy: The Journal of Arthroscopic & Related Surgery, Volume 19, Issue 4, 2003, 404–420

Internal Impingement

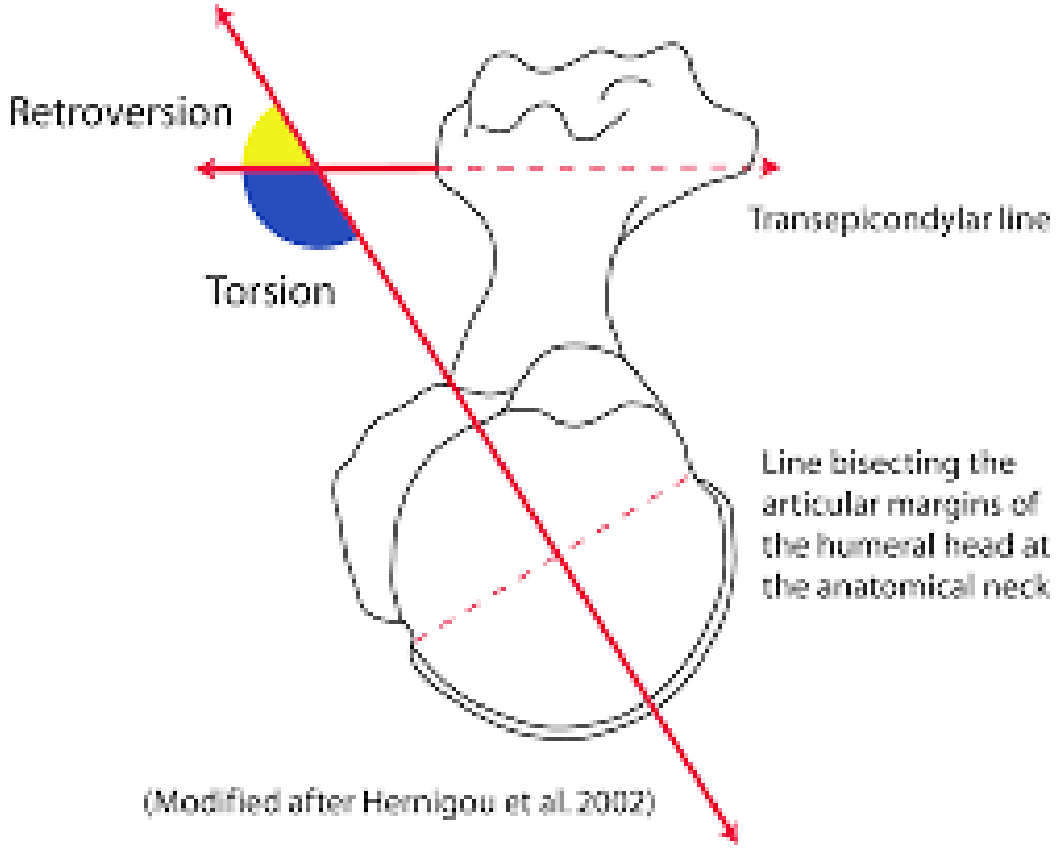
- Due to repeated contact of the undersurface of the rotator cuff tendons and the post/superior glenoid.
- Posterior rotator cuff affected (infraspinatus and teres minor)

Pathomechanics of Throwing

- With regard to the rotator cuff, the position of maximal GH joint ER is thought to produce articular surface partial-thickness rotator cuff tears through compressive loads of internal impingement.
- The repeated torsion in ER during throwing also leads to the remodeling of the thrower's humerus in external rotation torsion.

K.E. Wilk, L.C. Macrina, G.S. Fleisig, *et al.* Loss of internal rotation and the correlation to shoulder injuries in professional baseball pitchers. Am J Sports Med, 39 (2011), pp. 329–335

Humeral Angle of Torsion



Roach NT, et al. The effect of humeral torsion on rotational range of motion in the shoulder and throwing performance. J. Anat. (2012) 220, pp293–301.

Humeral Torsion

- Athletes who habitually throw tend to have 10–20 less torsion in their dominant, throwing arm compared to their non-dominant arm and the arms of non-throwing controls.
- No statistical difference has been found between arms in non-throwing controls
- When throwing athletes are subdivided into those with and without chronic pain, those reporting chronic pain did not show this reduction in dominant arm torsion.

Roach NT, et al. The effect of humeral torsion on rotational range of motion in the shoulder and throwing performance. J. Anat. (2012) 220, pp293–301.

Shoulder Joint Technical Anatomy

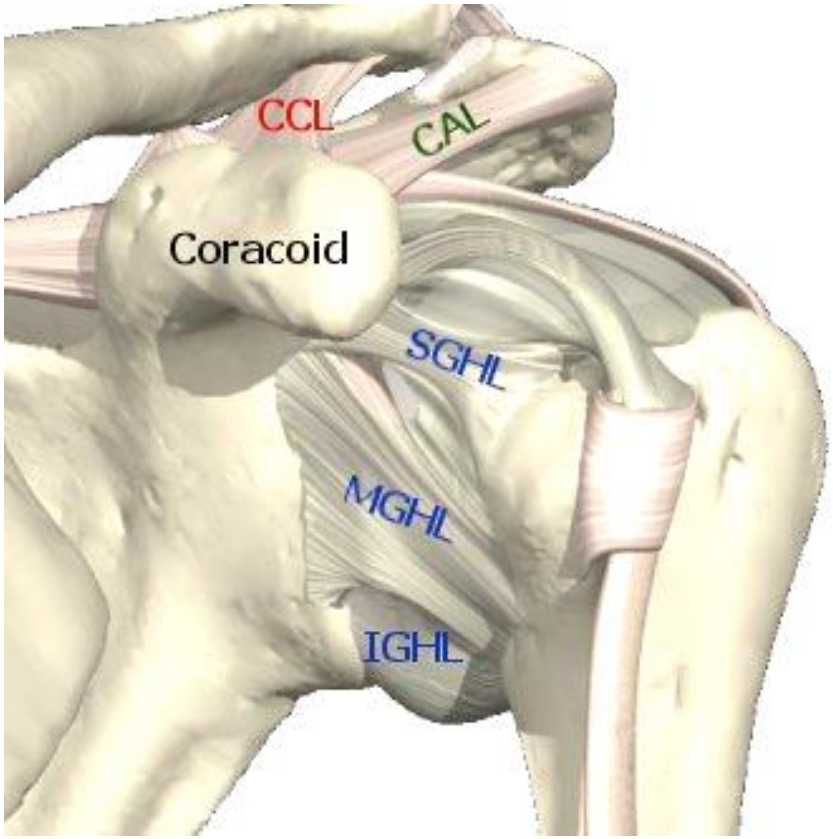
Glenohumeral ligaments

Biceps tendon

Labrum

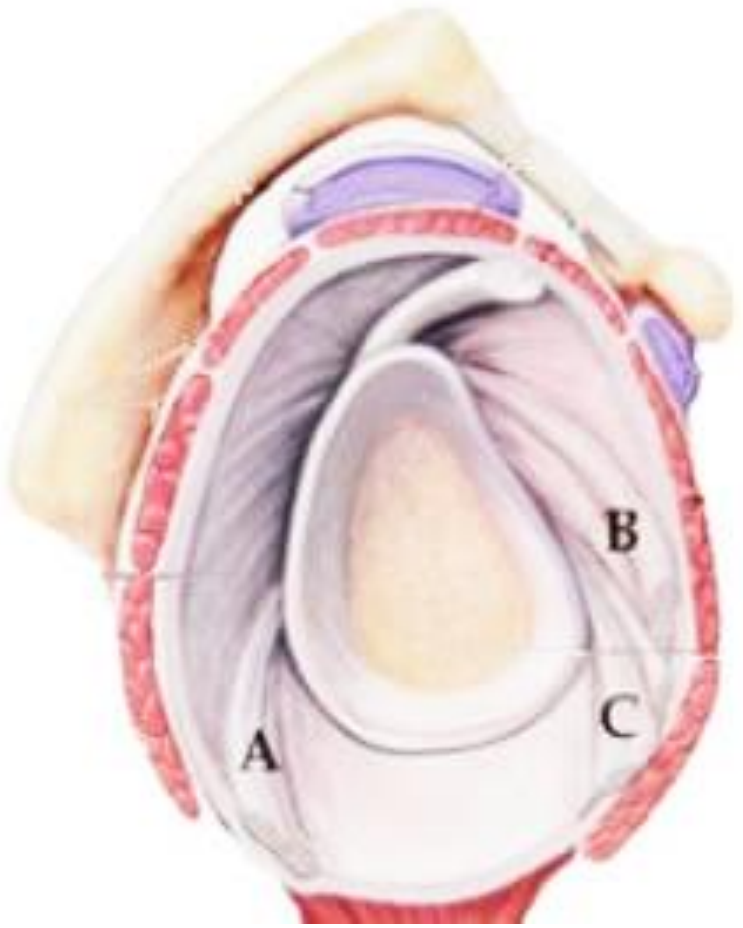
Capsular Ligaments

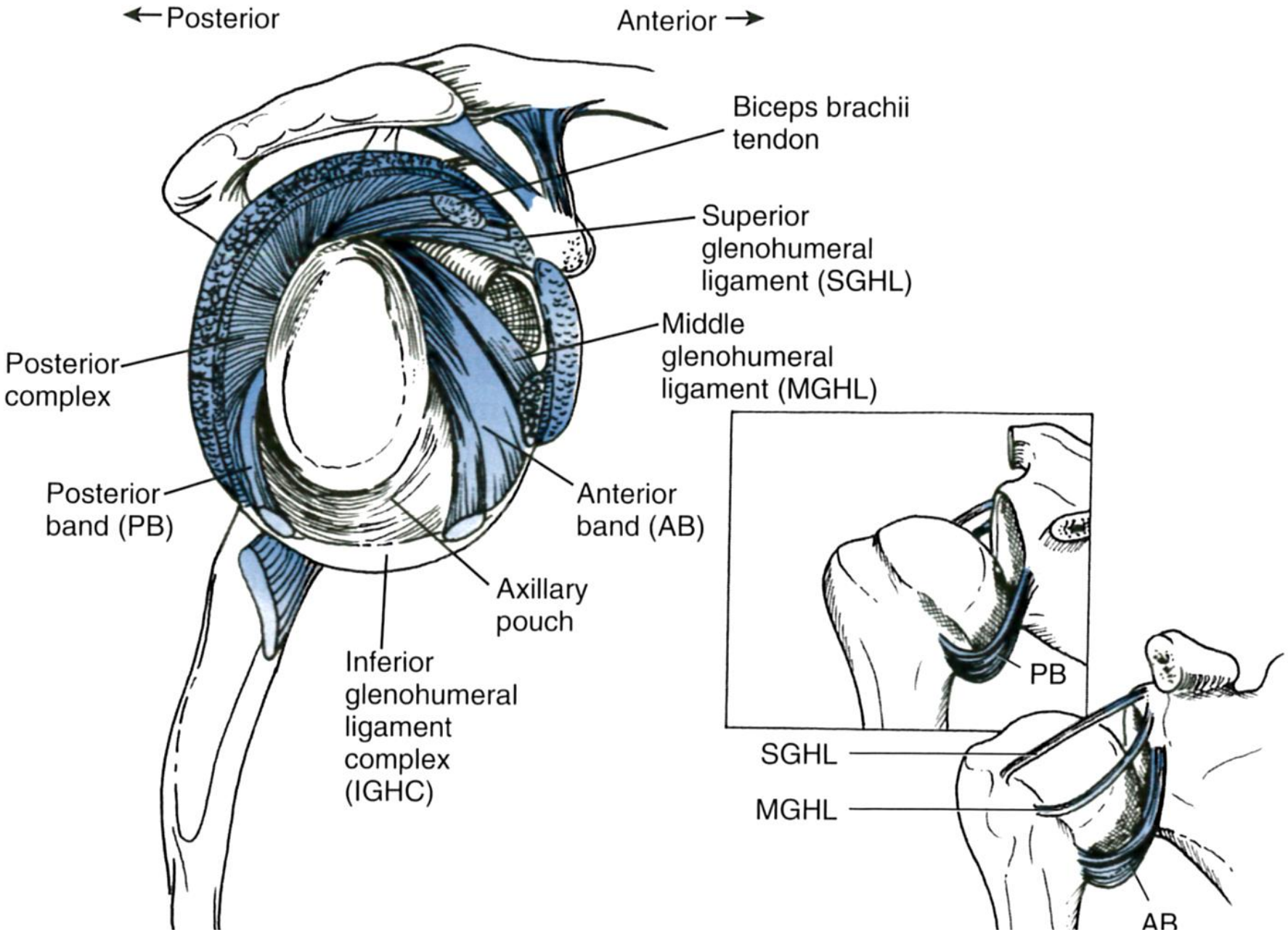
- 3 Ligaments help support the anterior capsule.
- The Superior, Middle, and Inferior glenohumeral Ligaments
- SGHL, MGHL, IGHL
- IGHL has two bands (anterior and posterior)



Capsular ligaments

- Inferior band has to give out for a dislocation to occur.
- 3 of the 4 bands are anterior and help limit ER and create more anterior stability.

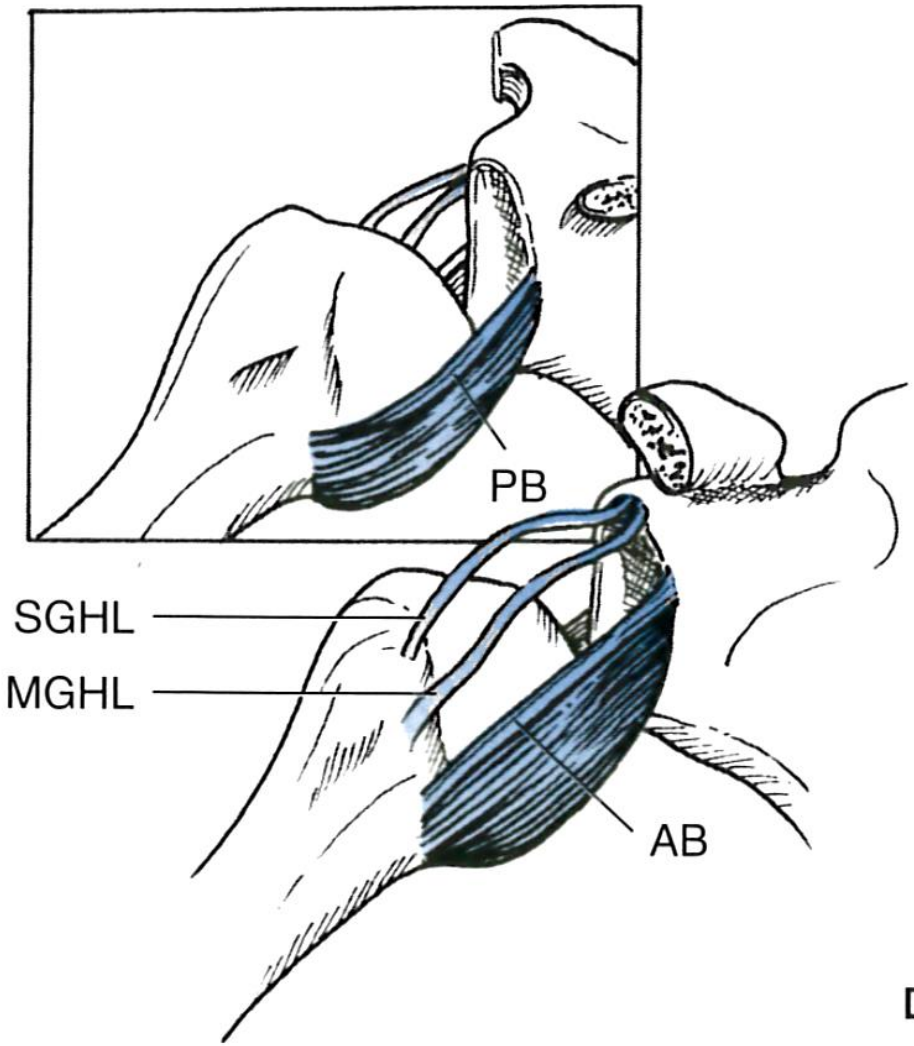


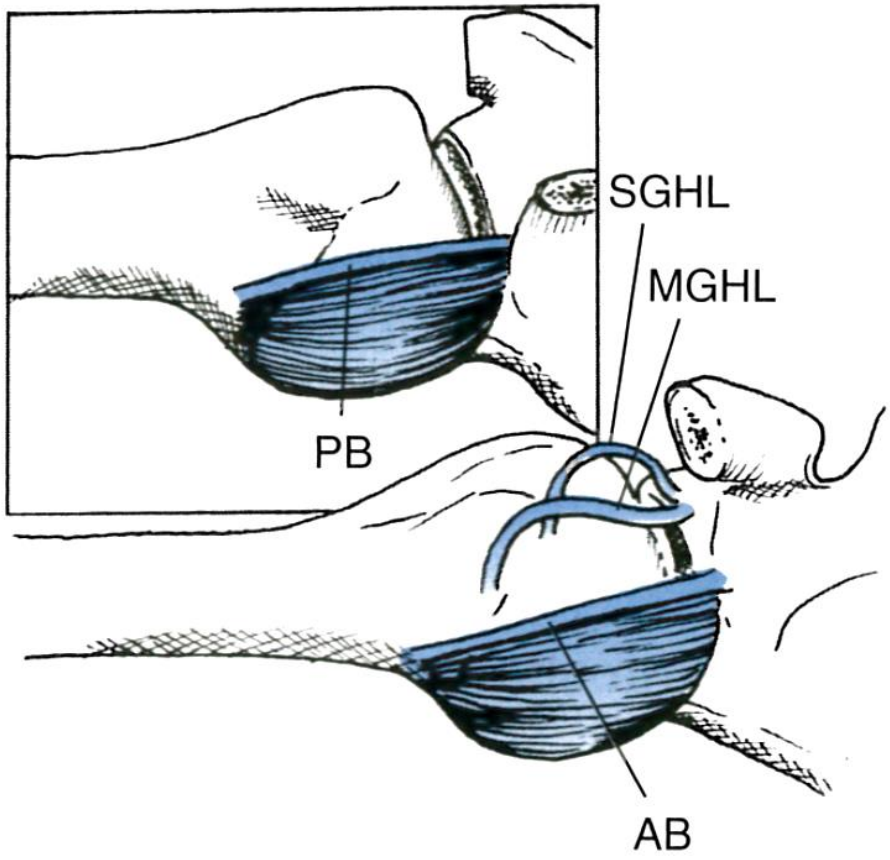


Picture: Nordin M, Frankel VH. Basic Biomechanics of the Musculoskeletal System 4th Ed

General GH-Ligament function

- ***SGHL*** - helps resist inferior translation when the arm is hanging or adducted.
- ***MGHL*** - Some help with inferior translation when arm is adducted. Helps resist anterior translation (maximal effect at about 45^0 abduction)
- ***IGHL*** – Anterior stabilization with arm in 90^0 abduction. Tighten when the arm is abducted and externally rotated and cradle inferior head. This is theorized to also add to the posterior/superior shift of the humeral head in throwing.





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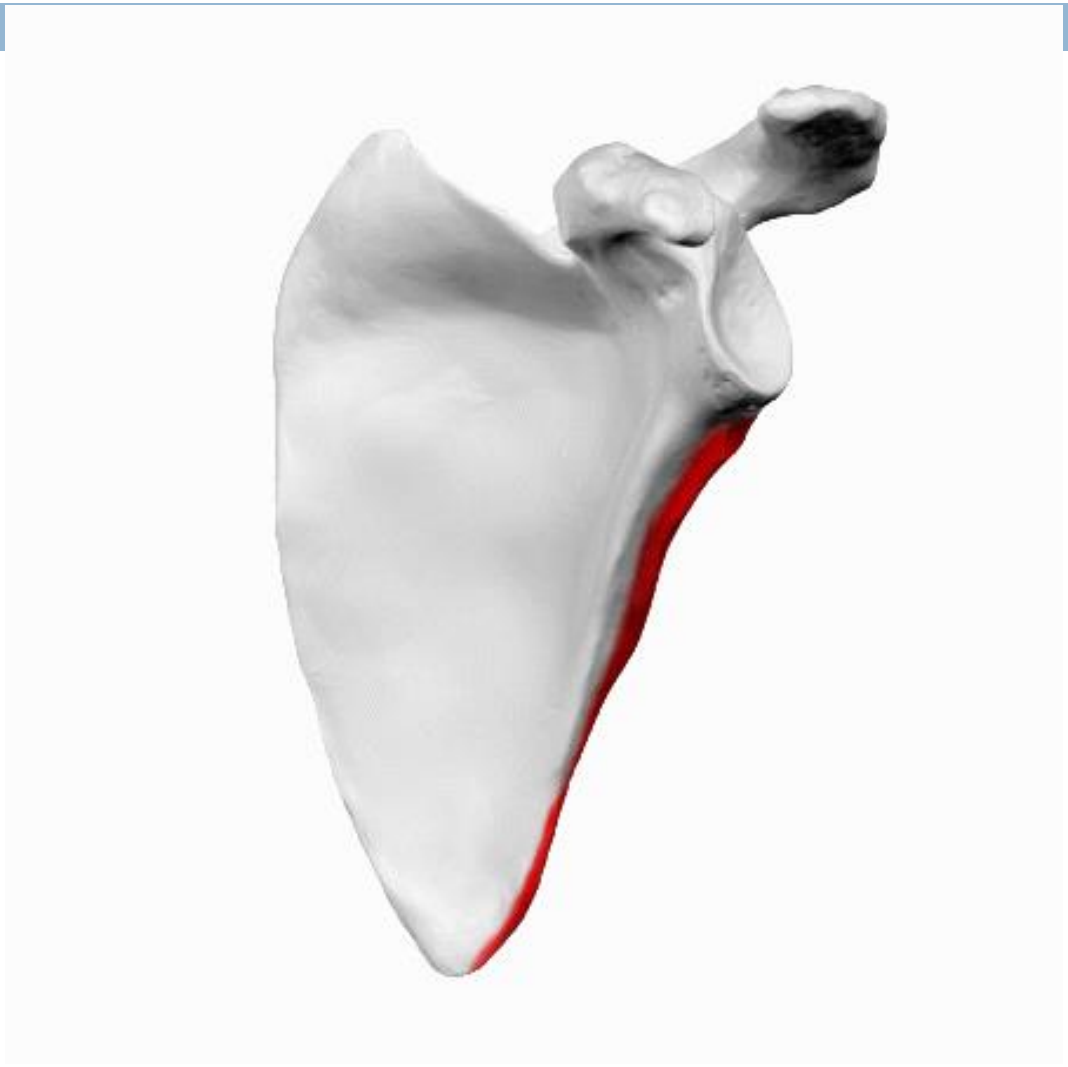
Picture: Nordin M, Frankel VH. Basic Biomechanics of the Musculoskeletal System 4th Ed.

What is the Labrum?

- A fibrocartilaginous rim that helps to deepen the glenoid.
- It is almost triangular in shape and the bottom portion is firmly attached to the underlying bone.
- The top portion has variable attachments, but is loosely connected.
- The superior portion is attached to the biceps tendon (long head) as it connects at the supraglenoid tubercle.

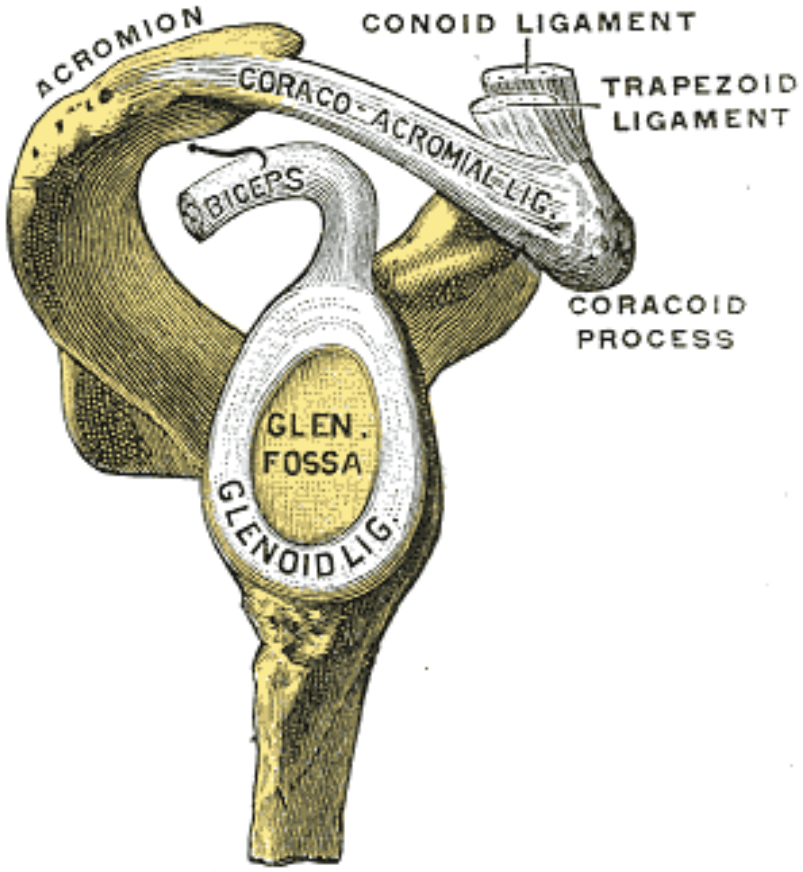
Scapula and Glenoid Fossa



By Polygon data is from BodyParts3D (Polygon data is from BodyParts3D) [CC BY-SA 2.1 jp (http://creativecommons.org/licenses/by-sa/2.1/jp/deed.en)], via Wikimedia Commons

Glenoid Labrum

- Functions to deepen socket and increase area of joint contact
- Superior part is not fixed to bone
- Increases depth to 5 mm Ant/Post, and 9mm Sup/Inf
- depth is only 2.5 mm without labrum



By Henry Vandyke Carter - Henry Gray (1918) Anatomy of the Human Body (See "Book" section below)Bartleby.com: Gray's Anatomy, Plate 328, Public Domain, https://commons.wikimedia.org/w/index.php?curid=108241

Labral Tears and

The Overhead Athlete

Labral Tears

The

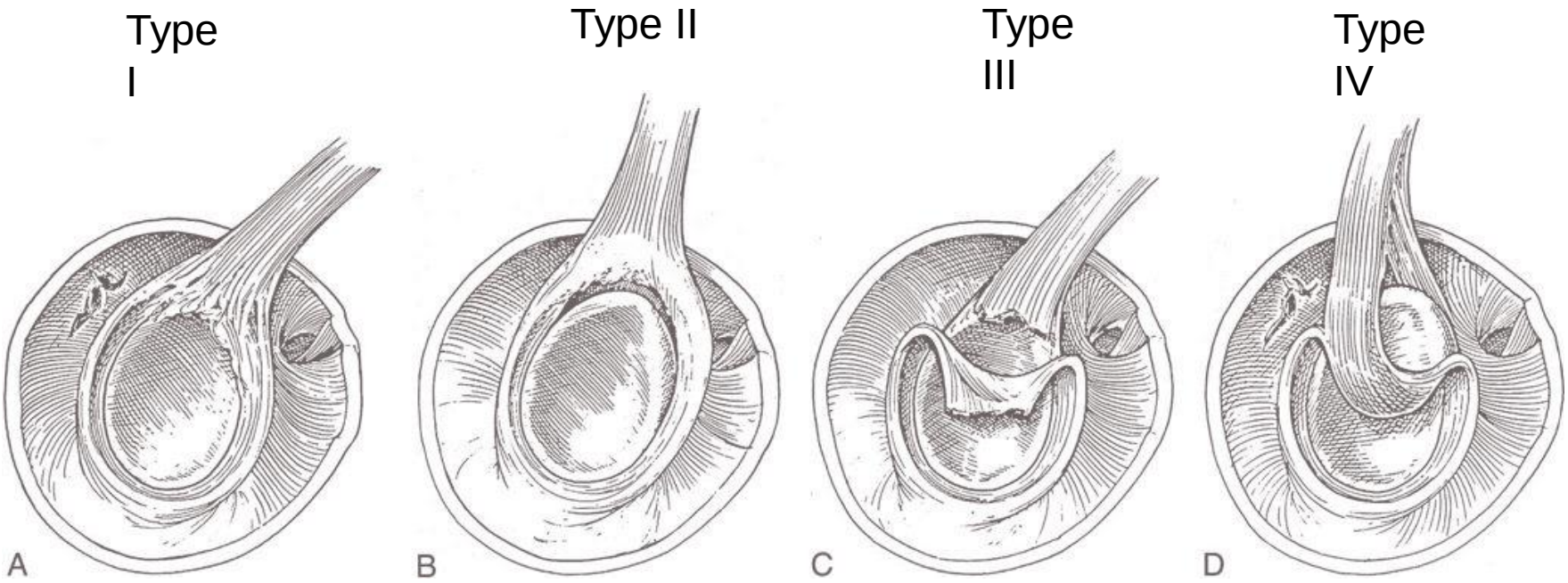
What is a Labral Tear?

- Often called a SLAP lesion (Superior Labral Anterior – Posterior). This is a tear in the superior aspect of the labrum and is commonly associated with undersurface rotator cuff tears.
  - Most often classified as a Type II lesion in overhead athletes
- One potential cause of “dead arm syndrome”
- Can be very disabling and career ending

SLAP Tear Classification

- Assessment
  - labrum is assessed, including stability of the biceps labral attachment, as well as biceps tendon;
  - SLAP tears will show more than 5 mm of exposed superior glenoid bone and often a “peel-back” sign;
  - Surgeons will look for positive "peel-back" sign to confirm the diagnosis of a SLAP tear. This can be demonstrated with abduction and external rotation during arthroscopy

Classification of SLAP Tears



SLAP Tear Classification

- Type I
  - fraying and degeneration of the superior labrum, normal biceps (no detachment)
  - most common type of SLAP tear (75% of SLAP tears)- based on a study by Kim TK et al. Of 544 shoulder arthroscopy procedures--139 (26%) demonstrated a SLAP lesion. One hundred and three (74%) of the SLAP lesions were Type I, twenty-nine (21%) were Type II, one (0.7%) was Type III, and six (4%) were Type IV
  - often associated with rotator cuff tears
  - these are treated w/ debridement

Info from Wheeless' textbook of orthopedics. Online: http://www.wheelessonline.com/ortho/superior_glenoid_labrum_lesions_slap

SLAP Tear Classification

- Type II
  - detachment of superior labrum and biceps insertion from the supra-glenoid tubercle
  - when traction is applied to the biceps, the labrum arches away from the glenoid
  - typically the superior and middle glenohumeral ligaments are unstable
  - may resemble a normal variant (Buford complex);

Info from Wheeless' textbook of orthopedics. Online: http://www.wheelessonline.com/ortho/superior_glenoid_labrum_lesions_slap

SLAP Tear Classification

- Type II Continued
  - - **3 subtypes**: shown on next slide
  - posterior labral tears may be caused by impingement of cuff against the labrum with the arm in the abducted and externally rotated position
  - A study by Kim TK et al. noted type-II lesions in patients older than 40 years of age were associated with a supraspinatus tear where as in patients younger than 40 years were associated with participation in overhead sports and a Bankart lesion
  - treatment involves anatomic arthroscopic repair;

Info from Wheeless' textbook of orthopedics. Online: http://www.wheelessonline.com/ortho/superior_glenoid_labrum_lesions_slap

3 Subtypes of a Type II SLAP

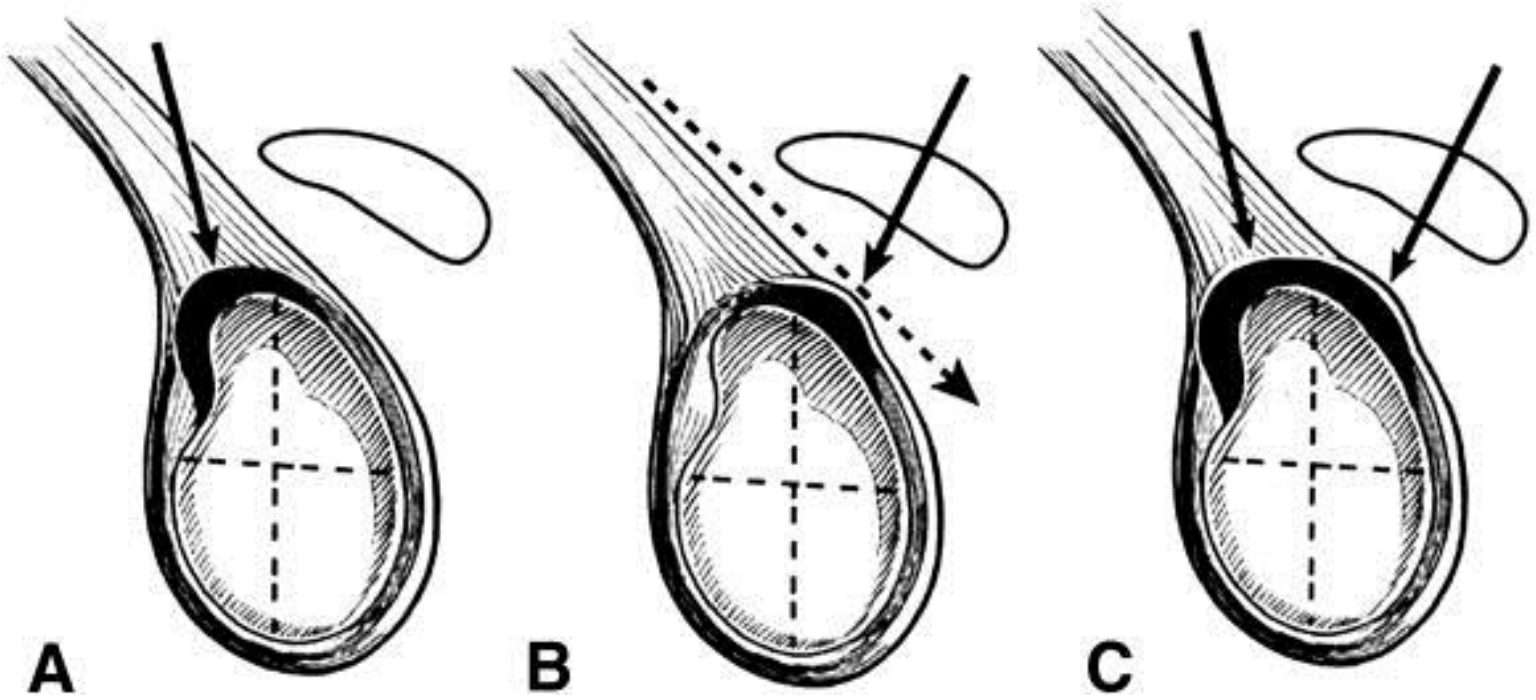


Fig. 1. Three subtypes of type 2 SLAP lesions, designated by anatomic location: (A) anterior, (B) posterior, and (C) combined anteroposterior.

Stephen S. Burkhart, Craig D. Morgan, W.Ben Kibler. The disabled throwing shoulder: Spectrum of pathology part I: Pathoanatomy and biomechanics. Arthroscopy: The Journal of Arthroscopic & Related Surgery, Volume 19, Issue 4, 2003, 404–420

SLAP Tear Classification

- Type III
  - bucket handle type tear
  - biceps anchor is intact
- Type IV
  - vertical tear (bucket-handle tear) of the superior labrum, which extends into biceps (intrasubstance tear)
  - may be treated w/ biceps tenodesis if more than 50% of the biceps tendon is involved

Info from Wheeless' textbook of orthopedics. Online: http://www.wheelessonline.com/ortho/superior_glenoid_labrum_lesions_slap

Burkhart and Morgan

- Reported on 53 baseball players, 44 of whom were pitchers, who had type 2 SLAP lesions that were surgically repaired after nonresponse to nonoperative treatment.
- Arthroscopic repair of these type 2 SLAP lesions returned 87% of these athletes to the preinjury level of performance and velocity.
- State that their clinical experience with the dead arm syndrome has confirmed that SLAP lesions are the most common pathologic entities associated with this problem.

The Labrum

Normal Labrum

Torn Labrum

Repaired Labrum

Picture from Dr. Struhl's website: http://www.shouldersandknees.com/labrum-tear.html

- Video of arthroscopic surgery of a shoulder with internal impingement (labral fraying, undersurface tear of rotator cuff)
- https://www.youtube.com/watch?v=hSWpmHU4biY

Humeral Mechanics

- Jobe reported gradual stretching of anterior capsule ligament structures during overhead motion and postulated that anterior instability allows for anterior and superior migration of the humeral head.
- Later Jobe advanced this principle by describing posterior-superior glenohumeral impingement. He expanded on the concept of internal impingement in relation to throwers.

Anterior Instability?

- *Jobe* theorized that internal impingement in throwers might progressively worsen because of gradual repetitive stretching of the anterior capsuloligamentous structures.

CM Jobe. Posterior superior glenoid impingement: Expanded spectrum. *Arthroscopy*, 11 (1995), pp. 530–537.

Conflicting Views

- *Jobe's* theory of anterior microinstability lead to treatment using anterior capsulolabral reconstruction, although the results of this treatment for throwing athletes were unpredictable.
- *Halbrecht et al.* disagreed and reported that an unstable shoulder that is subluxed anteriorly will have less contact with the posterosuperior glenoid (internal impingement).

CM Jobe. Posterior superior glenoid impingement: Expanded spectrum. *Arthroscopy*, 11 (1995), pp. 530–537.
JL Halbrecht, P Tirman, D AtkinInternal impingement of the shoulder: Comparison of findings between the throwing and nonthrowing shoulders of college baseball players. *Arthroscopy*, 15 (1999), pp. 253–258

Anterior Microtrauma?

- *Morgan and Burkhart* suggested that any stretching of the anterior structures that occurs is on the basis of hyperexternal rotation and hyperhorizontal abduction, rather than a true anterior instability pattern.
- They also stated that the most important pathologic process that occurs in throwers is a loss of IR in abduction. This loss is more important than ER gain.

Stephen S. Burkhart, Craig D. Morgan, W.Ben Kibler. The disabled throwing shoulder: Spectrum of pathology part I: Pathoanatomy and biomechanics. Arthroscopy: The Journal of Arthroscopic & Related Surgery, Volume 19, Issue 4, 2003, 404–420

Cadaver Model Study Conclusion

- A posterior capsular contracture with decreased internal rotation Range of Motion does not allow the humerus to rotate into it's normal posteroinferior position in the cocking phase of throwing.
- Instead, the humeral head is forced posterosuperiorly, which may explain the etiology of Type-II SLAP lesions in overhead athletes.

Grossman MG et al. A cadaveric model of the throwing shoulder: A possible etiology of superior labrum anterior to posterior lesions. *J Bone Joint Surg*. 2005; 87(4), pgs 824-831.

The Important Post-Inf Capsule

- *Burkhart and Morgan* proposed that an acquired internal rotation loss caused by a posteroinferior capsular contracture is the essential lesion that secondarily results in increased external rotation.
- GIRD - Glenohumeral internal rotation deficit is the loss in degrees of glenohumeral IR of the throwing shoulder compared with the non-throwing shoulder.

GIRD

- Morgan looked at 124 pitchers with Type II SLAP tears. ALL had GIRD.
- Included 40 professional, 43 college, and 41 high school pitchers
- average GIRD was 53° with a range from 25° to 80°. Not good considering the following comparison…
- Average GIRD of only 13° preseason and 16° postseason found in 19 asymptomatic dominant shoulders of professional baseball pitchers

GIRD = Problems

- There are many studies reporting higher GIRD resulting in shoulder problems which resulted in loss of performance.
- In general, it appears $>20^0$ tends to be problematic (my opinion based on reported averages).
- The smaller the GIRD the better.
- a prospective study showed that a GIRD of 18° was related to a 1.9 times increased risk of injury.

K.E. Wilk, L.C. Macrina, G.S. Fleisig, *et al.* Loss of internal rotation and the correlation to shoulder injuries in professional baseball pitchers. Am J Sports Med, 39 (2011), pp. 329–335

GIRD combat

Burkhart reported:

- Cooper manually stretched 22 major league level pitchers daily to minimize GIRD to less than 20° during the 1997, 1998, and 1999 professional baseball seasons (J. Cooper, personal communication, December 1999). During those seasons, he reported no innings lost, no intra-articular problems, and no surgical procedures in the study group.

Stephen S. Burkhart, Craig D. Morgan, W.Ben Kibler. The disabled throwing shoulder: Spectrum of pathology part I: Pathoanatomy and biomechanics. Arthroscopy: The Journal of Arthroscopic & Related Surgery, Volume 19, Issue 4, 2003, 404–420

GIR + GER = TROM

- Glenohumeral external rotation (GER) has not been associated with injury but is a key component of the cocking position.
- It is usually found to be asymmetrically increased on the dominant side.
- Total rotational range of motion (TROM) (GIR plus GER) is symmetric in throwers and servers but should not exceed 186° as an absolute number.

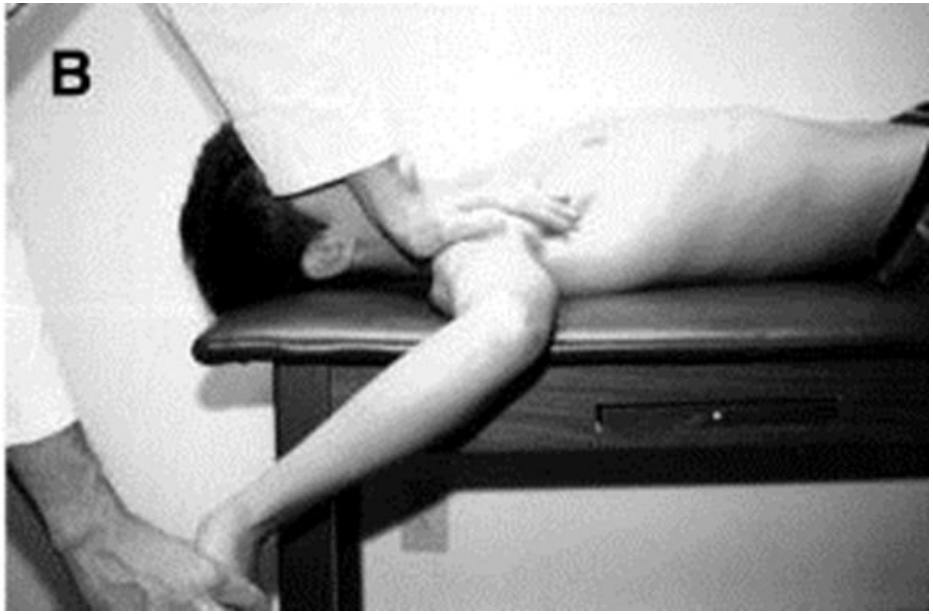
Kibler et al. The disabled throwing shoulder: spectrum of pathology – 10 year update. *Arthroscopy.* 2013 Jan;29(1):141-161.

How Humeral Torsion affects TROM

- Humeral torsion significantly affects rotational ROM at the shoulder.
- Low torsion (high retroversion) is strongly associated with reduced internal rotational ROM and a greater range of external rotational ROM.

Roach NT, et al. The effect of humeral torsion on rotational range of motion in the shoulder and throwing performance. J. Anat. (2012) 220, pp293–301.

Measurement of GIR and GER



Internal rotation is measured with the patient's shoulder in 90° abduction and the elbow in 90° flexion while the examiner stabilizes the scapula. The endpoint of internal rotation is taken as the point at which the scapula begins to rotate posteriorly

Stephen S. Burkhart, Craig D. Morgan, W.Ben Kibler. The disabled throwing shoulder: Spectrum of pathology part I: Pathoanatomy and biomechanics. Arthroscopy: The Journal of Arthroscopic & Related Surgery, Volume 19, Issue 4, 2003, 404–420

Humeral Mechanics

- When the shoulder joint is put into 90^0 of abduction and Externally Rotated to 90^0 or greater, the post/superior aspect of the glenoid may contact the intra-articular portion of the humeral neck.
- The would potentially cause injury to the rotator cuff and post/superior labrum.
- It is theorized that anterior capsular stretching would aggravate this effect.

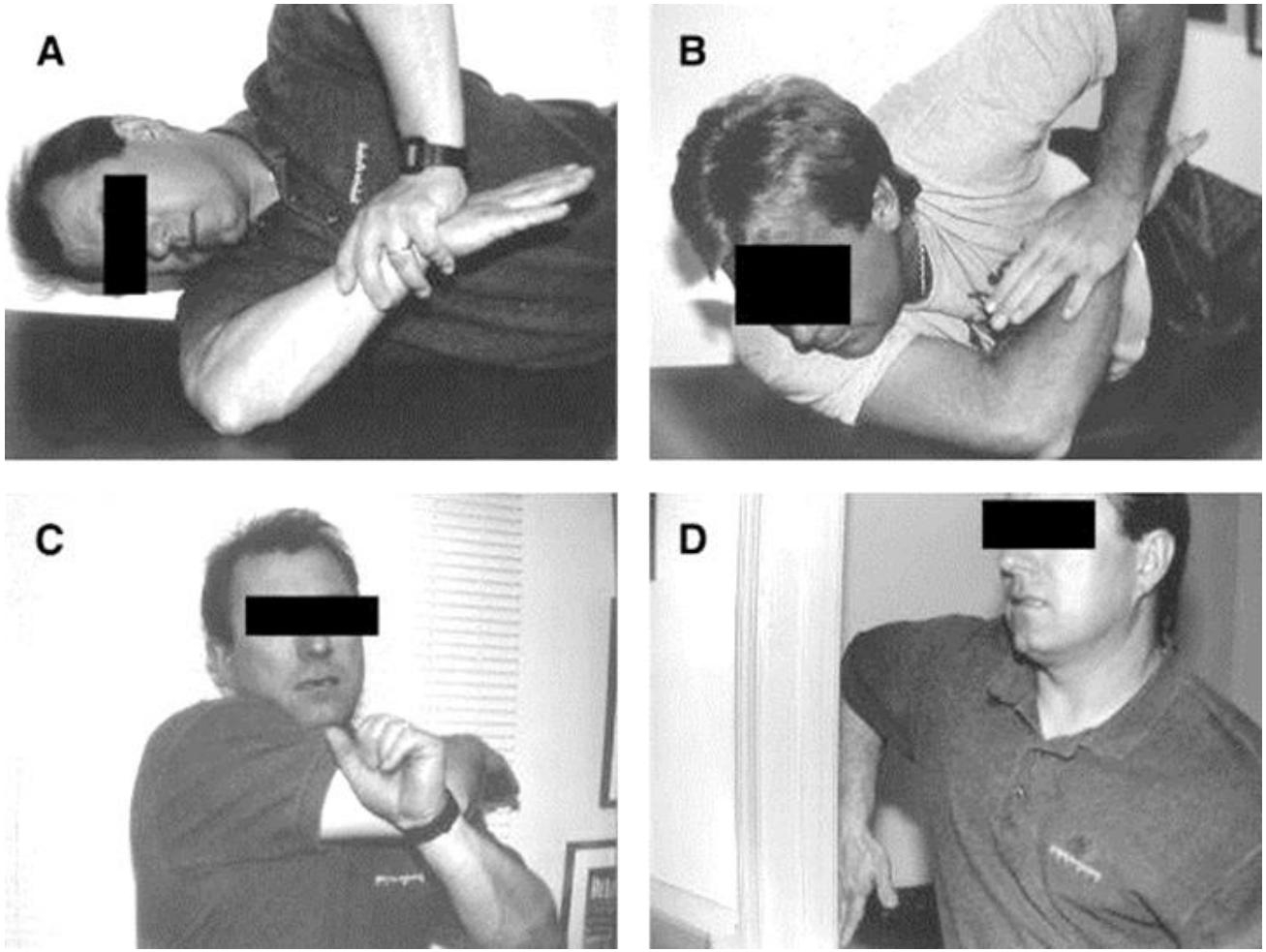
What can be addressed?

Posterior shoulder tightness and posterior shoulder capsule stretches.

Scapular dyskinesis

Common deficits

Posterior/Inferior Capsule Stretch



Focused posterior inferior capsular stretches.

Humeral Mechanics

- Burkhart and Morgan proposed the peel-back mechanism.
- The key issue for this mechanism is a post/inferior capsular contracture.
- This contracture would cause a post/superior shift of the humeral head when the joint is in 90^0 Abduction and 90^0 or more External Rotation.

Burkhart SS, Morgan CD. The peel-back mechanism: its role in producing and extending posterior type II SLAP lesions and its effect on SLAP repair rehabilitation. Arthroscopy. 1998; 14: 637-640.

Scapular Dyskinesis

- Throwers have exhibited similar patterns or direction of scapular motions during arm motion. These patterns include increased upward rotation, internal rotation, and retraction of the scapula during humeral elevation. Deviations from these patterns are considered to have implications for injury in throwers.

Myers JB, Laudner KG, Pasquale MR, Bradley JP, Lephart SM. Scapular position and orientation in throwing athletes. Am J Sports Med, 33 (2005), pp. 263–271

Scapular Dyskinesis

- Addressing the dyskinesis has been shown to decrease impingement symptoms, improve rotator cuff strength, and decrease symptoms in labral injury (Stephanie Moore, data presented at the Disabled Throwing Summit).
- Specific rehabilitation protocols have been developed to restore flexibility and strength in the scapular stabilizing muscles.

Kibler et al. The disabled throwing shoulder: spectrum of pathology – 10 year update. *Arthroscopy.* 2013 Jan;29(1):141-161.

Scapular Dyskinesis

- Rehabilitation protocols/exercises include:
  - specific methods of mobilizing the tight anterior coracoid muscles (pectoralis minor, short head of the biceps) by corner stretches.
  - Early activation of the weakened and inhibited lower trapezius and serratus anterior can be achieved through the scapular stability series.
  - More advanced rehabilitation can be achieved by prone exercises and kinetic chain diagonal exercises.

Kibler et al. The disabled throwing shoulder: spectrum of pathology – 10 year update. *Arthroscopy.* 2013 Jan;29(1):141-161.

Scapular Dyskinesis

- Scapular pattern strengthening is predominantly the role of a rehabilitation specialist since these are mostly specialized movements that differ from traditional strength and conditioning routines. Check with your athletic trainers and see if there are some exercises which could be addressed in training.
- Scapular stability should be sought even before rotator cuff strengthening.

Scapular Dyskinesis

- The scapula is the base from which the rotator cuff originates. Complete scapular rehabilitation allows for more normal scapular positioning and more normal patterns of activation of the rotator cuff.
- Control of elevation of the acromion decreases impingement and improves rotator cuff compression into the glenohumeral joint.
- Refer your AT's to the following article.

Kibler et al. The disabled throwing shoulder: spectrum of pathology – 10 year update. *Arthroscopy.* 2013 Jan;29(1):141-161.

Common deficits found in those with SLAP lesions

- Kinetic chain deficits are discovered on examination in a majority of patients with SLAP injuries.
  - Deficits in hip abductor or extensor strength
  - Deficits in hip rotation flexibility
  - Core strength weakness have been identified in 50% of SLAP injuries (this is due to the fact that better throwers are able to generate power from the ground up rather than mostly from the arm)

Common deficits found in those with SLAP lesions

- GIRD and TROMD are seen in virtually all patients with SLAP injury and have been found to be predictive of future injury in asymptomatic patients.
- Scapular Dyskinesis
- Scapular forward posture has been implicated as a negative factor for success of nonoperative treatment in SLAP injury (S.M., data presented at summit). This posture results from weaker posterior scapular muscles and tight pectoralis minor muscles

Shoulder Summit Thoughts

- The article referenced below is the result of many shoulder specialists. I highly suggest this article for reading.
- The rehabilitation must address deficits in internal rotation (GIRD) and total range of motion (TROMD), as well as scapular dyskinesis and kinetic chain deficits.

Kibler et al. The disabled throwing shoulder: spectrum of pathology – 10 year update. *Arthroscopy.* 2013 Jan;29(1):141-161.

Shoulder Summit Thoughts

- Throwing requires repetitive high loading of the osseous and soft-tissue structures. To achieve the extremes of external rotation required for throwing with high velocity, these structures undergo adaptive remodeling and possibly failure.
- Athletes have developed these anatomic alterations to throw at high levels, just as their humerus has remodeled into greater retroversion
- Chronic SLAP lesions in throwers may allow for increases in external rotation required for throwing.

Shoulder Summit Thoughts

- Articular-side partial-thickness rotator cuff tears may represent failure of the tissue in external rotation, again allowing for the extremes of external rotation required for high-level throwing.
- Anatomic repair of these structures may lead to an inability to achieve the extremes of external rotation required to throw at high velocity and may end their careers.
- This may be why surgical repairs have had relatively poor results

My Final Thoughts

Thanks for attending!