Please click on the following link to watch the lecture online:-

https://www.youtube.com/watch?v=MZusw_D5jeM

Rotator Cuff Pathology

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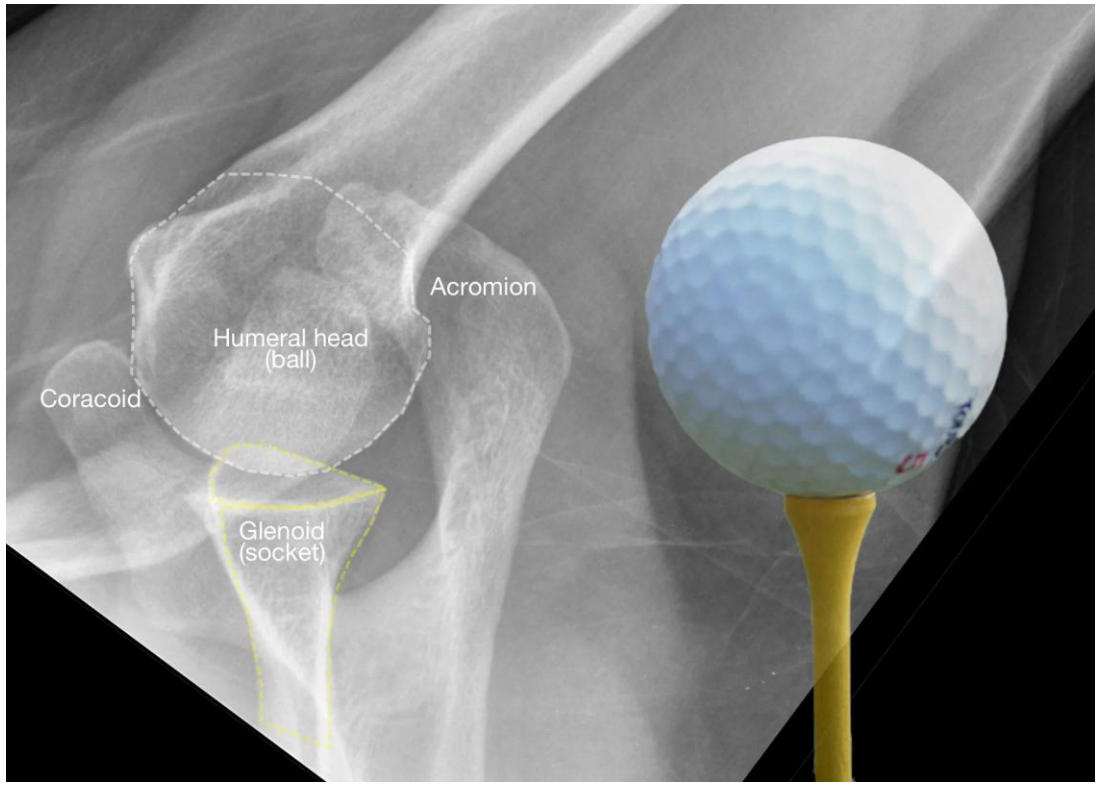
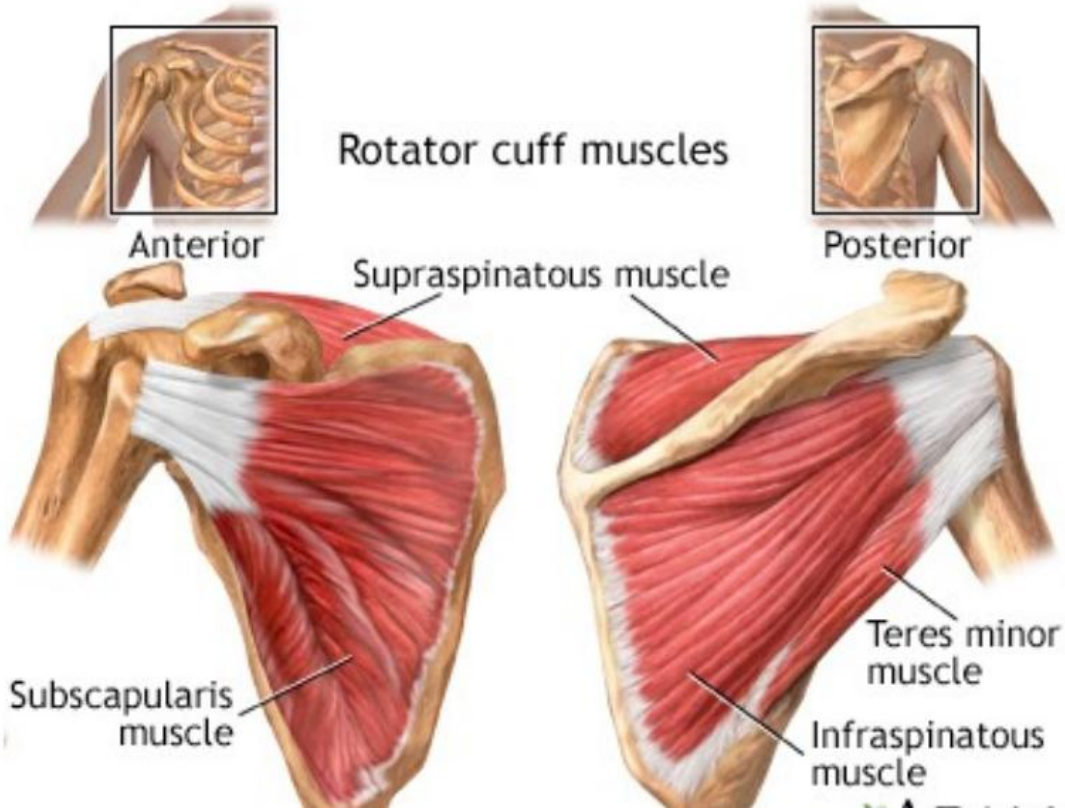
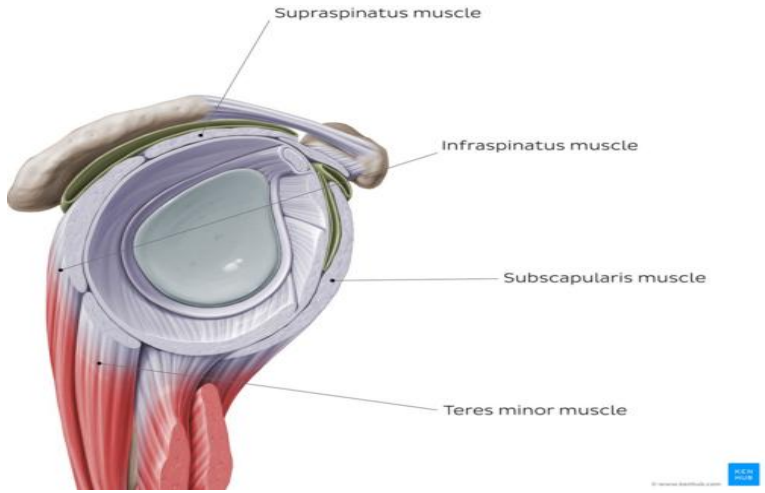
Outline

- Anatomy of rotator cuff
- Function of rotator cuff
- Biomechanics
- Spectrum of the of rotator cuff injury

Anatomy

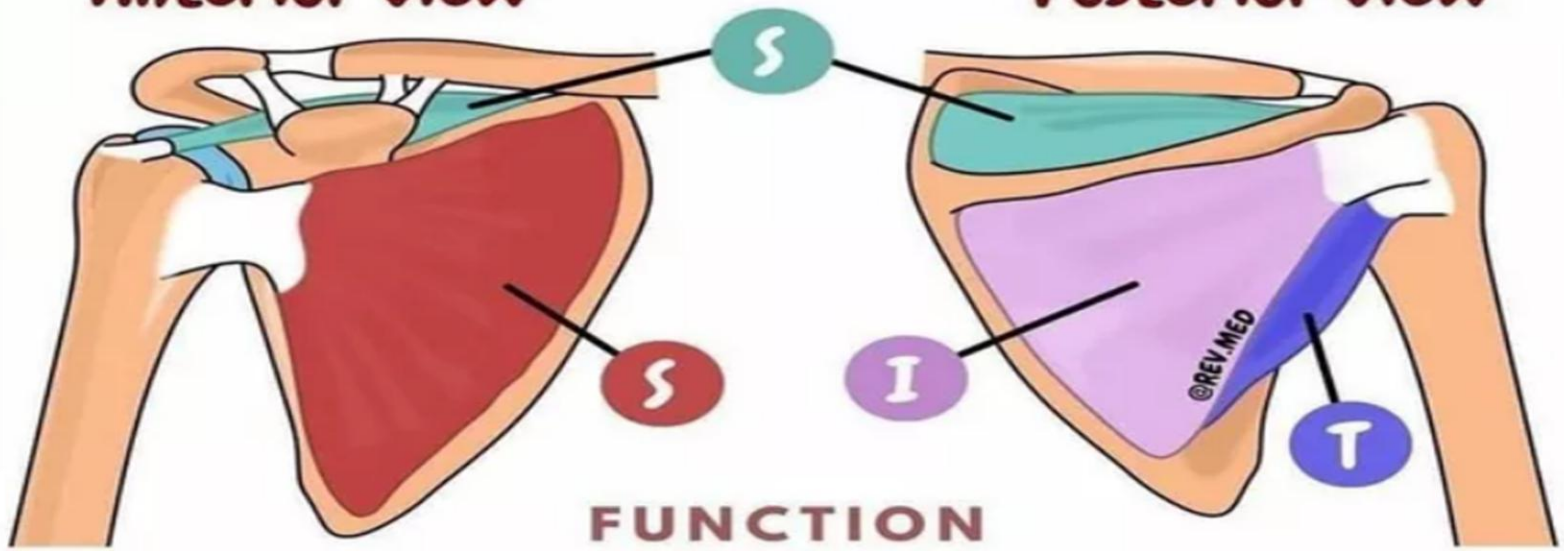

Acromion
Humeral head
(ball)
Coracoid
Glenoid
(socket)


Rotator cuff muscles
Anterior
Posterior
Supraspinatous muscle
Subscapularis
muscle
Teres minor
muscle
Infraspinatous
muscle


Supraspinatus muscle
Infraspinatus muscle
Subscapularis muscle
Teres minor muscle

Rotator Cuff Muscles

S I T S Muscles



FUNCTION

S — Supraspinatus muscle
Initiation of abduction of arm to 15°, assists deltoid 15°– 90°

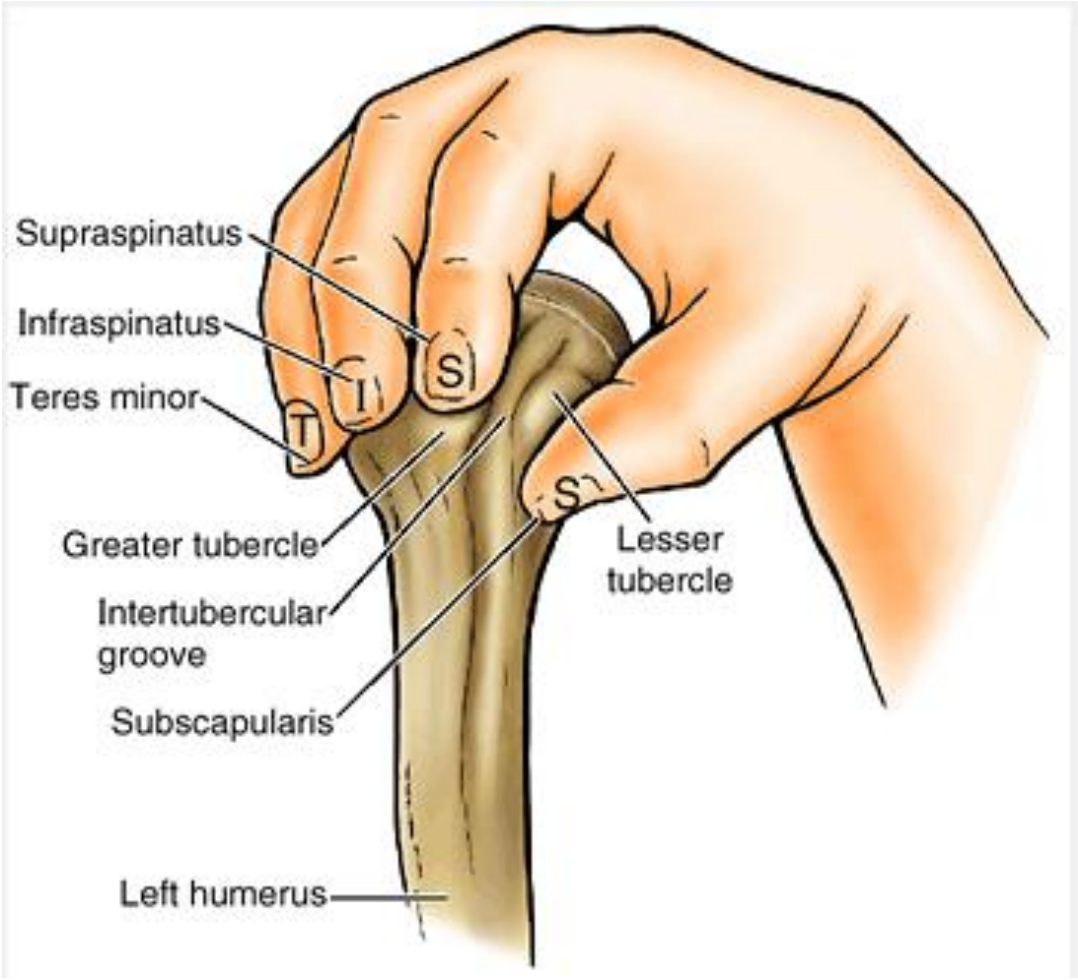
I — Infraspinatus muscle
Lateral rotation of arm at glenohumeral joint

T — Teres Minor muscle
Lateral rotation & adduction of arm at glenohumeral joint

S — Subscapularis muscle
Medial rotation of the arm at the shoulder joint

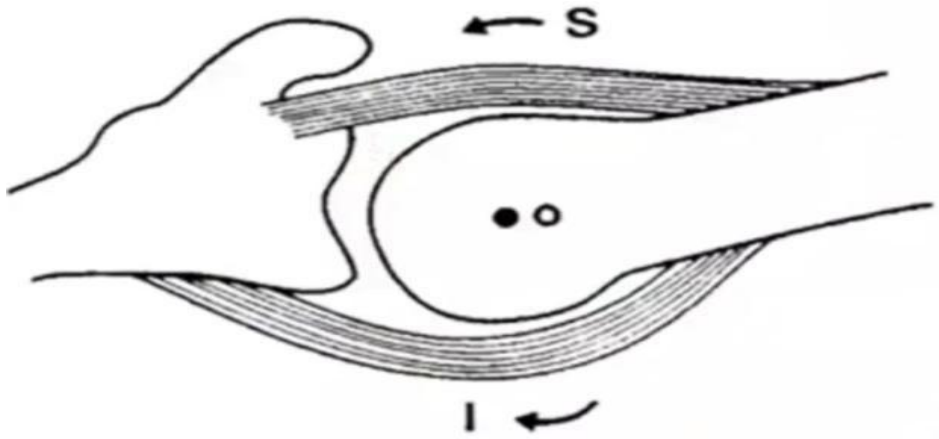
Function of rotator cuff

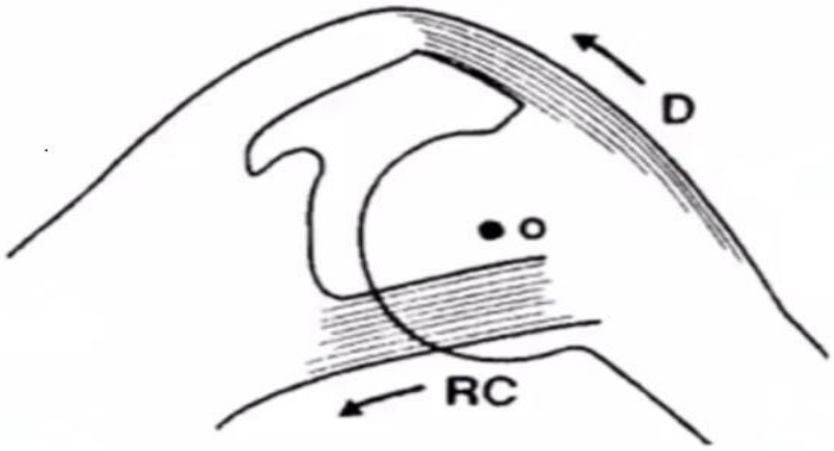
- Stabilisers of shoulder mainly anterior and posterior cuff providing fixed fulcrum for concentric rotation of the humeral head.
- Neutralises shearing forces of deltoid in early abduction.
- Initiation of abduction.
- Rotation of shoulder.



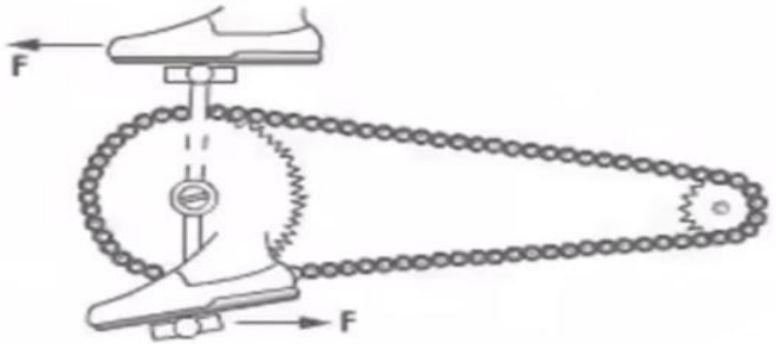
Biomechanics

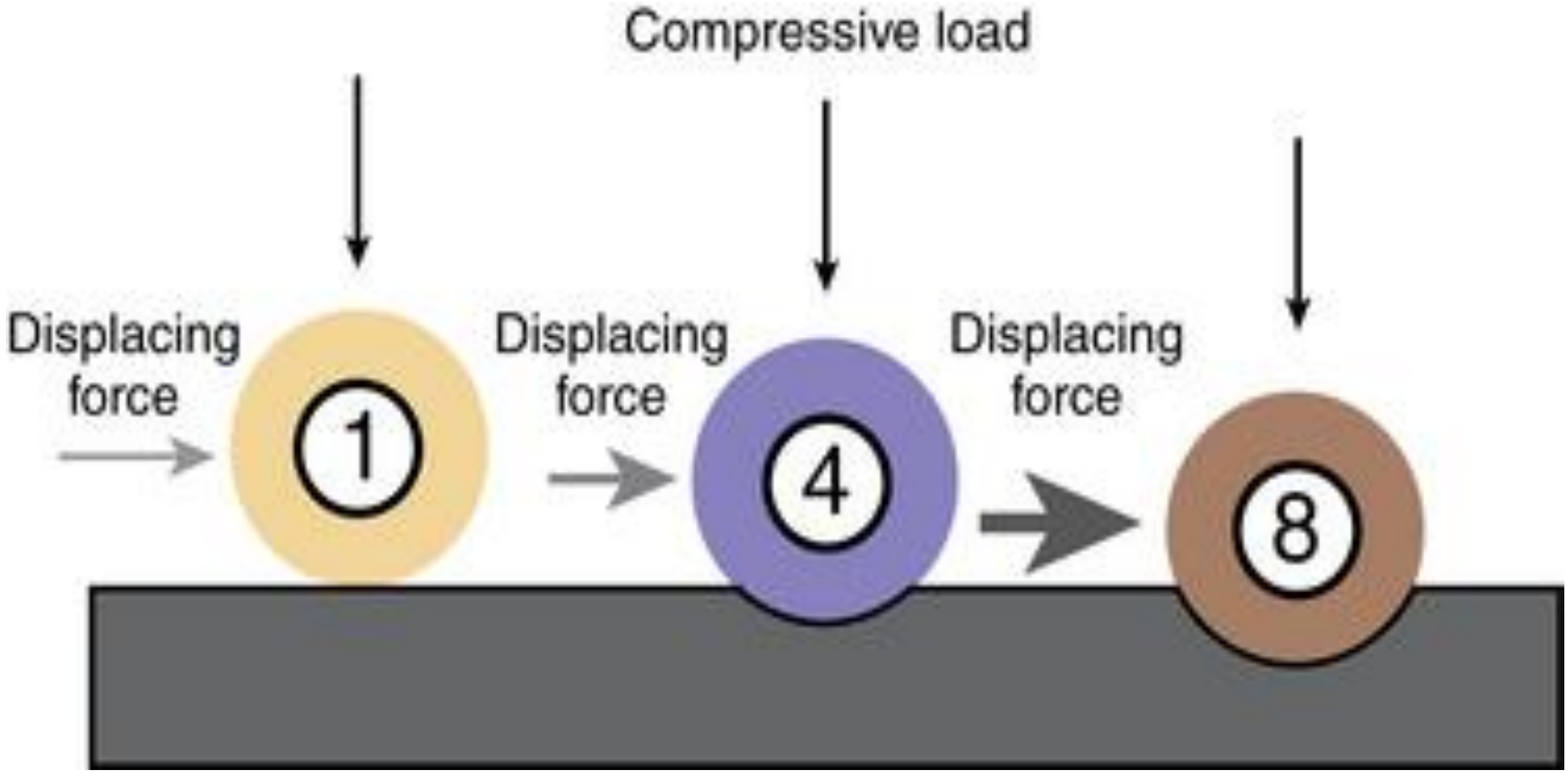
Force Couples



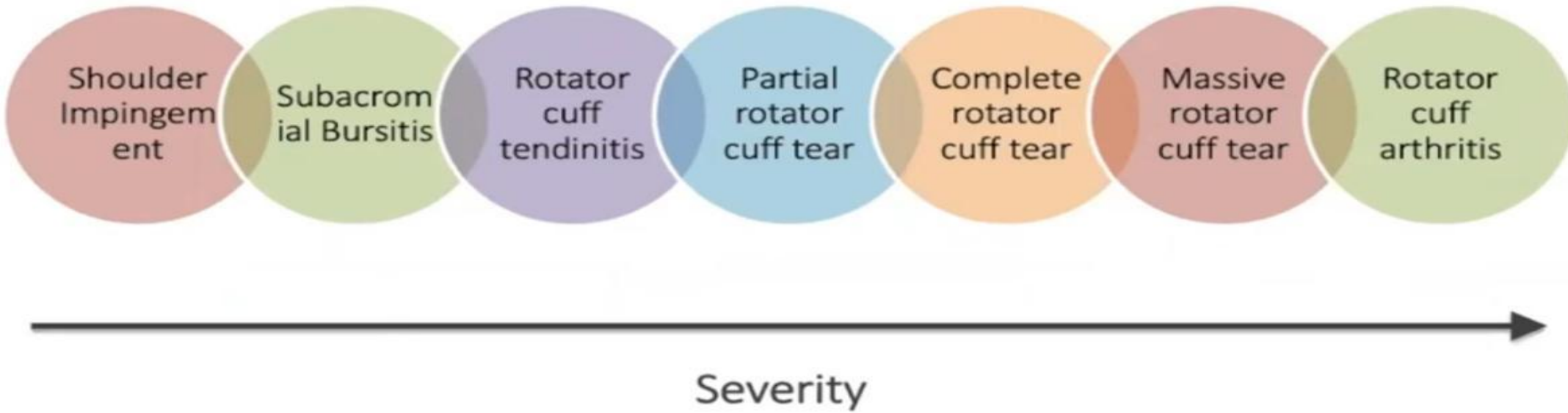


Rotating forces : couples




Compressive load
Displacing force
Displacing force
Displacing force
1
4
8

Rotator cuff injury spectrum

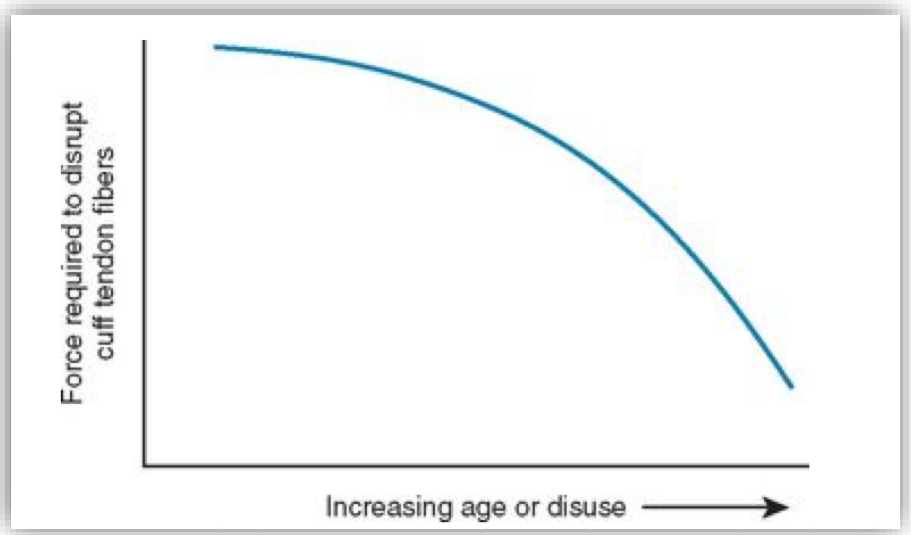


Causes of Cuff tears

Intrinsic

Proposed by Codman (1934):

- Age related cuff degeneration
- Decreased blood-flow
- Link Smoking & Cuff tears
- Genetic predisposition

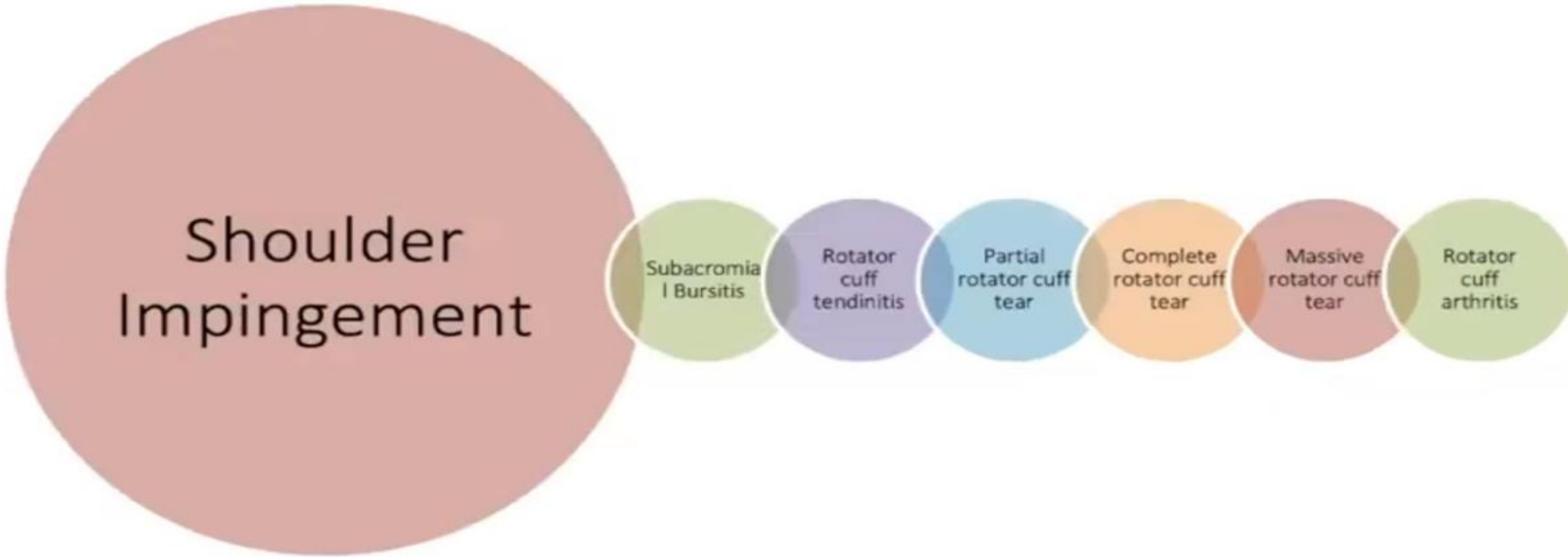


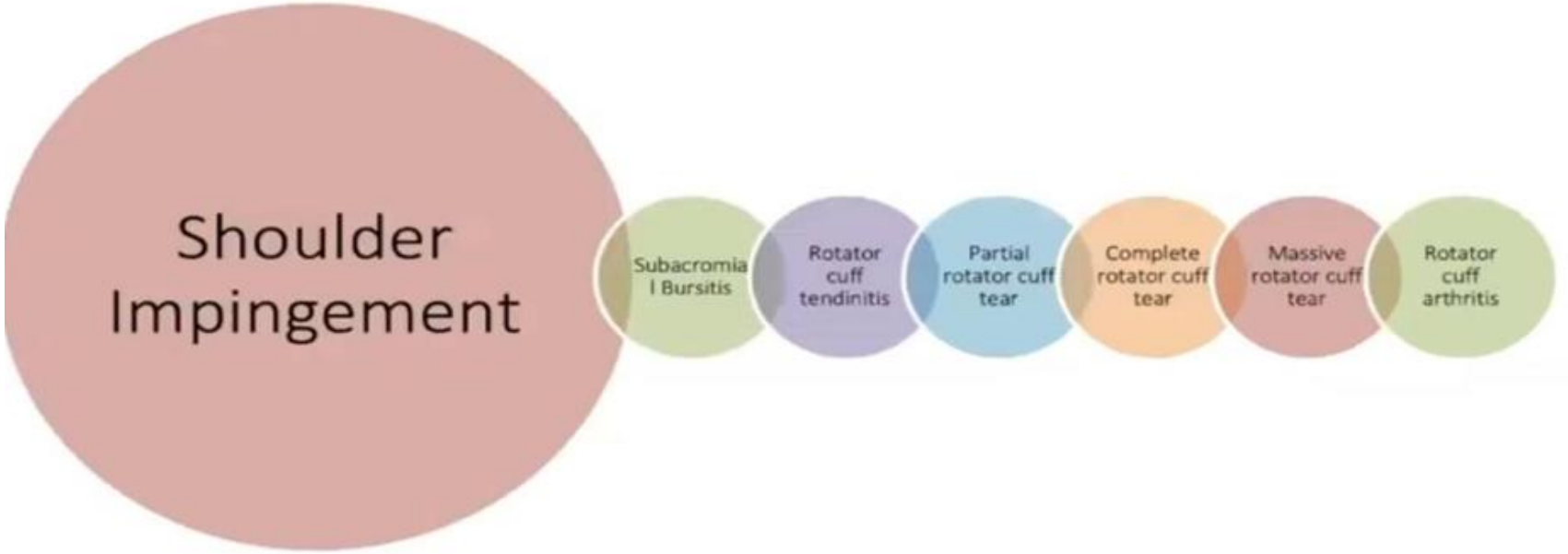
Extinsic

Proposed by Meyer (1924):

- Association Subacromial spur and cuff tear
- An association in throwers with repetitive throwing trauma
- Association with a tight posterior capsule leading to medial footprint impingement

Rotator cuff injury spectrum





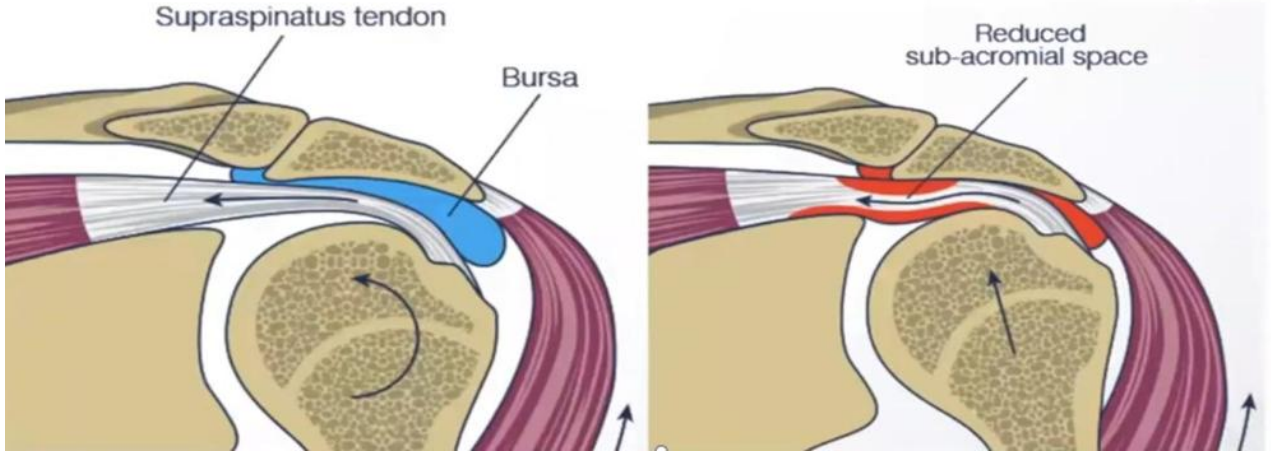
1- Subacromial Impingement

- Primary
- Secondary

2- Subcoracoid Impingement

3- Internal (Glenoid) Impingement

- ASI (Antero-Superior Impingement)
- PSGI (Postero-superior glenoid Impingement)



- The subacromial space is 10.2 mm in men and 9.5 mm in women.
- 95% range is 6.6 - 13.8 mm in men and 7.1-11.9 mm in women.
- In absolute values, a mean acromiohumeral distance of 9.2 mm ± 1.8 on MRI in comparison to 10.4 mm ± 2.4 on the radiographs was calculated.

Hufeland, M., Brusis, C., Kubo, H. *et al.* The acromiohumeral distance in the MRI should not be used as a decision criterion to assess subacromial space width in shoulders with an intact rotator cuff. *Knee Surg Sports Traumatol Arthrosc* **29**, 2085–2089 (2021). https://doi.org/10.1007/s00167-020-06090-6

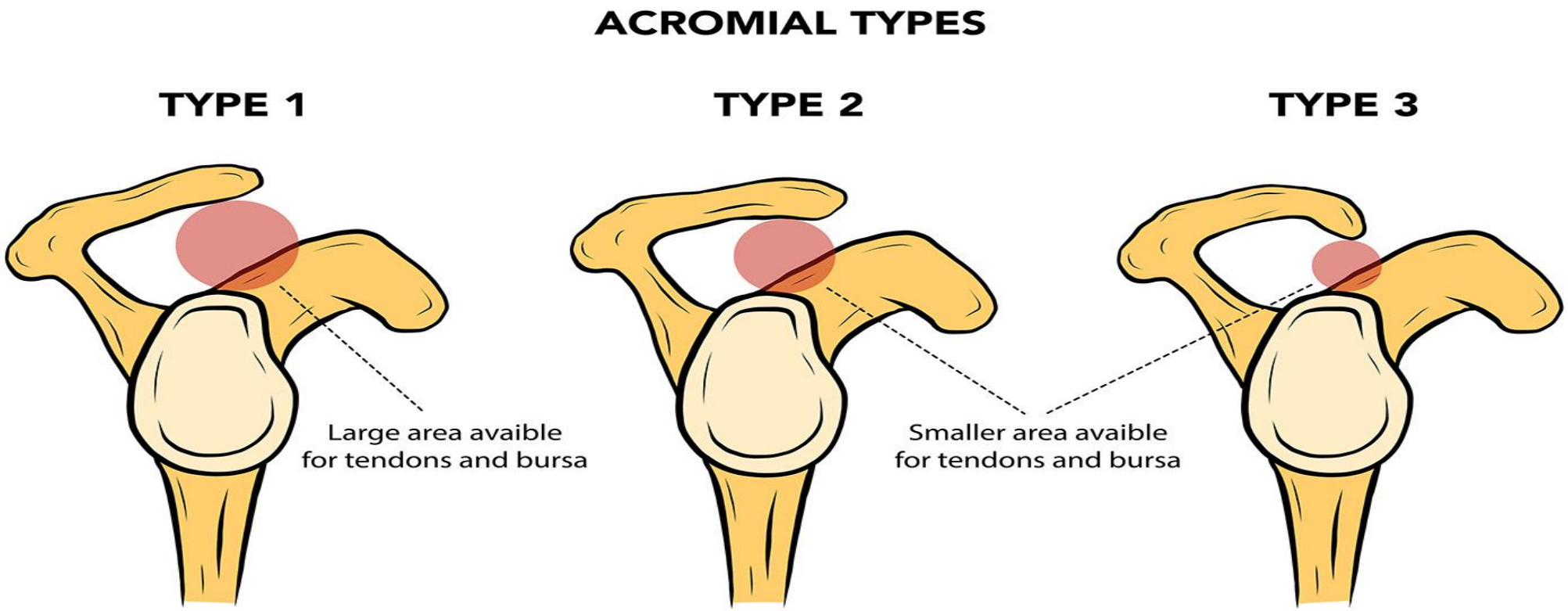
Primary subacromail impingement

- Primary Subacromial Impingement can be:
- **Instrinsic**:The structures passing beneath the coracoacromial arch enlarge resulting in abutment against the arch.
  - Thickening of the rotator cuff
  - Calcium deposition
  - Thickening of subacromial bursa

Primary subacromail impingement

- **<u>Extrinsic</u>**:When the space available for the rotator cuff diminished; examples include
  - Subacromial spurring
  - Acromial fracture or pathological os acrominale
  - Osteophytes off the undersurface of the acromioclavicular joint
  - Exostosis at the greater tuberosity

- Different shapes of acromia (Biglianni et al) –anterior slope
  - Type 1 - Flat (3 % of cuff tears)
  - Type 2 - Curved (24 % of cuff tears)
  - Type 3 - Hooked (73 % of cuff tears)



- Secondary Shoulder Impingement: this is **when the humeral head isn't centred within the shoulder joint causing impingement when the arm is moved**.

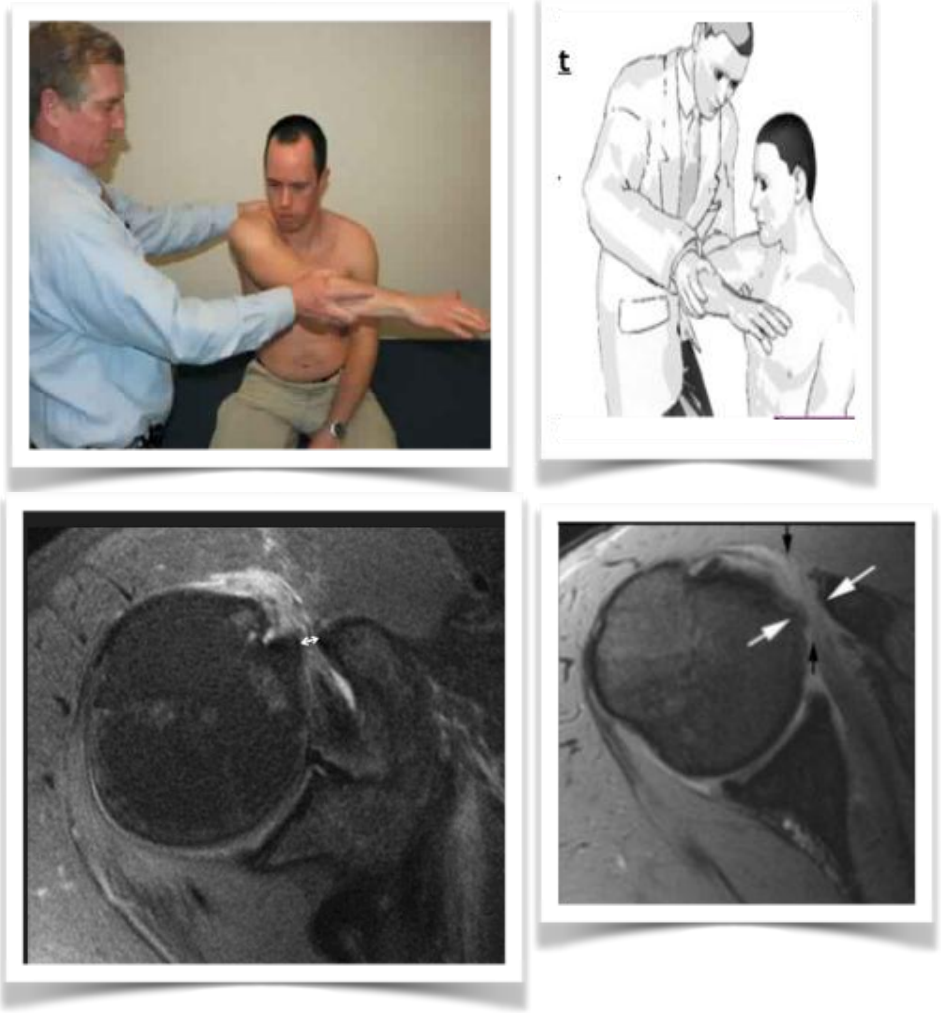
- Common causes include
  - poor posture,
  - muscle imbalances such as rotator cuff weakness.

Subcoracoid Impingement

- Subcoracoid space: Interval between the tip of the coracoid and the humeral head (the coracohumeral interval).
- Normal coracohumeral interval: 8.4- 11.0 mm and should be large enough to accommodate the subscapularis tendon, bursa and the rotator interval tissues.
- Subcoracoid stenosis: Narrowing of the Subcoracoid space with a coracohumeral interval of less than 6mm.
- Subcoracoid impingement may be
  - Idiopathic due to enlargement or mal-direction of the coracoid process,
  - Traumatic fracture of coracoid or lesser tuberosity,
  - Space occupying lesion as ganglion or calcification
  - Iatrogenic post surgery involving coracoid process.

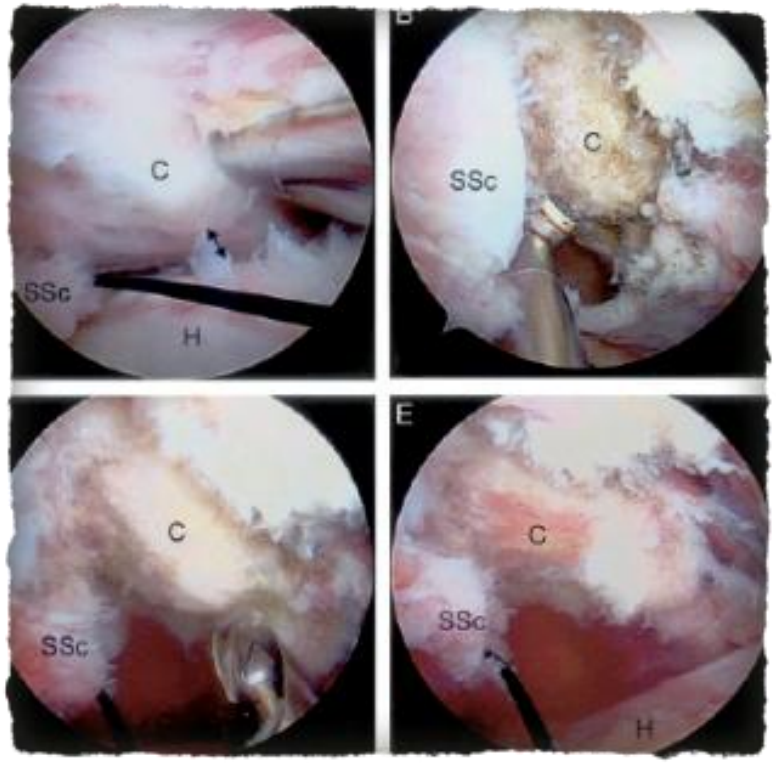
Subcoracoid Impingement

- Presentation is anterior shoulder pain that increase by elevation and rotation of the arm.
- Clinically: tenderness over the coracoid process
- Positive Gerber Sign
- MRI: Increase the intensity of subacapularis tendon with decrease the coracohumeral distance.



Management of Subcoracoid Impingement

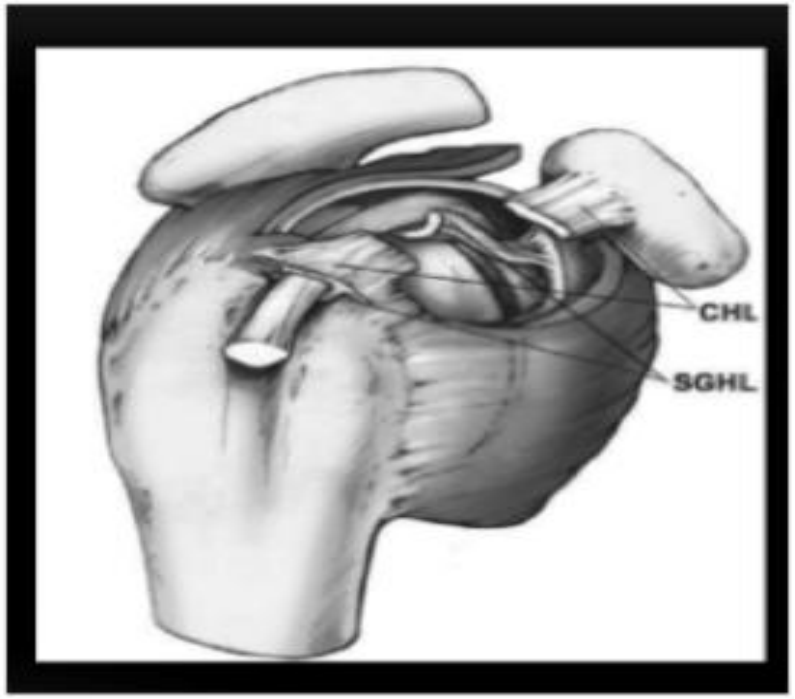
- Usually resistant to conservative
  Surgical treatment is usually warranted.
- Surgical treatment involves a coracoplasty (removing a portion of the coracoid process) with debridement or repair of the subscapularis tear.



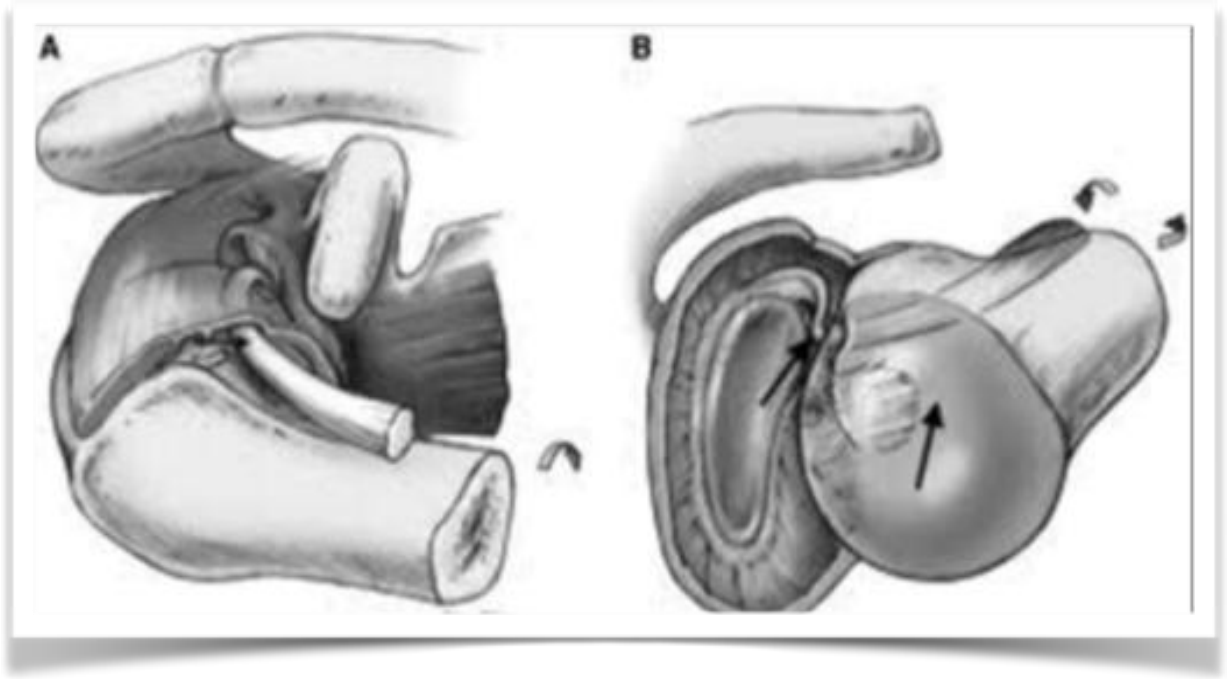
Internal glenoid Impingement

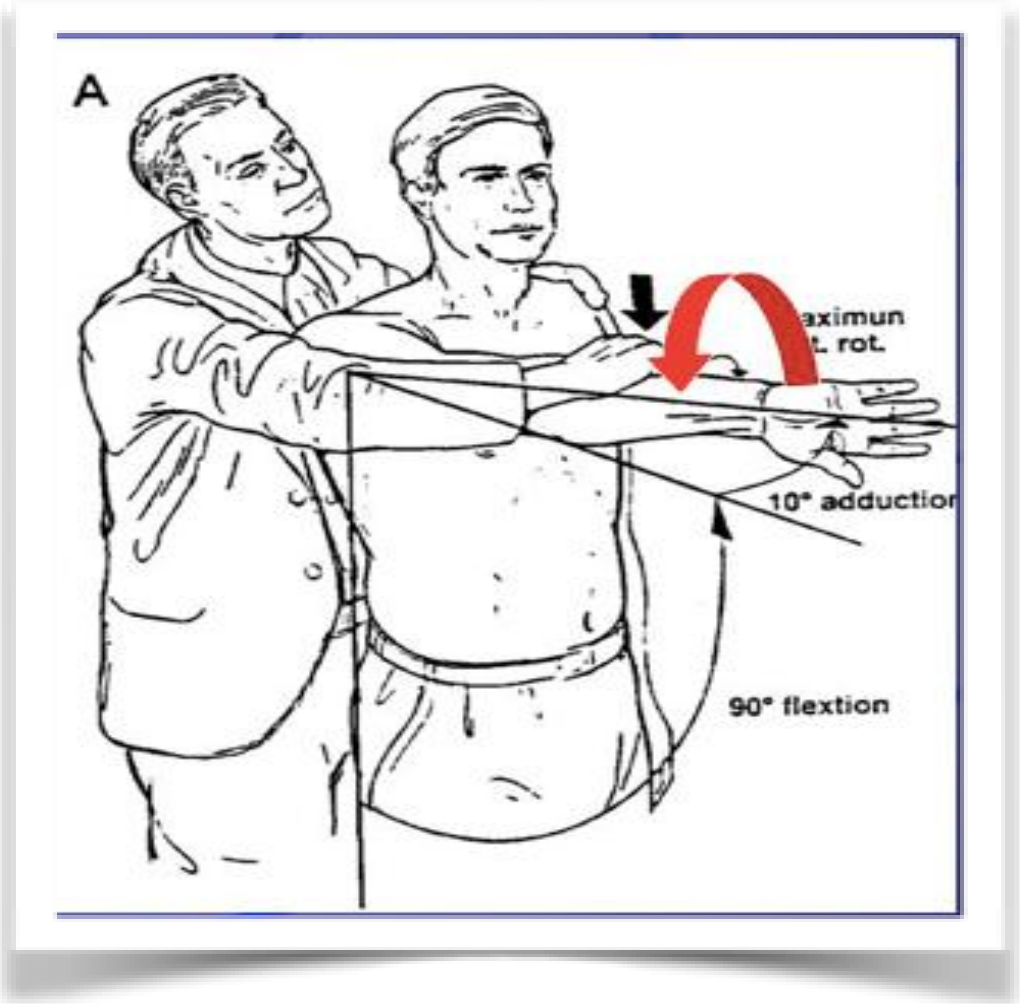
A. Antero-Superior Impingement:

- Injury to the LHB pulley system
- The pulley system is formed of the coracohumeral ligament, the Superior glenohumeral system, fibers of subscapularis and supraspinatus
- This pulley system protect and stabilize the biceps tendon in its intra-articular position
- Common in swimmers due to repetitive forced elevation, adduction and internal rotation of the shoulder
- Injury to the shoulder pulley leads to medial subluxation of the LHB, superior migration of the humeral head >> antero-superior impingement.
- Clinically presented by anterior shoulder pain with positive O'Brein test
- Clinical tests and imaging are not specific for ASI.



ASI is best determined by dynamic evaluation in arthroscopy also surgical treatment guidelines are not well established it is usually treated as part of other associated injuries.

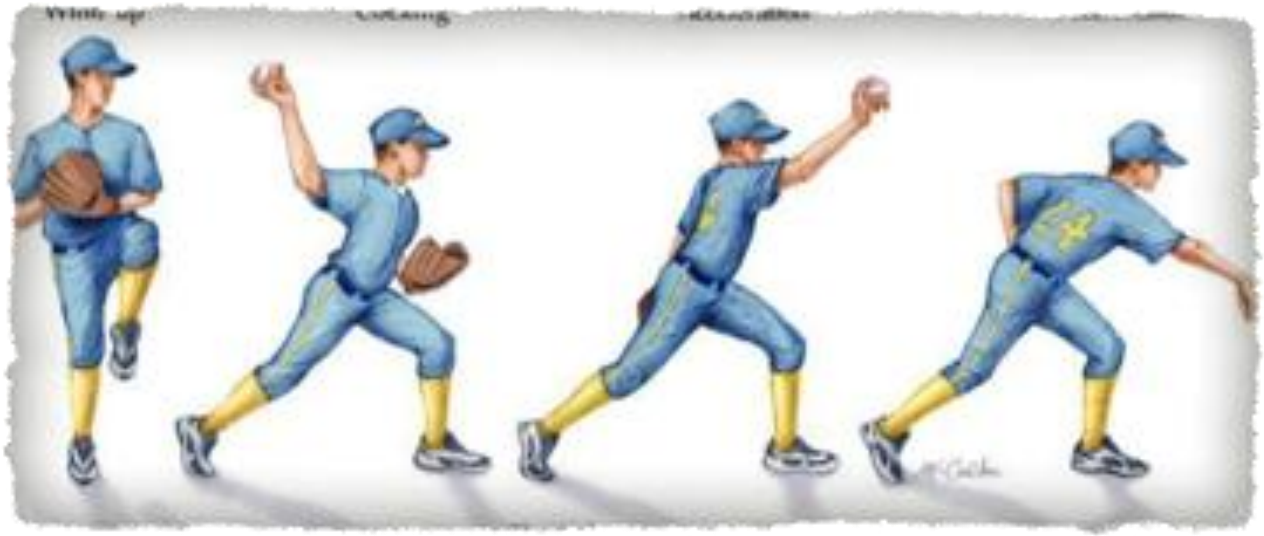




Internal glenoid Impingement

B. Postero-superior glenoid impingement (PSGI):

- Repetitive forceful extreme abduction external rotations (ABER) in the late cocking phase of throwing leads to impaction of the undersurface of supraspinatus and infraspinatus with the poster-superior glenoid rim
- This leads to tendon degernation and tearing of the postersuperior glenoid labrum

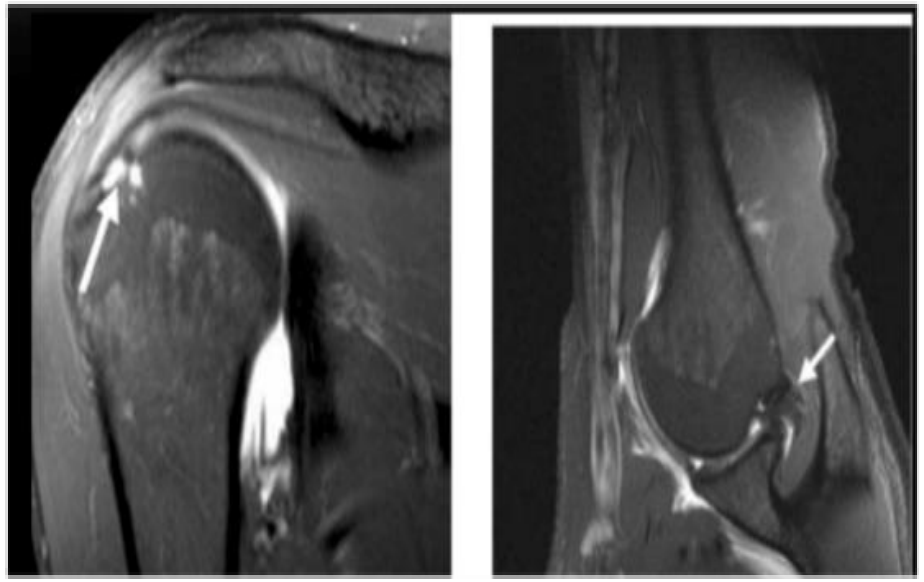


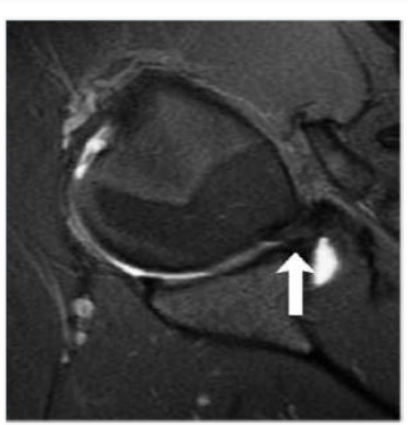
Postero-superior glenoid impingement (PSGI)

- Typically patient is an overhead athlete presented with posterior shoulder occurying while playing specially in the late cocking phase.
- Clinically; posterior glenoid tenderness, negative Neer test and O'brein test
- Positive Internal Impingement test
- Relocation test = positive

Postero-superior glenoid impingement (PSGI)

- MRI: Tearing of the posterior fibers of supraspinatus and anterior fibers of infraspinatus with fraying and tearing of the posterior superior glenoid rim with cystic changes in the greater tuberosity.
- Non surgical treatment include rest, avoid overhead athletic activity, posterior capsular stretching exercises.
- If symptoms persist: Arthroscopic debridement, Arthroscopic Arthrolysis of posterior capsule, repair of rotator cuff tear.

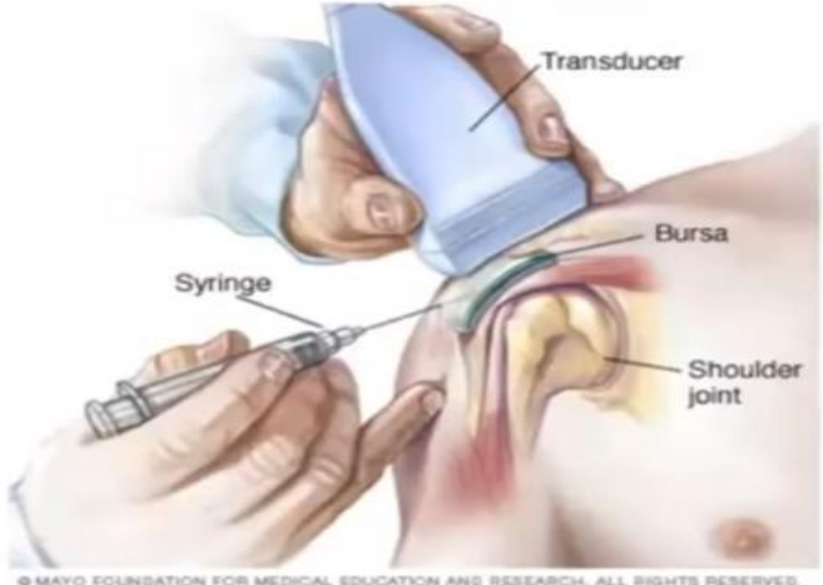


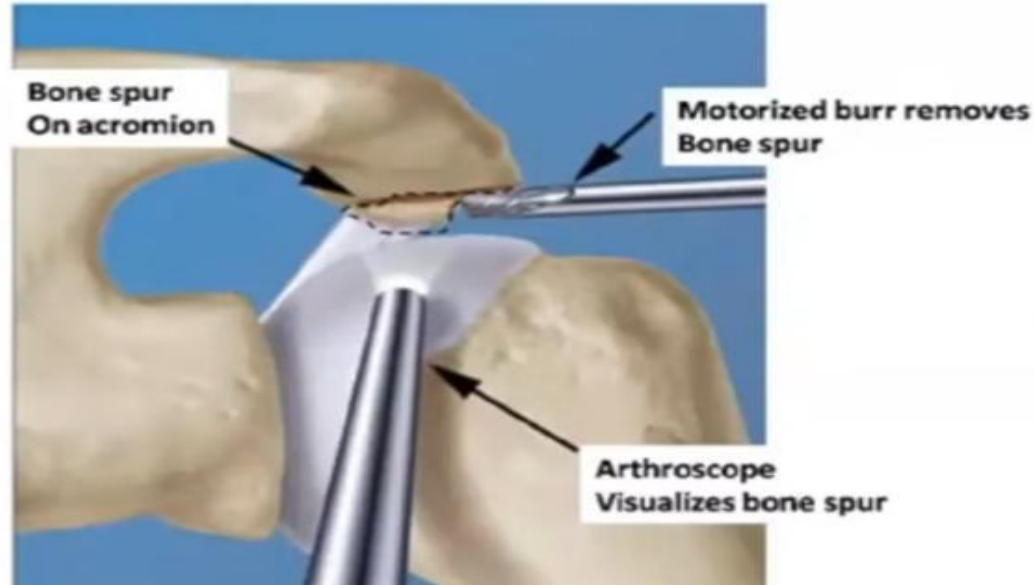


Shoulder Impingement

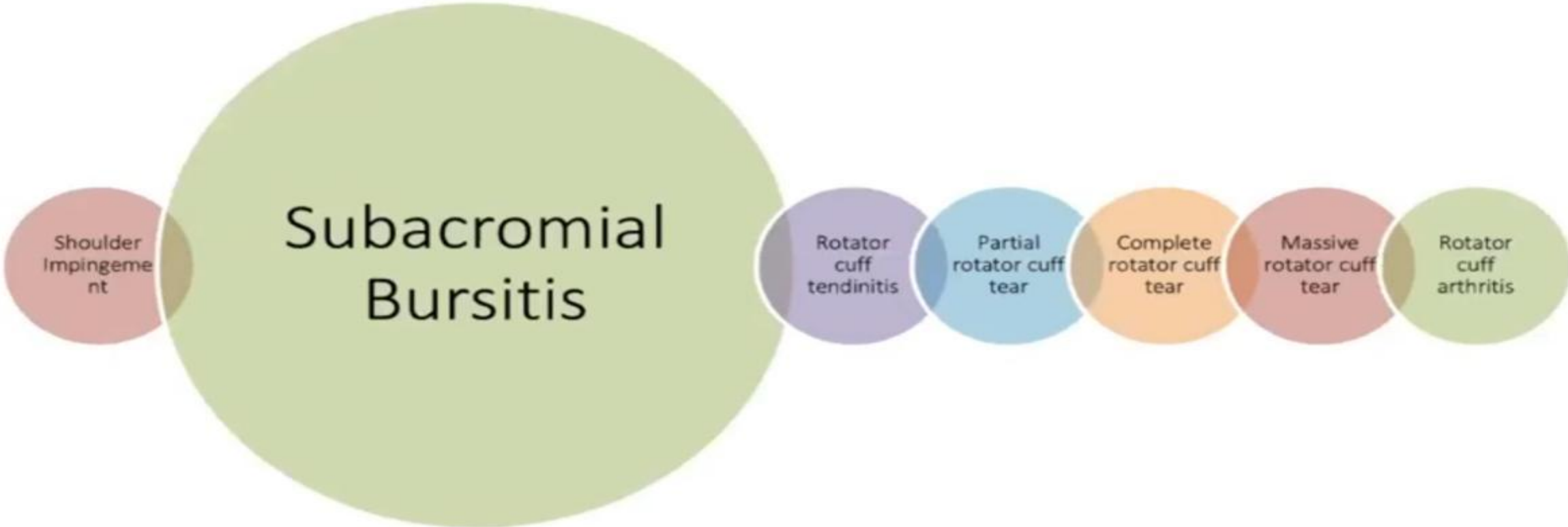
TREATMENT

- PT
- Anti-inflammatories
- Injections
- Surgery

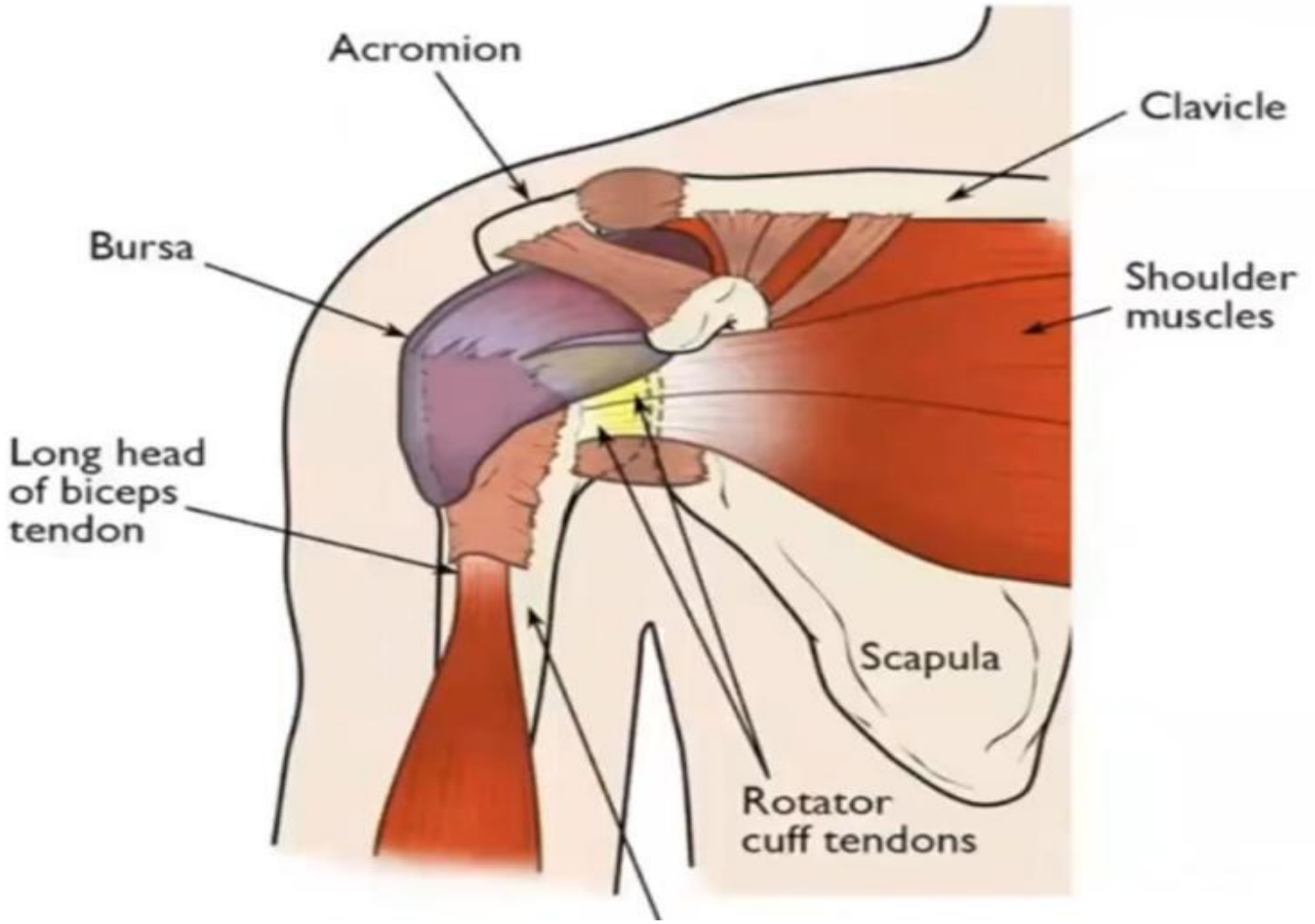




Rotator cuff injury spectrum



Subacromial Bursitis

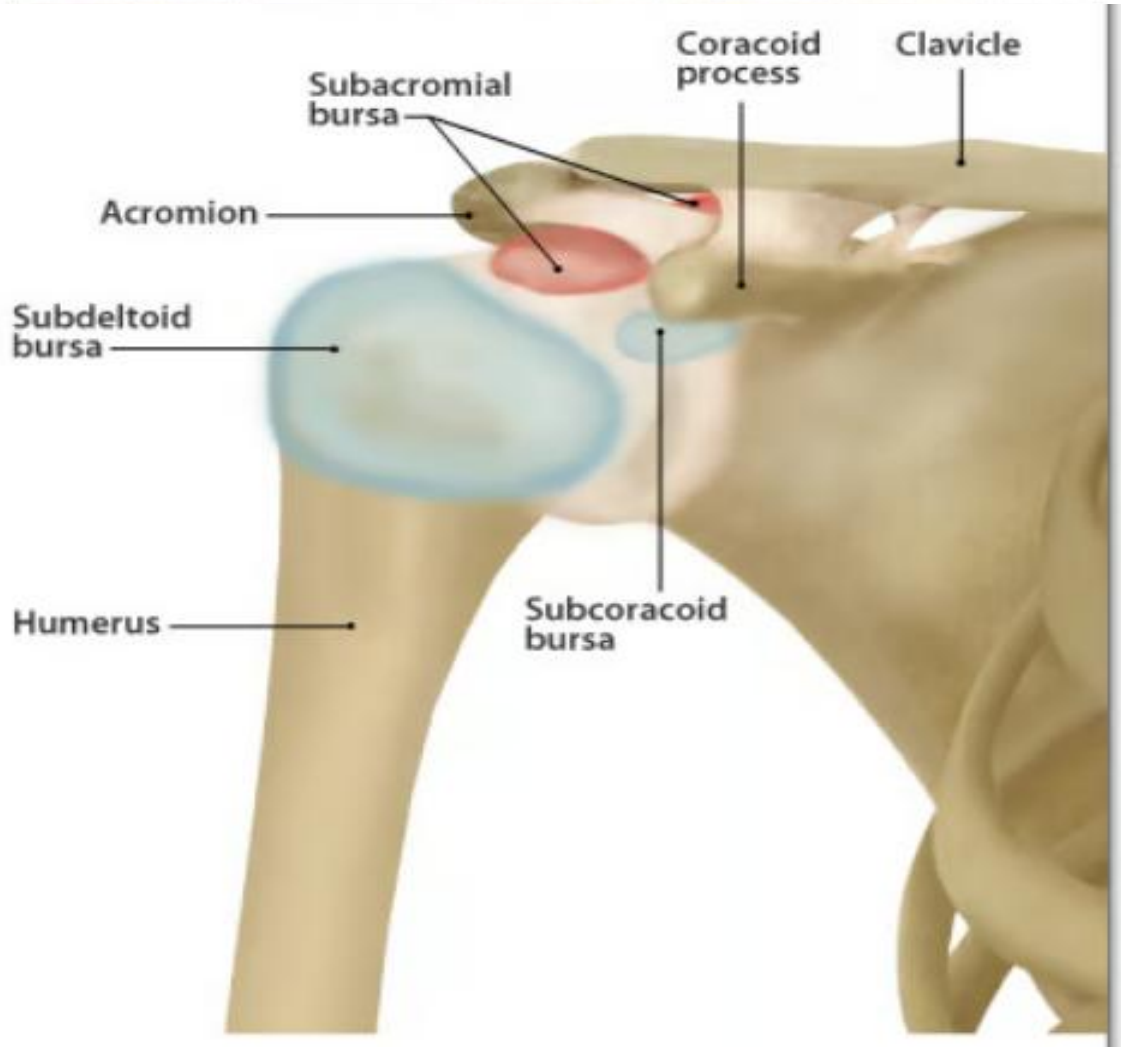


- Shoulder bursitis is a painful condition caused by inflammation of one of the shoulder bursae between the shoulder acromion bone and rotator cuff tendons

Subacromial Bursitis

Causes

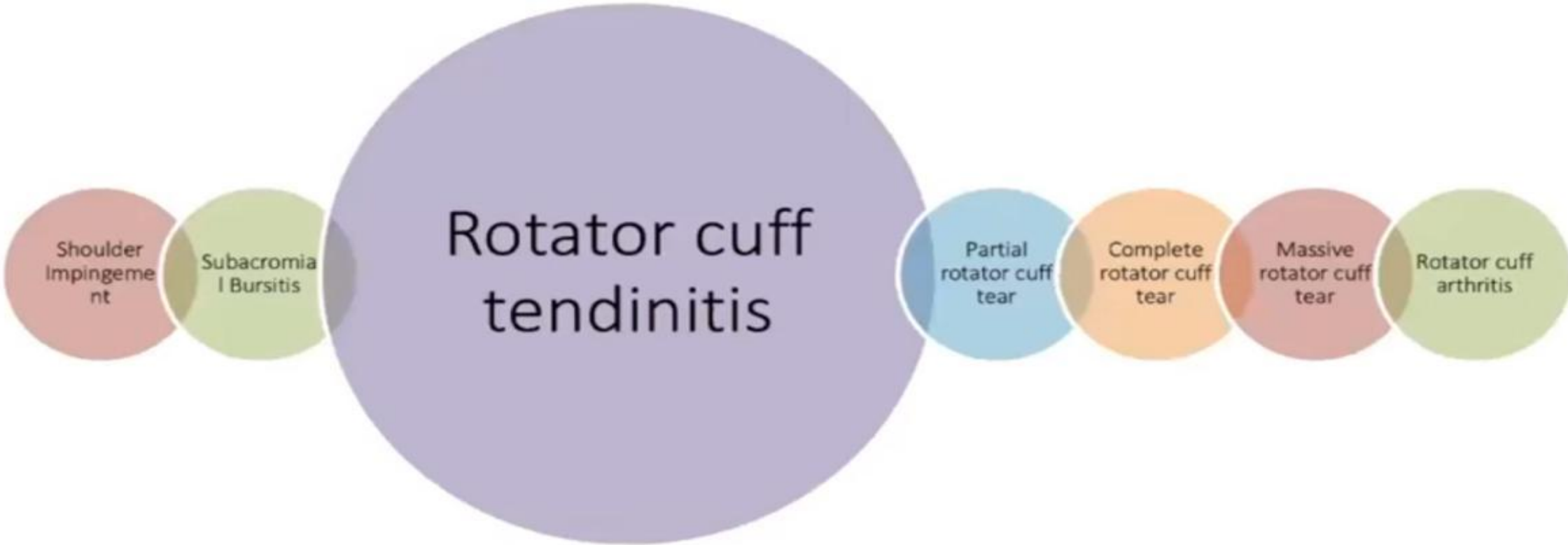
- Rotator cuff muscle weakness and imbalance
- Repetitive shoulder motion
- Direct trauma or fall on the shoulder
- Idiopathic with no known cause



Subacromial Bursitis

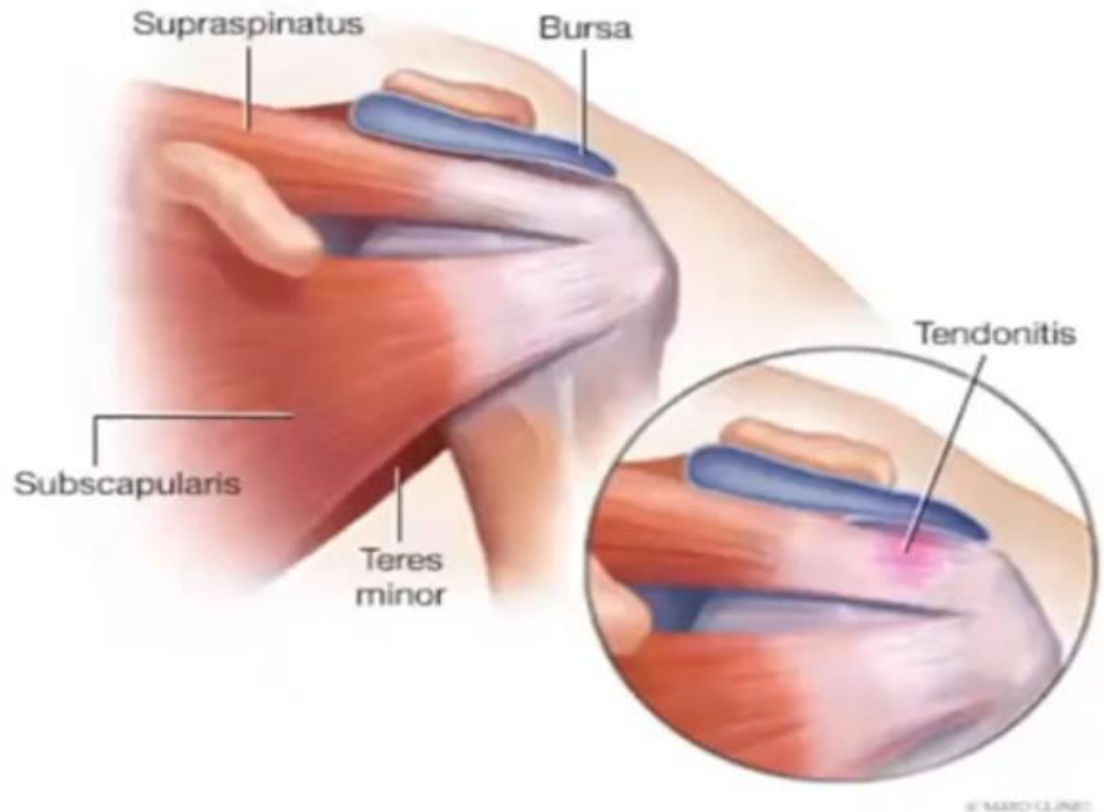
- Treatment
  - PT or home exercise program
  - Rest, ice, and anti-inflammatories
- Prevention
  - Maintaining a strong and stable shoulder girdle can help decrease the chance of developing shoulder subacromial bursitis

Rotator cuff injury spectrum



Rotator Cuff Tendinitis

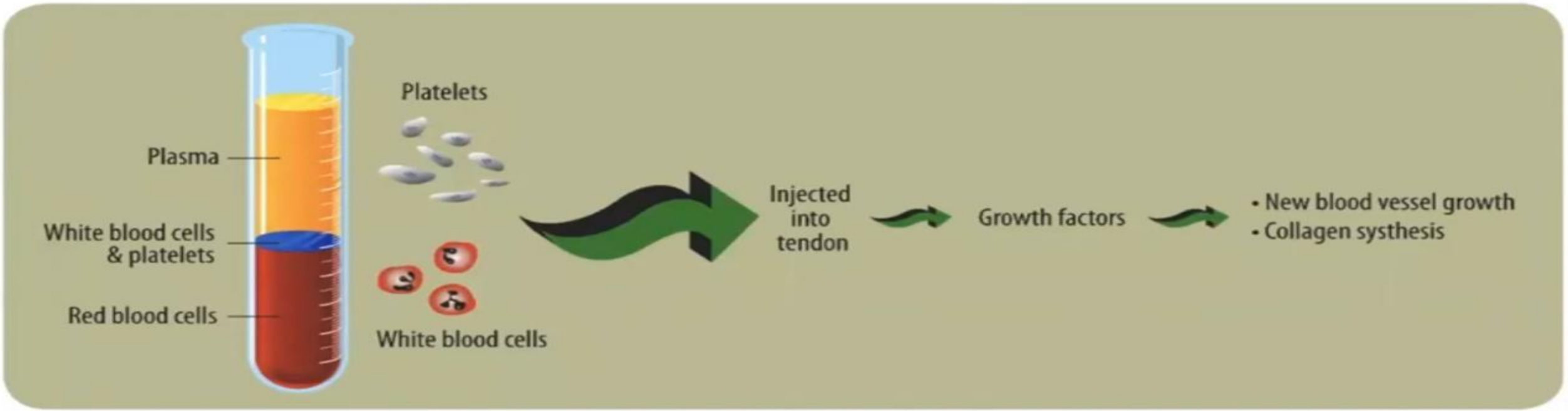
- Rotator cuff tendinitis is a common shoulder pathology
- The repetitive rubbing of the rotator cuff tendon and subacromial bursa leads to rotator cuff tendinitis which is very painful and worse with overhead activities



Rotator Cuff Tendinitis

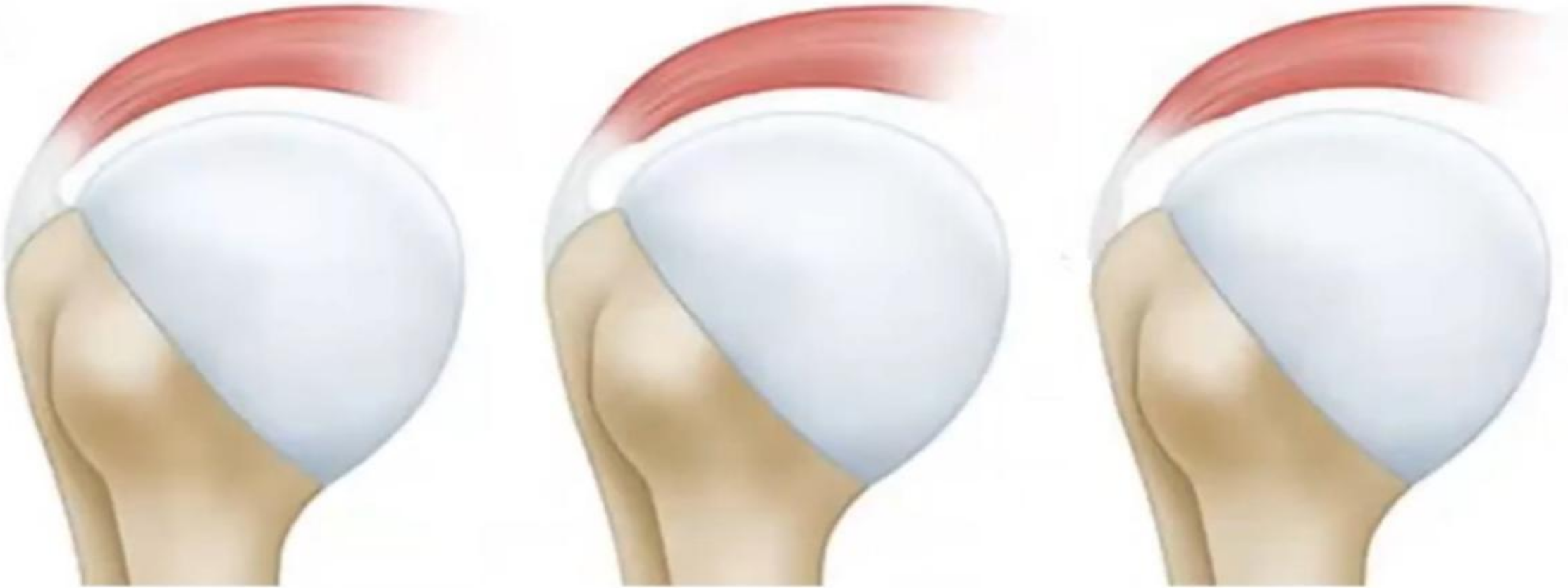
Treatment

- PT, NSAIDs, Orthobiologics such as platelet rich plasma (PRP)



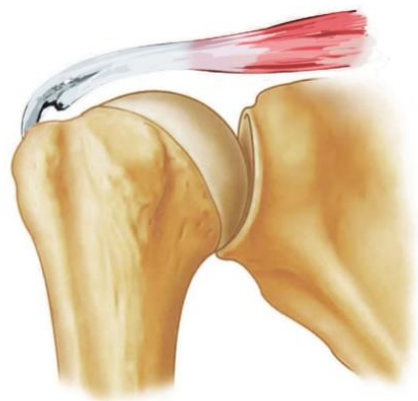
Rotator cuff injury spectrum

Partial Rotator Cuff Tear



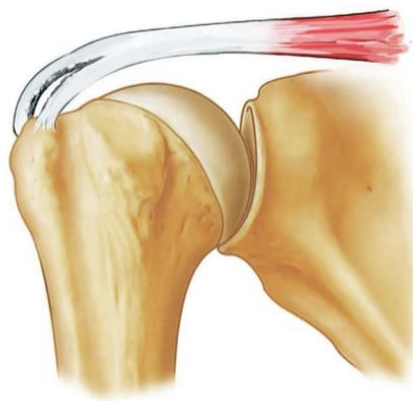
Ellman Classification of Partial-Thickness Rotator Cuff Tears	
Grade	*Description*
I	< 3mm (< 25% thickness)
II	3-6 mm (25-50%)
III	> 6 mm (>50%)
Location	
A	Articular sided
B	Bursal sided
C	Intratendinous

Articular Side Tear



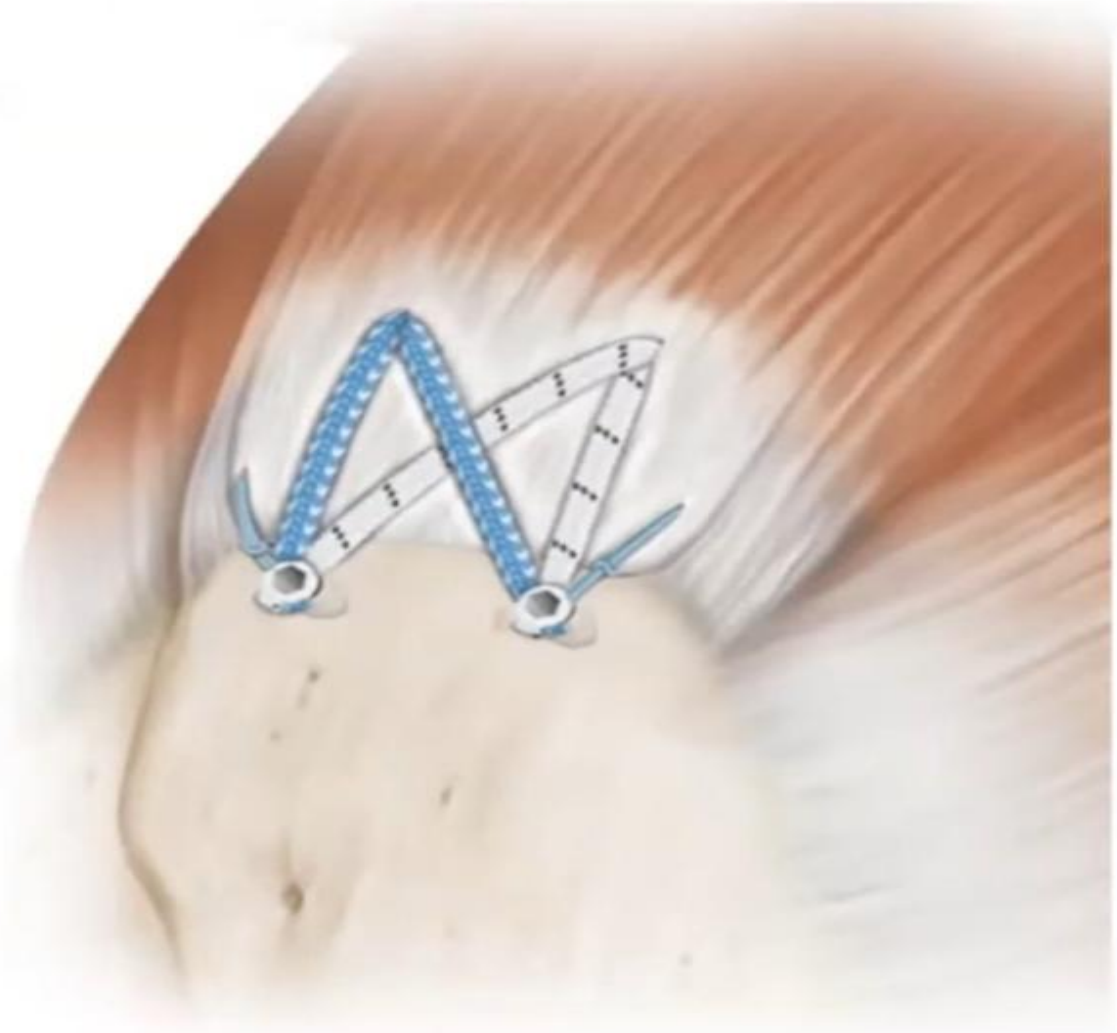
Bursal Side Tear

Full Thickness Tear

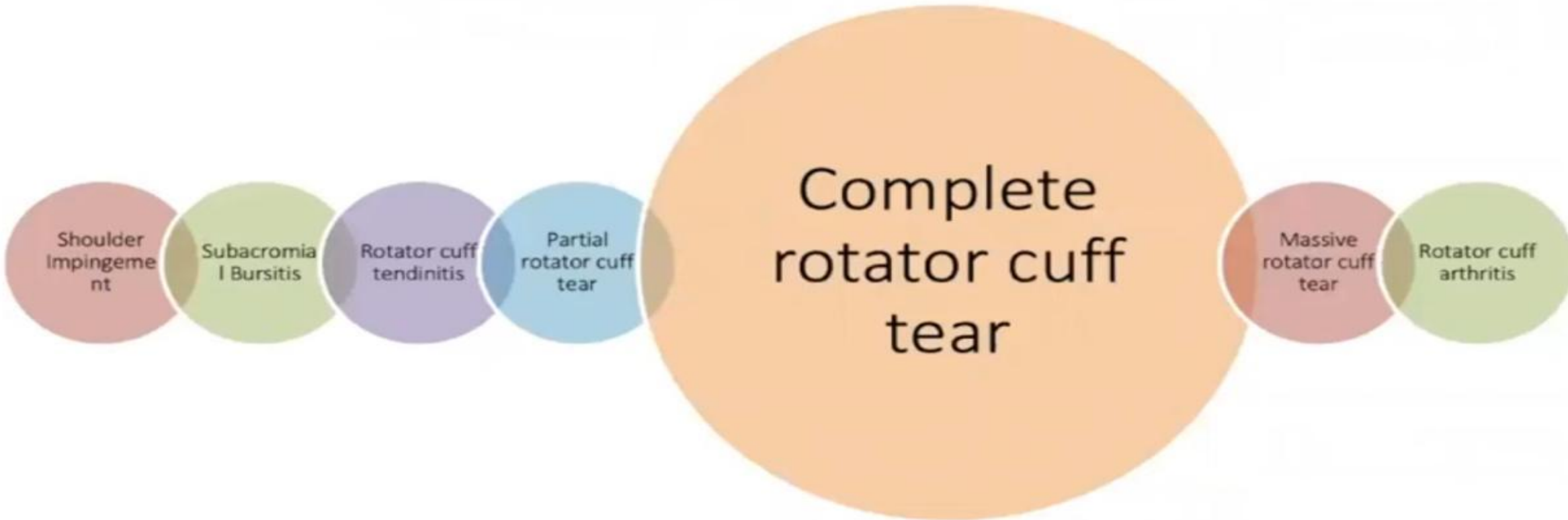


Partial Rotator Cuff Tear

- Treatment
  - Minimum 3-6 months of conservative treatment including PT, injections, activity modification
  - Consider PRP
  - Surgery if symptoms persistent and progressive



Rotator cuff injury spectrum



Classification

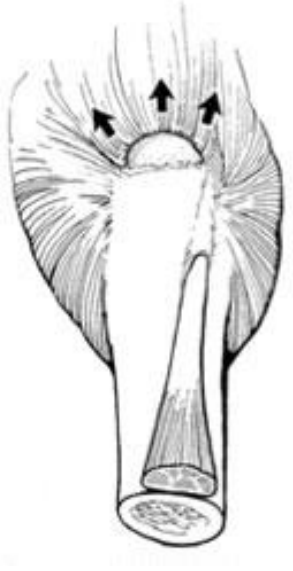
1. Duration: Acute or chronic
2. Degree of tear: Partial or full thickness tear.
3. Etiology: Traumatic or degenerative.
4. Cofield: Based on size of tear.

SIZE OF TEAR	DEGREE
<1 cm	SMALL
1- 3 cms	MEDIUM
3-5cms	LARGE
>5 cms	MASSIVE

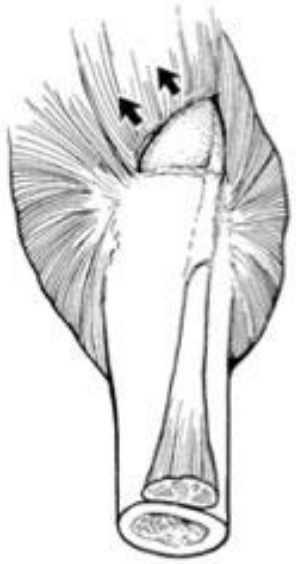
Anatomic Classification		
Supraspinatus, infraspinatus, teres minor (SIT) tears	Make up the majority of tears Associated with subacromial impingement Mechanism is often a degenerative tear in older patients or a shoulder dislocation in patients > 40 yrs.	
Subscapularis tears	New evidence suggests higher prevalence than previously thought Associated with subcoracoid impingement Mechanism is often an acute avulsion in younger patients with a hyperabduction/external rotation injury or an iatrogenic injury due to failure of repair	

Full Thickness Tear

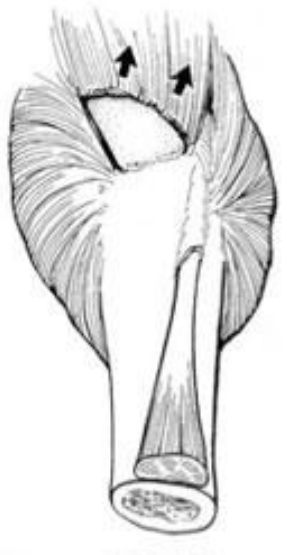
Cuff Tear Shape	
Crescent	Usually do not retract medially, are quite mobile in the medial to lateral direction, and can be repaired directly to bone with minimal tension.
U-shape	Similar shape to crescent but extend further medially with apex adjacent or medial to the rim of the glenoid. Must be repaired side-to-side using margin convergence first to avoid overwhelming tensile stress in the middle of the rotator cuff repair margin.
L-shape	Similar to U shape except one of the leaves is more mobile than the other. Use margin convergence in repair.
Massive & immobile	May be u-shaped or longitudinal. Difficult to repair and often requires and interval slide.



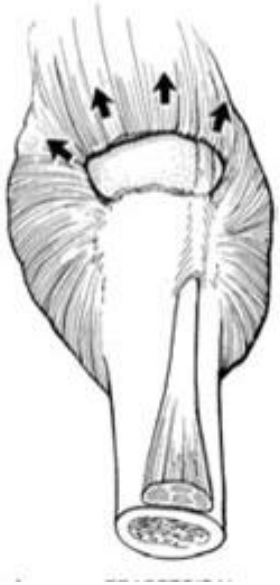
Crescent



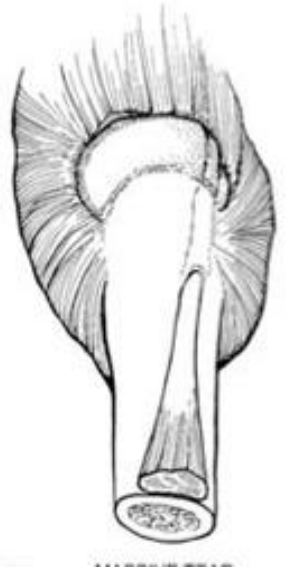
Reverse 'L'



'L' Shaped

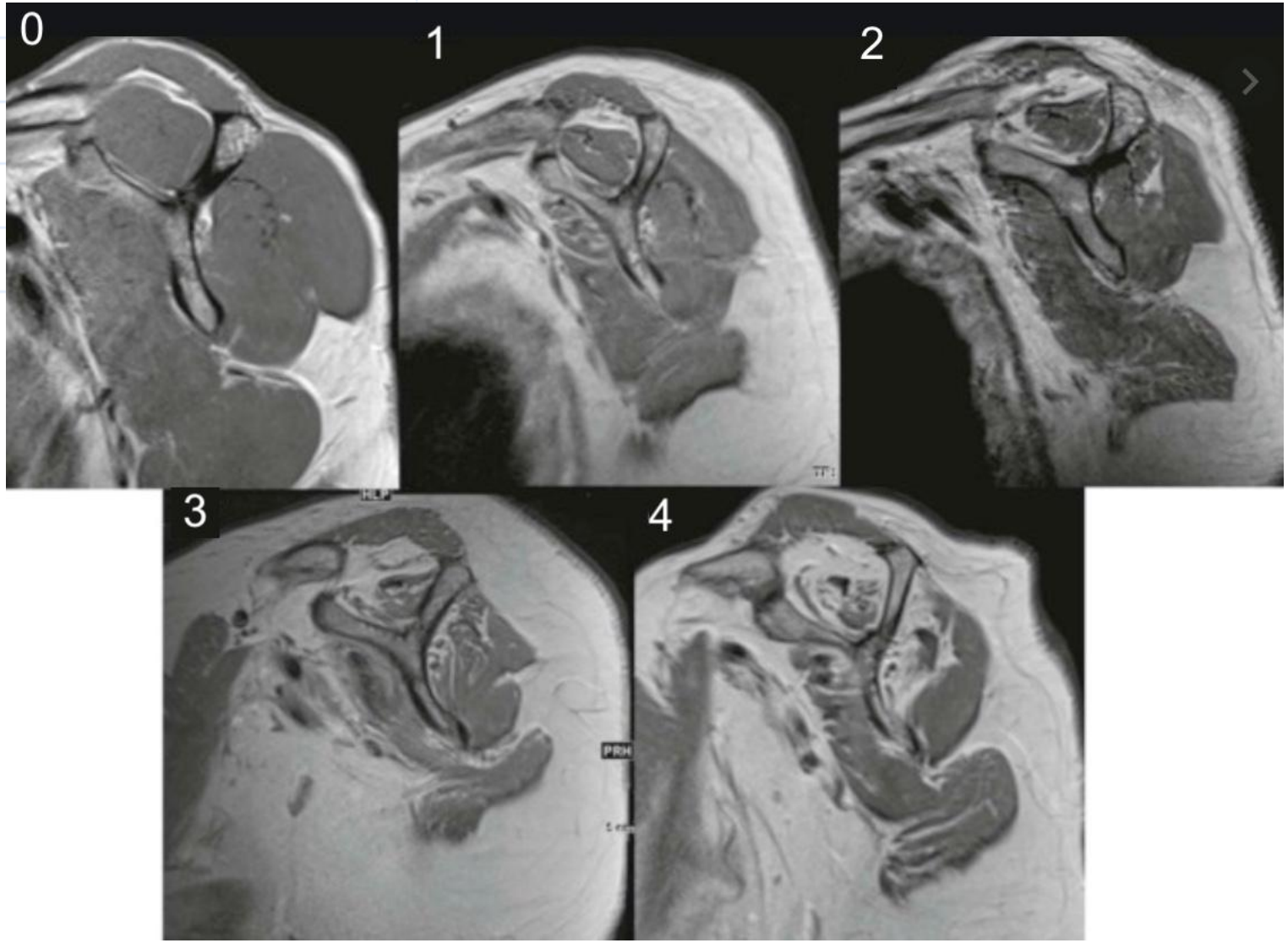


Trapezoidal



Massive tear

Goutallier Classification of Rotator Cuff Atrophy	
0	Normal
1	Some fatty streaks
2	More muscle than fat
3	Equal amounts fat and muscle
4	More fat than muscle



Complete Rotator Cuff Tear

Causes

- Trauma from a fall or lifting heavy objects
- Degenerative in older patients
- Repetitive overhead activities or longstanding impingement

Signs and Symptoms

- Patients with rotator cuff tears have shoulder pain on the side of the tear that is worse with overhead activities
- Patient with rotator cuff tears often have pain at night and pain when sleeping on affected side
- Loss of motion and strength are common in patients with larger tears

Complete Rotator Cuff Tear

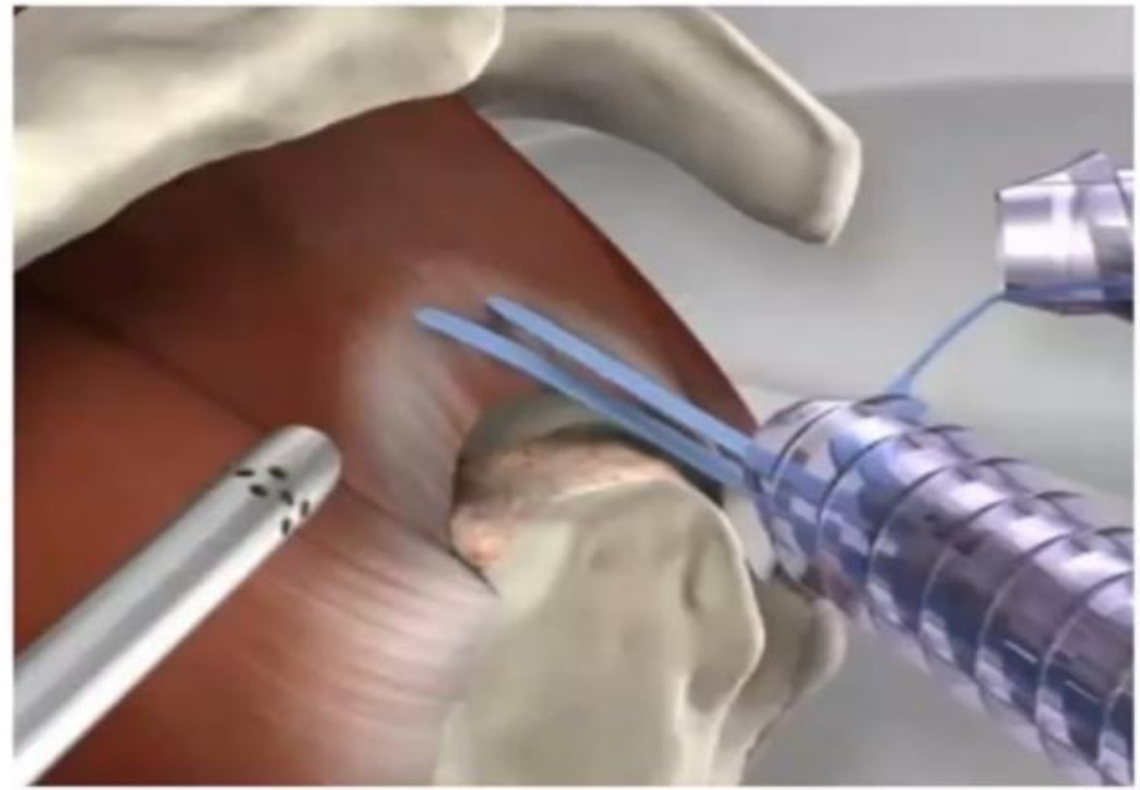
Treatment

- PT
- NSAIDs
- Surgery

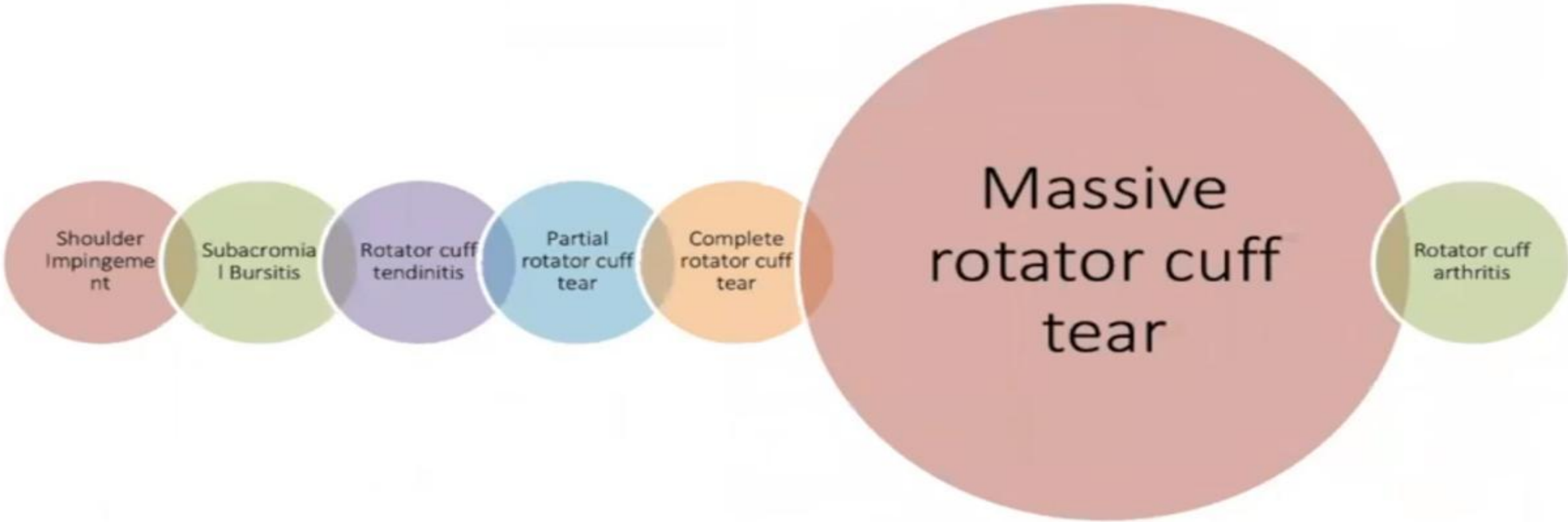
Complete Rotator Cuff Tear

- Complete anatomic repair, when reasonable, should be performed

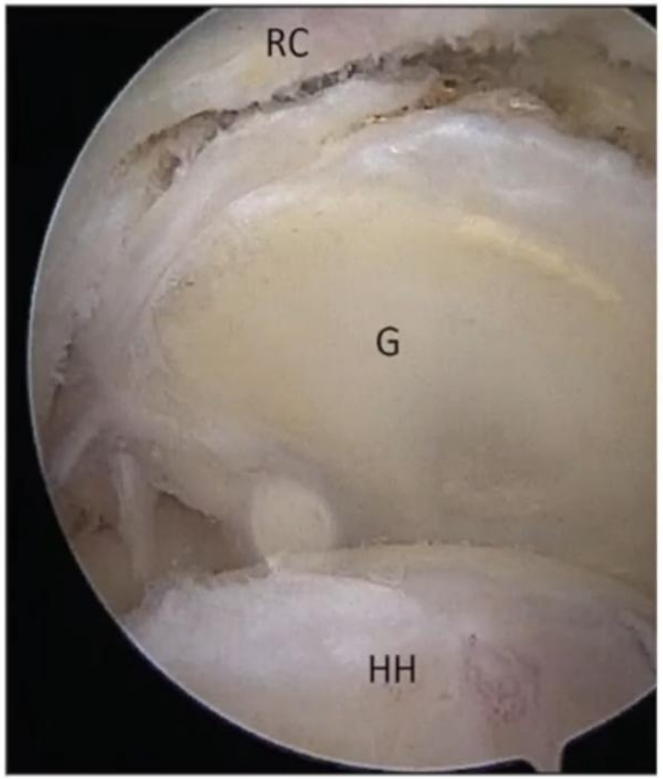
- Goals of Rotator Cuff Repair
  - Restore anatomy
  - Restore biomechanics
  - Strong fixation
  - Promote healing
  - Improve shoulder function



Rotator cuff injury spectrum



- Massive Rotator Cuff Tears are defined as very large tears measuring more than 5 cm maximum diameter or tears involving 2 or more rotator cuff tendons



- Not all massive cuff tears are repairable
- Not all irreparable cuff tears are massive
- At what point does the force couple effect go? :
  - MRCT with a fixed pivot point
  - MRCT with superior migration

Massive RCT

- At 4 year follow up 50% of repairable MRCT progress to irreparable MRCT with conservative treatment[1].
  - Increased fatty infiltration
  - Decreased subaromial distance
  - Increased arthritic changes

1. Zingg PO1, Jost B, Sukthankar A, Buhler M, Pfirrmann CW, Gerber C. **Clinical and structural outcomes of nonoperative management of massive rotator cuff tears.** J Bone Joint Surg Am. 2007 Sep;89(9):1928-34.

MRCT treatment options

- Conservative treatment
- Subarcomial decompression and debridement
- Partial repair and marginal conversion
- Full cuff repair
- Tendon augmentation
- Superior capsular reconstruction
- Subacromial ballon
- Tendon transfers
- Suprascapular nerve ablation
- Arthroplasty

MRCT treatment options

- Conservative treatment[1]:
  - PT, analgesia, injection

- Subarcomial decompression and debridement:
  - Mainly for pain relief
  - Improved function as a secondary gain from pain relief
  - Ability to address the biceps
  - NB beware CAL release

1. Zingg PO1, Jost B, Sukthankar A, Buhler M, Pfirrmann CW, Gerber C. **Clinical and structural outcomes of nonoperative management of massive rotator cuff tears.** J Bone Joint Surg Am. 2007 Sep;89(9):1928-34.

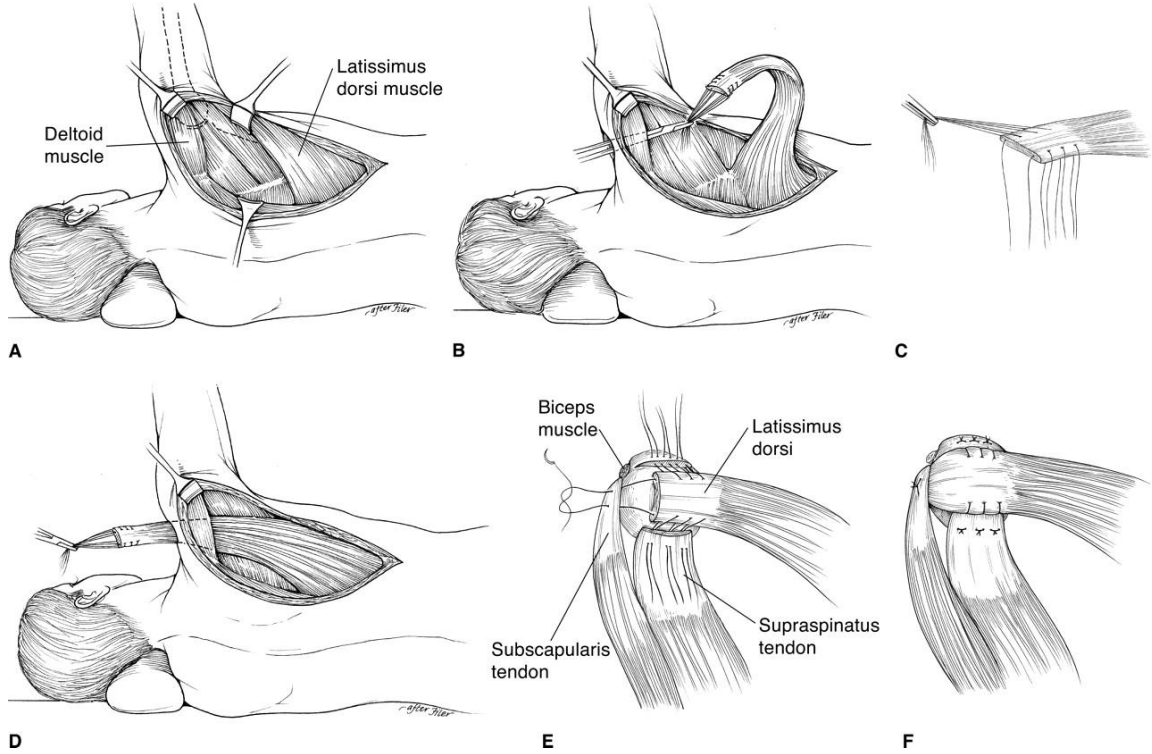
MRCT treatment options

- Partial repair and marginal conversion:
  - Suitable when half the infraspinatus is repairable to bone
  - Each suture as part of partial closure decreases the tension
  - Not a substitute for full repair

- Full cuff repair

MRCT – tendon transfers

- Latissumus Dorsi transfer
  - Long recovery period (6-9 months), technically demanging, risk of rupture
  - Slightly better results when performed as a primary procedure compared to revision[1]:
    - Better functional scores
    - Rupture rate 17% vs 44%



1. Warner JJ1, Parsons IM 4th. **Latissimus dorsi tendon transfer: a comparative analysis of primary and salvage reconstruction of massive, irreparable rotator cuff tears.** J Shoulder Elbow Surg. 2001 Nov-Dec;10(6):514-21.

MRCT – tendon transfers

- Pectoralis major transfer (30 pt study[1]):
  - Useful for subscapularis ruptures
  - Over vs under conjoint transfer
  - Total or split tendon transfer
  - Better results for isolated tears with intact supraspinatus and infraspinatus tears

- Deltoid flap reconstruction:
  - Posterosuperior tears
  - poor results.

1. Jost B1, Puskas GJ, Lustenberger A, Gerber C. **Outcome of pectoralis major trar for the treatment of irreparable subscapularis tears.** J Bone Joint Surg Am. 20(Oct;85-A(10):1944-51.

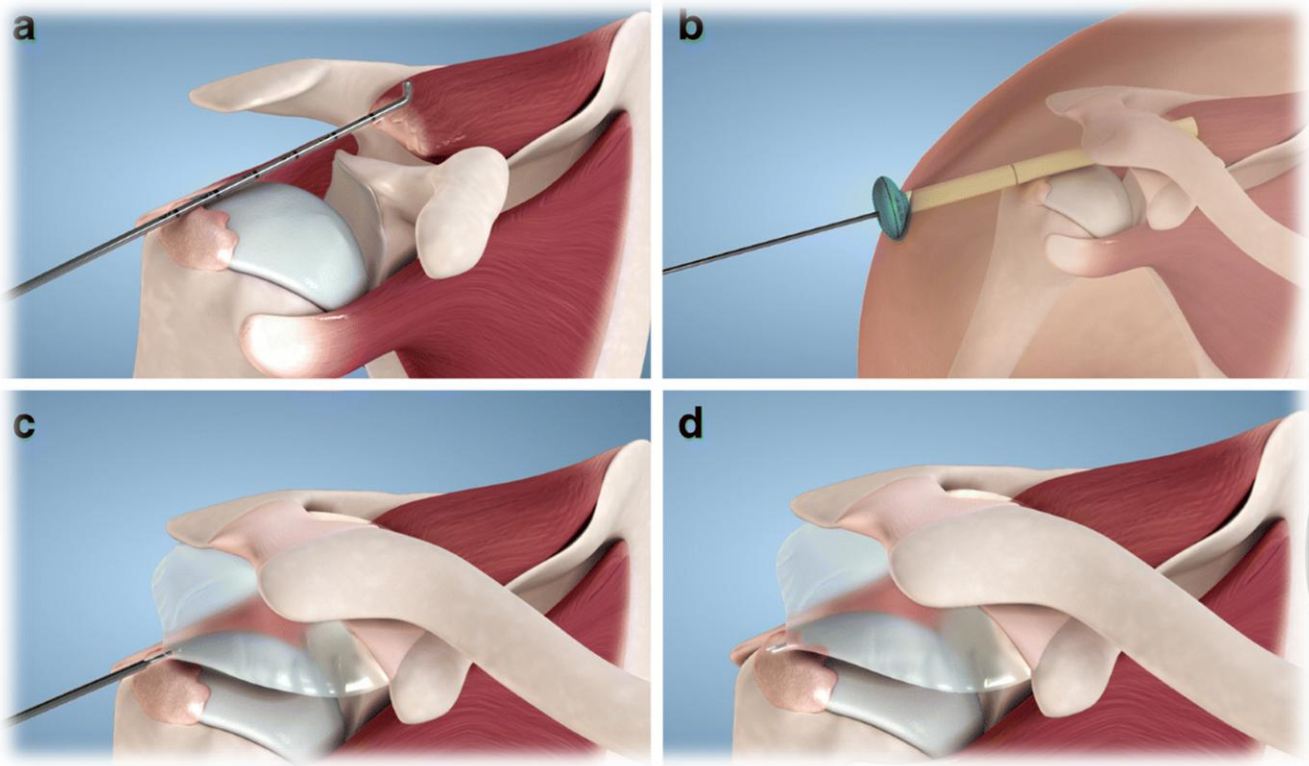
End-stage MRCT – Arthroplasty

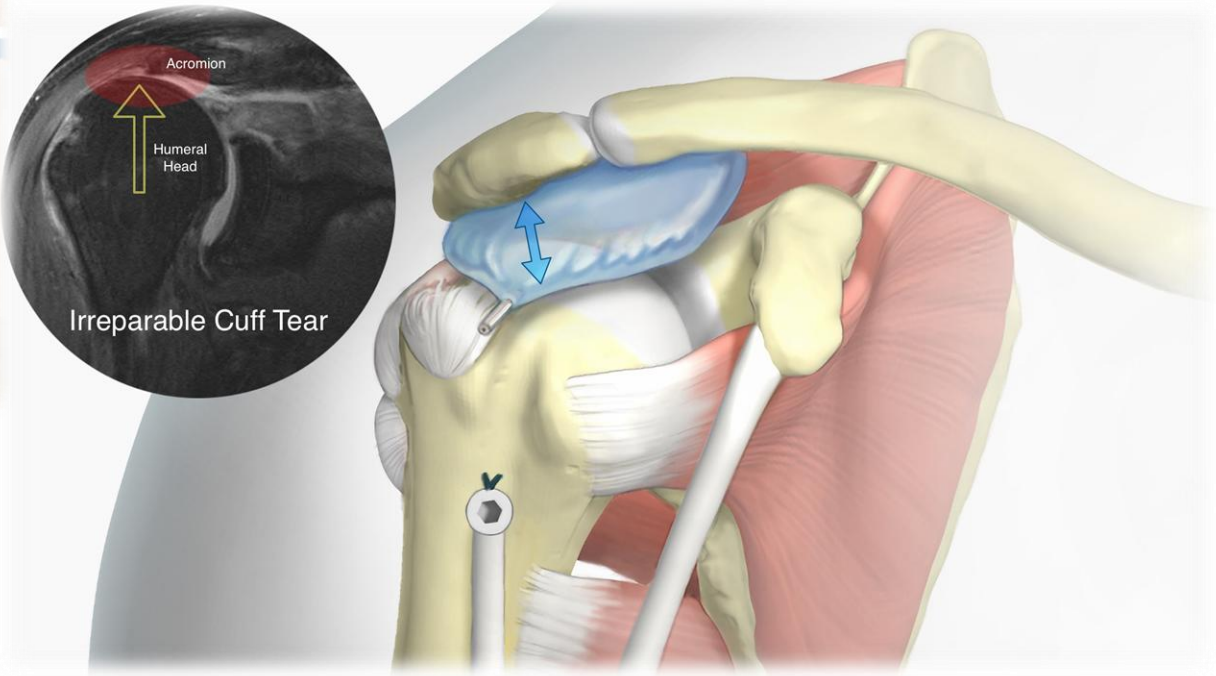
Biologic Augmentation

- External Collagen Matrix:
    - Porcine intestines
    - Porcine dermal
    - Human cadaver dermal
  - All small studies with no comparative RCT's
  - Limited role for partial cuff repairs
  - Less morbidity than tendon transfers
- PRP:
  - No evidence of any benefit in RCT[1].

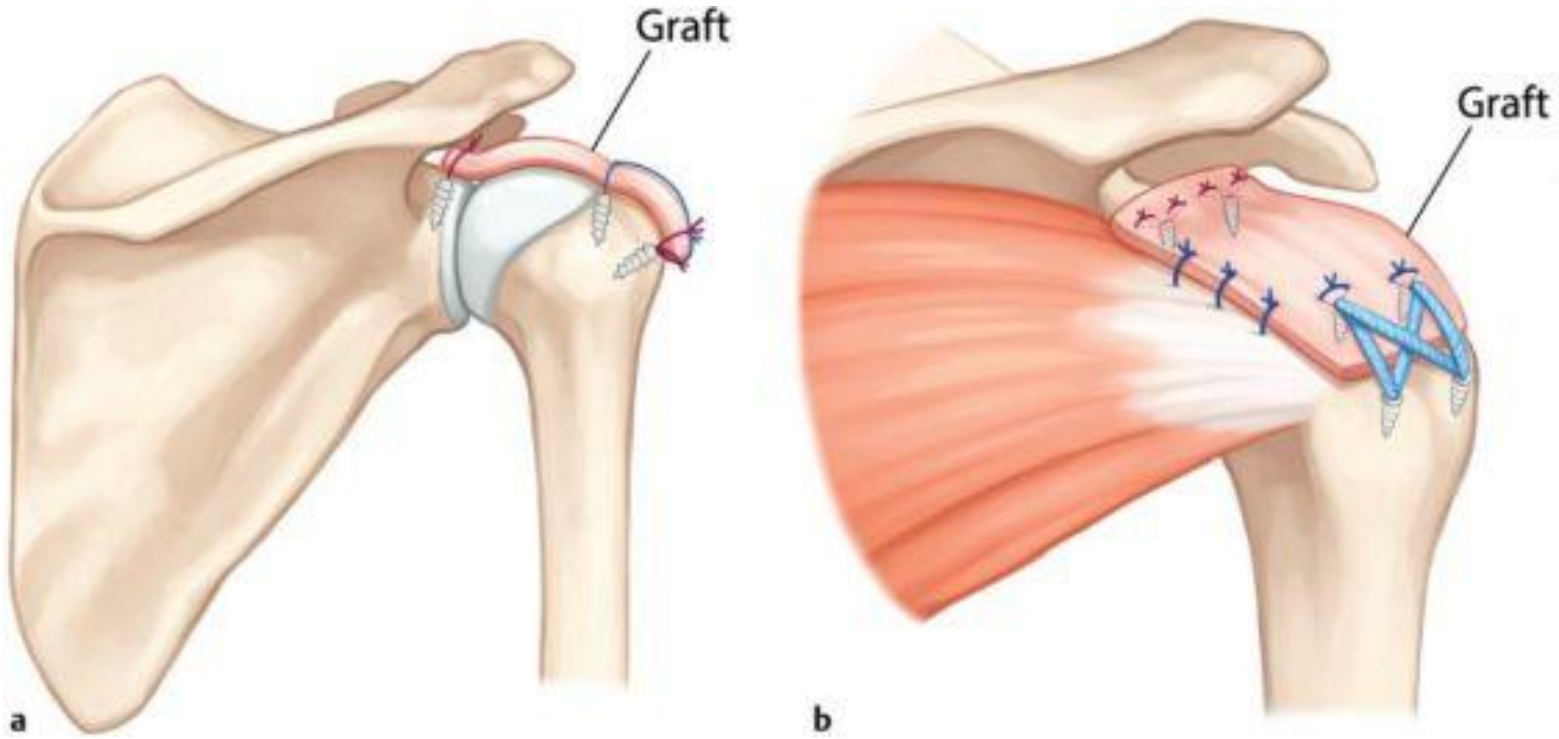
1. Castricini R1, Longo UG, De Benedetto M, Panfoli N, Pirani P, Zini R, Maffulli N, Denaro V. **Platelet-rich plasma augmentation for arthroscopic rotator cuff repair: a randomized controlled trial.** Am J Sports Med. 2011 Feb;39(2):258-65. doi: 10.1177/0363546510390780. Epub 2010 Dec 15.

Subacromial balloon spacer

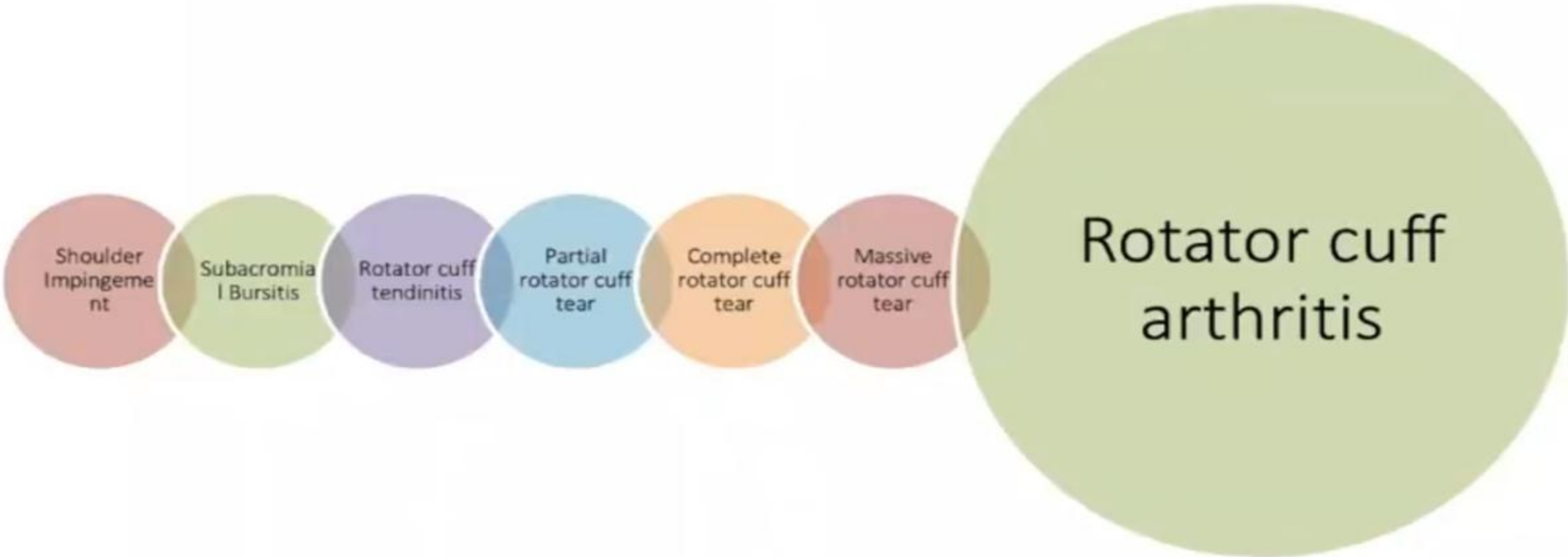




Superior capsule reconstruction

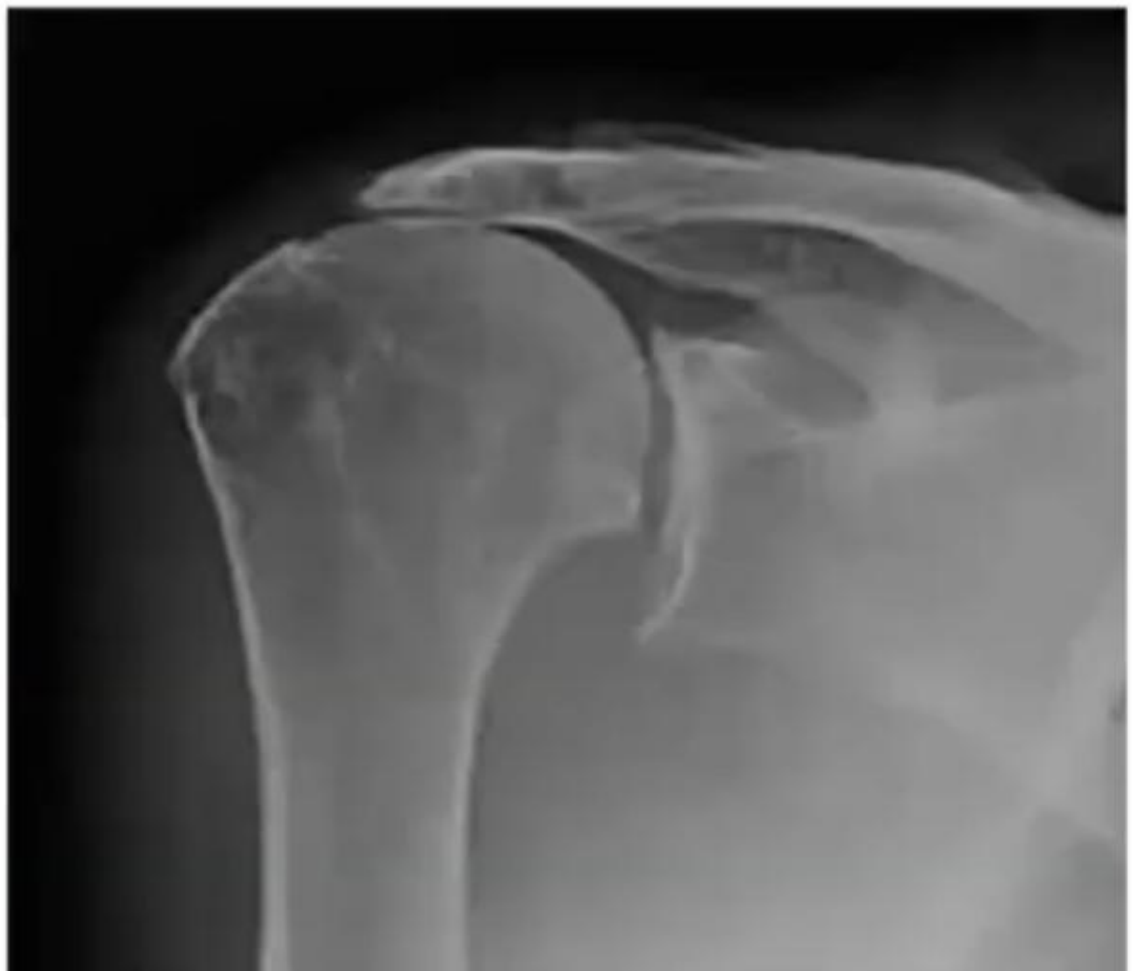


Rotator cuff injury spectrum

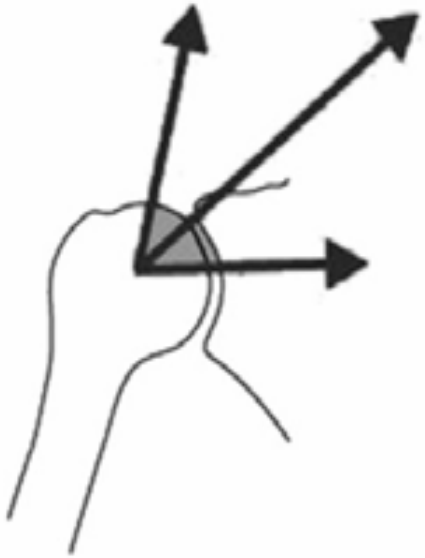


Rotator Cuff Arthritis

- Rotator cuff arthropathy occurs when a patient has a chronic large rotator cuff tear that leads to abnormal shoulder mechanics and gradual cartilage loss

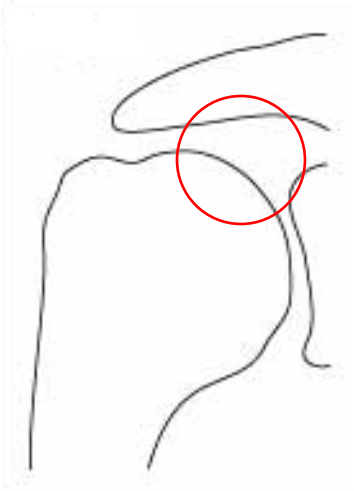


PATHOLOGY



Torn Rotator Cuff

Can not Counterbalance the upward pull of the deltoid on the humerus

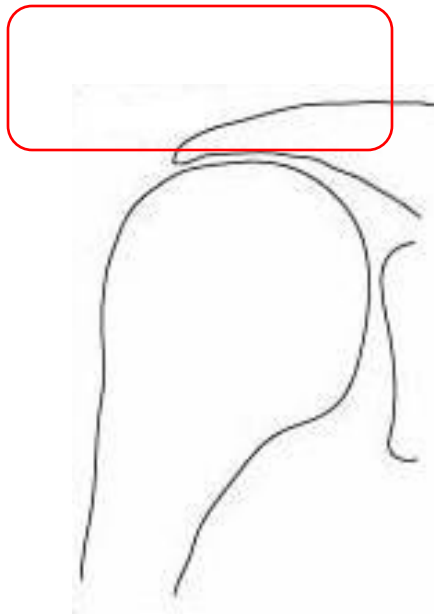


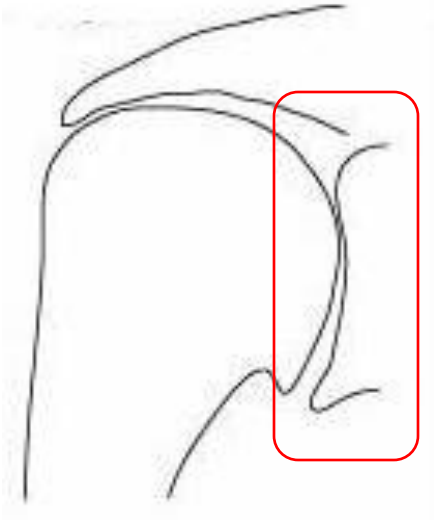
Not able to Hold the head of the humerus secure in the glenoid

AHD <6mm

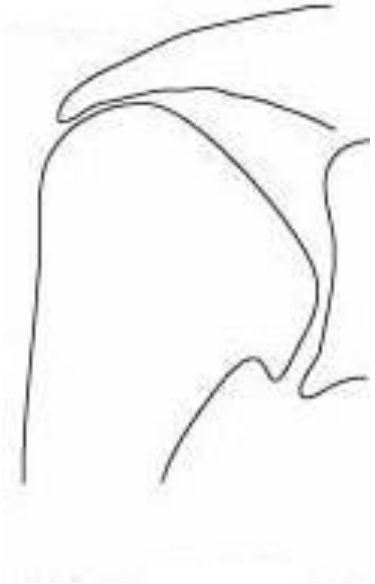
Leads to abutement of humeral head against acromion

Acetabulization: Concave deformity of under surface of Acromion





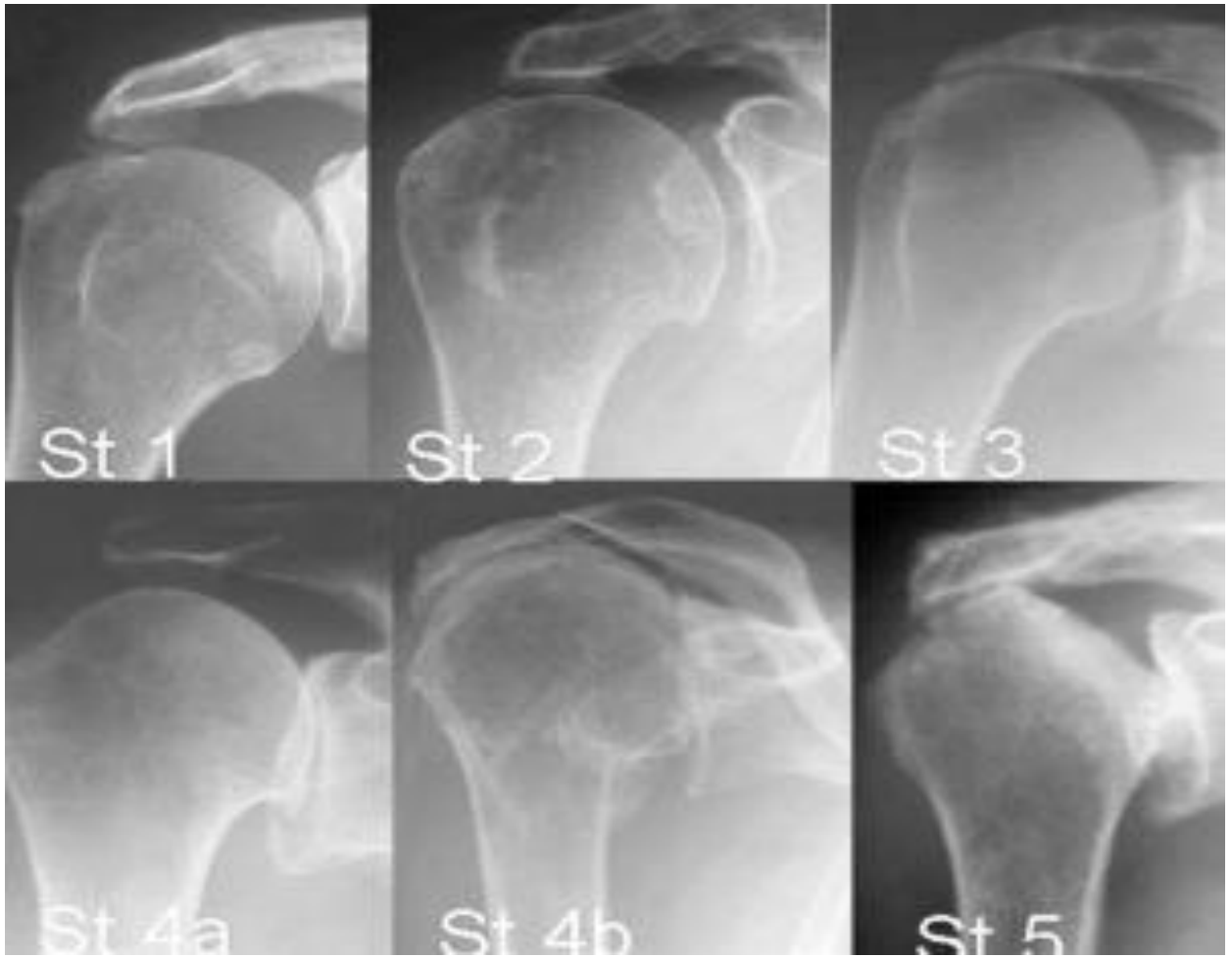
Narrowing & Arthritis
of Gleno-Humeral Joint



Last stage of Cuff tear
arthropathy with collapse of
humerus head

Hamada and Fukuda Stages of Cuff Arthropathy

Grade 1	Acromiohumeral distance >6 mm
Grade 2	Acromiohumeral distance <6 mm
Grade 3	Grade 2+acetabulizatino of acromion
Grade 4	Grade 3+evidence of glenohumeral arthritis
Grade 5	Grade 4+humeral head collapse



Rotator Cuff Arthritis

- Pain from bone-on-bone rubbing within the joint is the most common symptom of rotator cuff arthropathy
- At first the pain may come and go, but it tends to increase with time, usually over several years. Movement usually adds to the discomfort
- The pain is commonly present at night and interferes with sleep. There may or may not be pain at rest
- Loss of motion is another common symptom

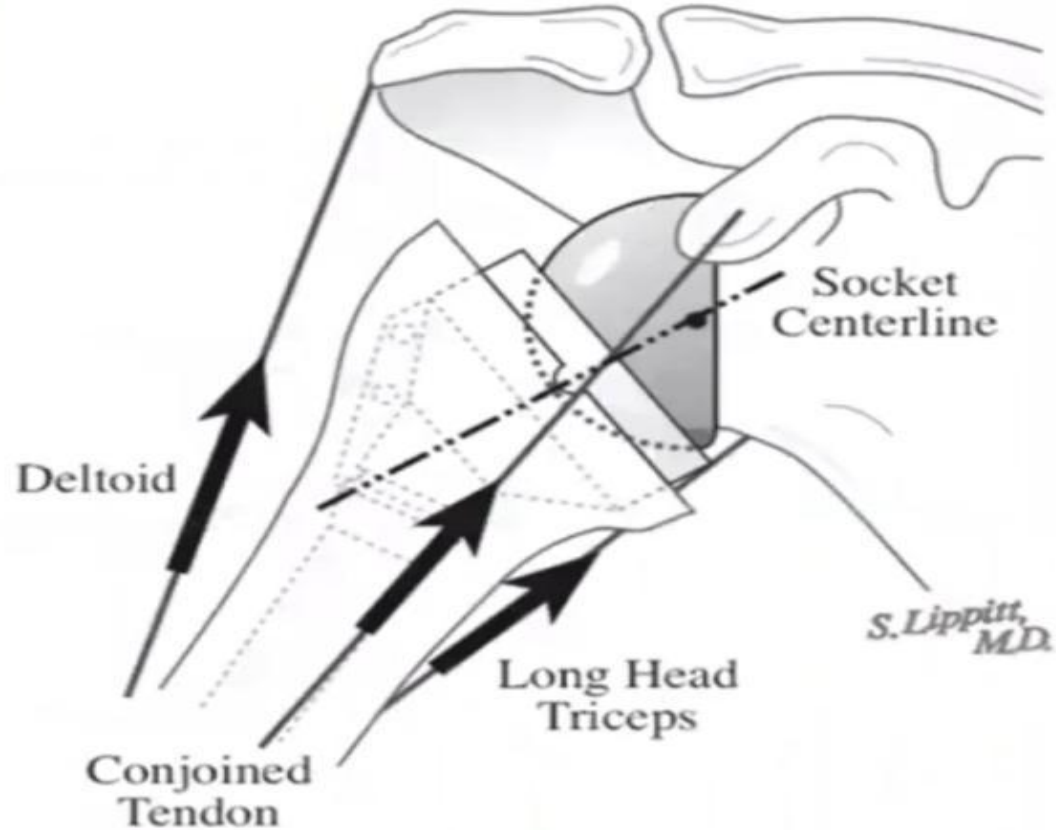
Rotator Cuff Arthritis

TREATMENT

- Reverse shoulder replacement is a safe and effective treatment option in patients with rotator cuff arthropathy
- It is done by removing the arthritic humeral head (ball) and glenoid (socket) and replacing with alloy metal and highly crosslinked polyethylene (plastic) components with the goal of decreasing pain and improving function

Reverse Shoulder Replacement

- A reverse shoulder replacement utilizes the deltoid to compensate for a deficient rotator cuff
- Patients with rotator cuff arthritis or chronic, massive rotator cuff tears can achieve predictable, often excellent clinical results with a reverse shoulder replacement



There is a cuff tear, I must fix it…"?

- ¼ of the population will have asymptomatic cuff tears at post mortem
- 50% of asymptomatic partial thickness cuff tear become symptomatic by 2.8 years[1]
- Some patients can have good function despite an absent cuff, particularly in the elderly
- Bilateral tears are common
- Progression over 5 years[2]:
  - FTCT, PTCT and control groups
  - 49% tear enlargement
    - 61% in FTCT
    - 44% PTCT
    - 14% in controls
  - 46% new pain
  - An enlarging tear is significantly associated with pain and fatty degeneration

1. Deutsch A1. **Arthroscopic repair of partial-thickness tears of the rotator cuff.** J Shoulder Elbow Surg. 2007 Mar-Apr;16(2):193-201. Epub 2006 Nov 16.
2. Keener JD1, Galatz LM1, Teefey SA2, Middleton WD2, Steger-May K3, Stobbs-Cucchi G1, Patton R1, Yamaguchi K **A prospective evaluation of survivorship of asymptomatic degenerative rotator cuff tears.** J Bone Joint Surg Am. 2015 Jan 21;97(2):89-98. doi: 10.2106/JBJS.N.00099.

FTRCT- Open/mini open vs Arthroscopic

- UKUFF trial:
  - Multicenter trial of 474 patients
  - No difference at 2 years
  - Similar overall costs
  - Yet to peer review publish final findings
- Systemic review[1]:
  - No significant difference in outcome or complications @ 24 months

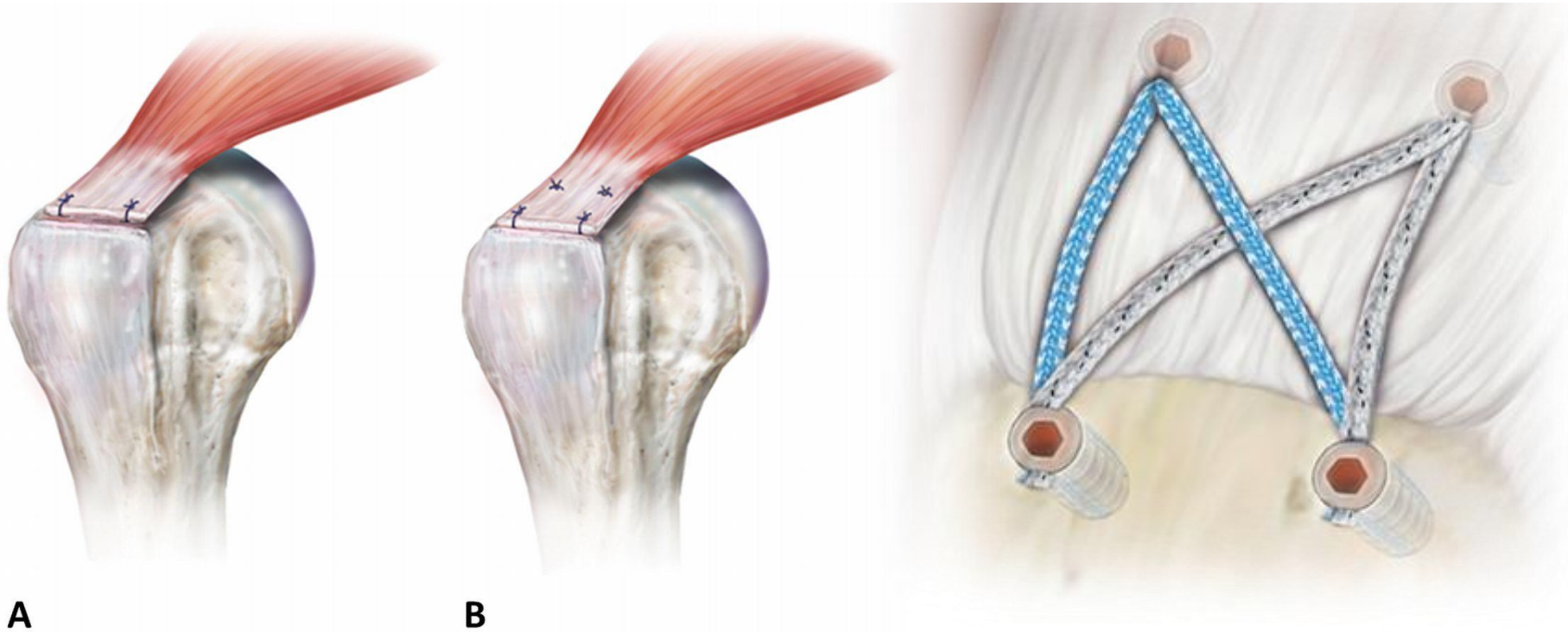
1. Nho SJ1, Shindle MK, Sherman SL, Freedman KB, Lyman S, MacGillivray JD. **Systematic review of arthroscopic rotator cuff repair and mini-open rotator cuff repair.** J Bone Joint Surg Am. 2007 Oct;89 Suppl 3:127-36.

FTRCT – Single Vs Double Row vs Suture bridge

- Originally transosseous techniques were used
- Anchor subsequently introduced & constantly changing anchor and suture technology

- Large metaanalysis 9 studies[1]:
  - DR was significantly better in terms of outcome, re-tear, IR
  - Difference was greatest in tears >3cm
- Large metaanalysis 32 studies[2]:
  - DR and SB significantly better thatn SR
  - No difference between DR and SB

1. Caiqi Xu, MD, Jinzhong Zhao, MD, Dingfeng Li, MD. Meta-analysis comparing single-row and double-row repair techniques in the arthroscopic treatment of rotator cuff tears. **February 2014Volume 23, Issue 2, Pages 182–188**
2. Joel Hein, M.D.[a], Jordan M. Reilly, M.S.[b], Jonathan Chae, M.D.[a], Tristan Maerz, Ph.D.[b,*], Kyle Anderson, M.D.[a] Retear Rates After Arthroscopic Single-Row, Double-Row, and Suture Bridge Rotator Cuff Repair at a Minimum of 1 Year of Imaging Follow-up: A Systematic Review. Arthroscopy: The Journal of Arthroscopic & Related Surgery. Available online 15 July 2015


A
B

Re-tear rates

- Lower re-tear rates in patients under 60[1]
- 2 failure mechanisms:
  - Unhealed footprint
  - Medial tendon failure
- Tear size and age is the greatest predictive factor[2]
  - PTRCT 5%
  - FTRTC 27%

- Re-tears are not necessarily clinically significant

[1] Lichtenberg S1, Siebold R, Habermeyer P. **Arthroscopic supraspinatus tendon repair using suture anchors and a modified Mason-Allen technique: an intra-articular approach.** Arthroscopy. 2004 Nov;20(9):1007-11.

[2] Le BT1, Wu XL, Lam PH, Murrell GA. **Factors predicting rotator cuff retears: an analysis of 1000 consecutive rotator cuff repairs.** Am J Sports Med. 2014 May;42(5):1134-42. doi: 10.1177/0363546514525336. Epub 2014 Apr 18.

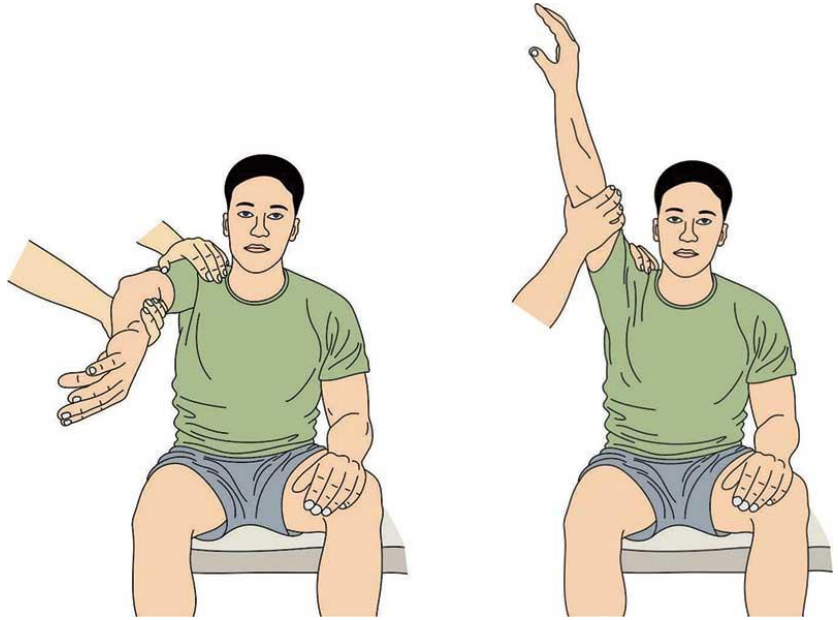

History
Investigation
Diagnosis
Examination

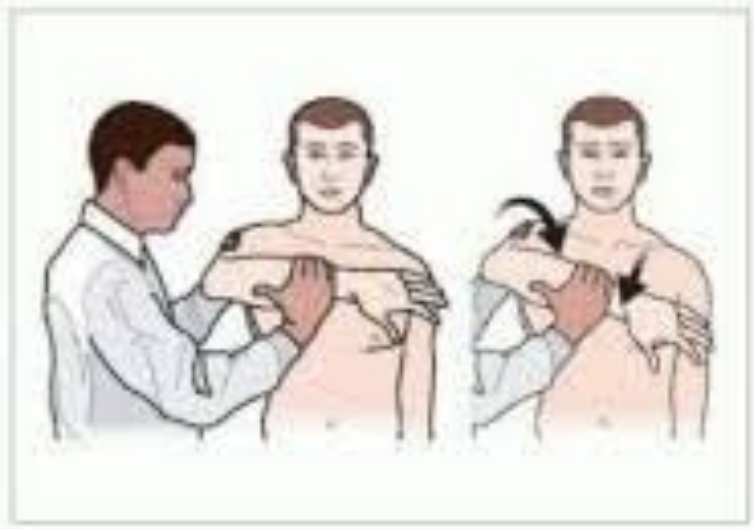
Differential Diagnosis

- Cervical spondylosis (C5 and C 6)
- Brachial plexopathy /suprascapular nerve
- Traction injuries
- Suprascapular nerve entrapment
- Fractures
- Frozen shoulder
- Snapping scapula syndrome
- ACJ OA

Provocative tests - Impingement

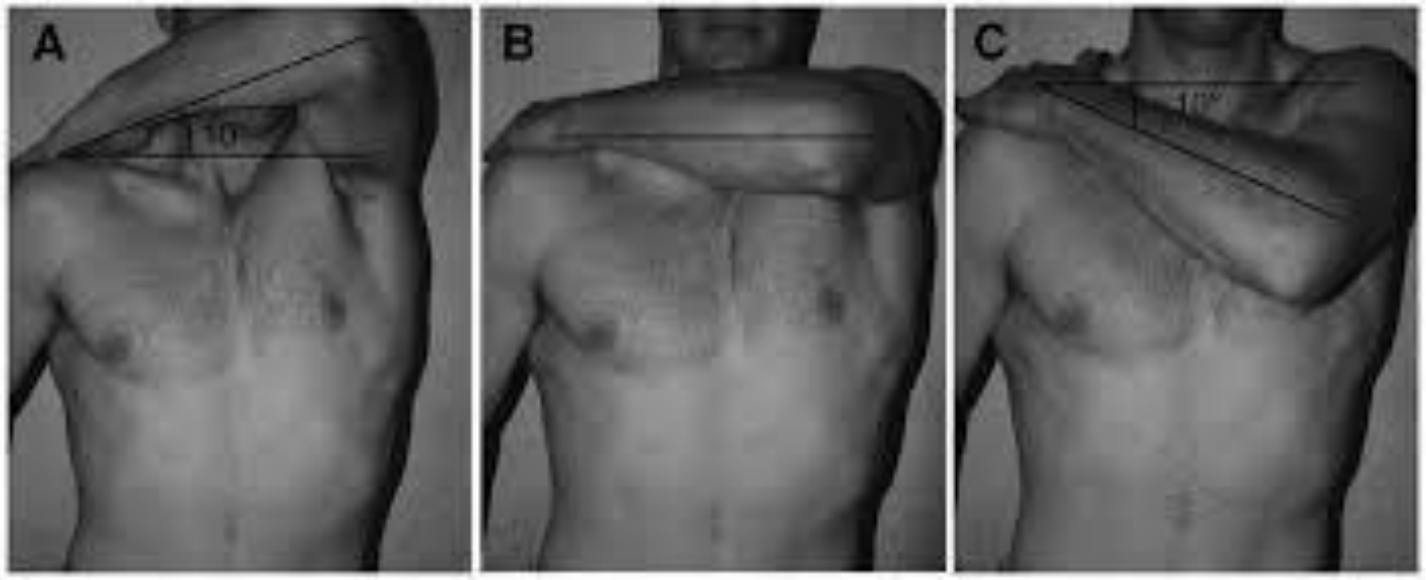
- Neer Impingement Sign
- Neer Impingement Test
- Hawkins Test
- Internal Impingement test





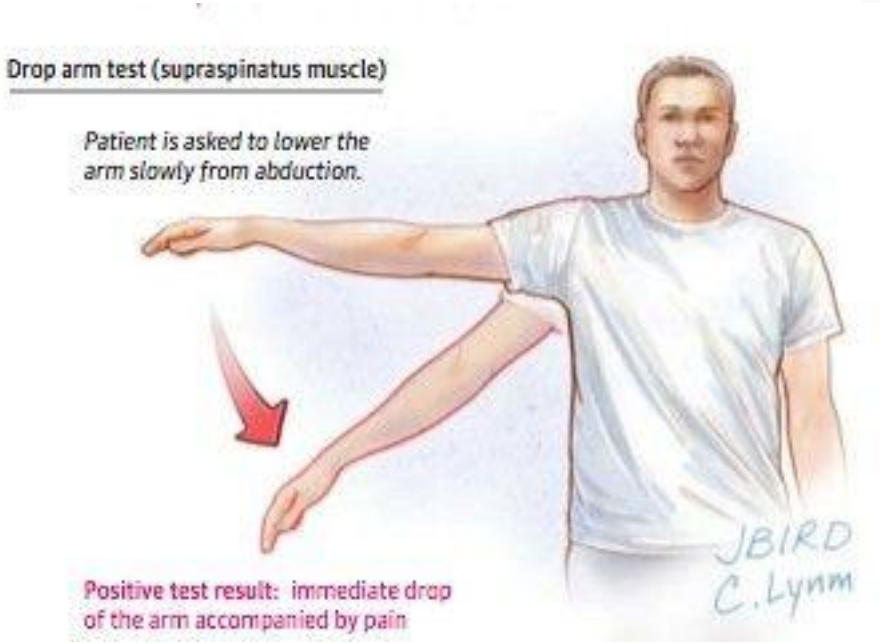
Provocative tests - Rotator Cuff Pathology

- Subscapularis Tests
  - Subscapularis Strength
  - Internal Rotation Lag Sign
  - Increased Passive ER
  - Lift Off Test
  - Belly Press
  - Bear Hug



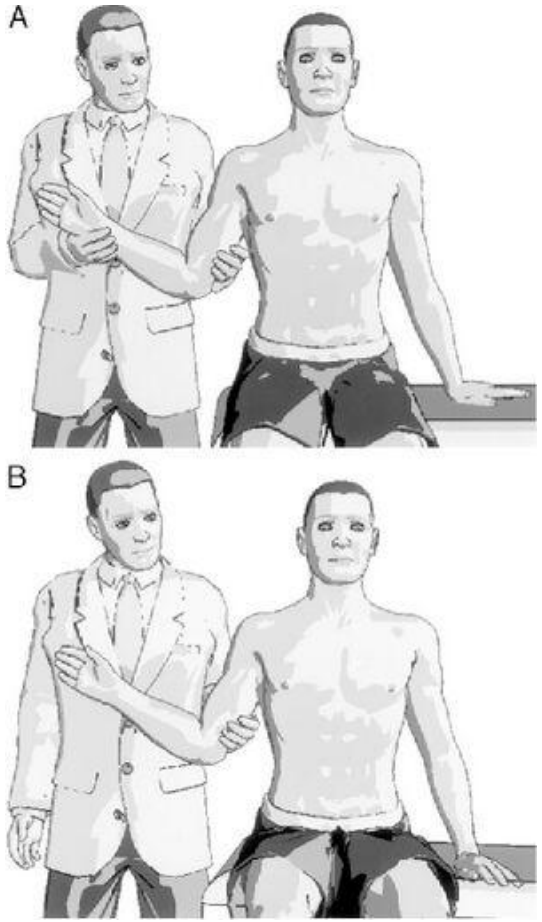
Supraspinatus Tests

- Supraspinatus Strength
- Jobe's Test (empty can test)
- Drop Sign



Infraspinatus test

- Infraspinatus Strength
- External Rotation Lag Sign



Teres Minor

- Teres Minor Strength
- Hornblower's sign

Take home message

- Rotator cuff pathology follows an expected spectrum of issues.
- Impingement, bursitis and tendonitis usually conservative with PT, NSAID.
- Complete tear, massive tears and arthropathy treated surgically or conservatively according to the patient symptoms and conditions.
- PRP is an evolving treatment option for inflammation.
- RSA is the final treatment option for Massive RCT or arthropathy.