МРТ: РОТАТОРНАЯ МАНЖЕТА ПЛЕЧЕВОГО УСТАВА

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MRI OF THE ROTATOR CUFF

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Rotator cuff disease

- Common cause of shoulder pain and dysfunction
- Prevalence of RC tears in general population: 5-39%
- Increases with age
- Exact cause and best treatments still are being explored

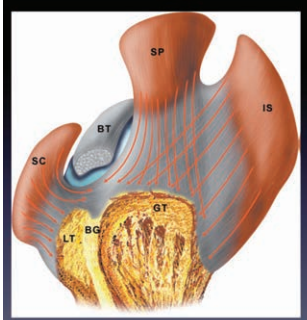
Sports with increased frequency of shoulder injuries

- Baseball pitchers
- Tennis
- Volleyball
- Javelin throwing
- Swimmers
- Non-throwing sports: direct trauma

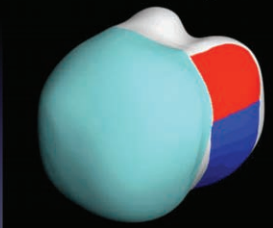
Resulting injuries

- Rotator cuff impingement and tear
- SLAP lesions
- Bankart lesions and variants
- Hill Sachs
- Capsulo ligamentous lesions
- Instability, pain, decreased athlete performance

Anatomy



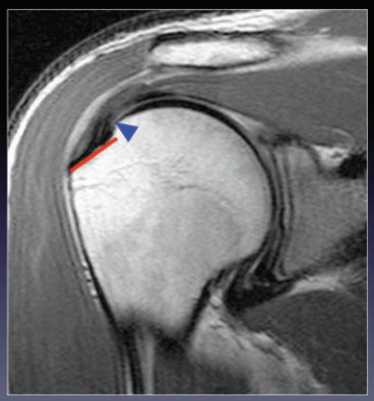
Rotator cuff footprint

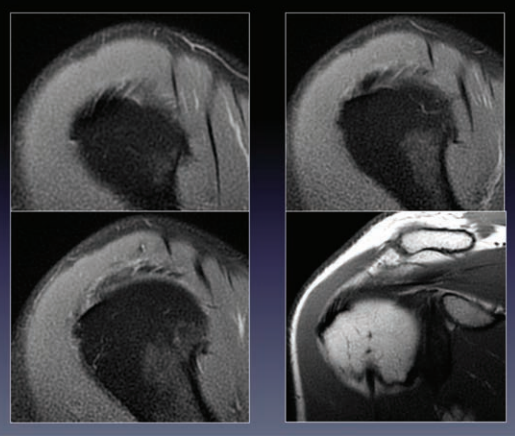


Tendons splay out and interdigitate to form a continuous cuff

Supraspinatus
Infraspinatus

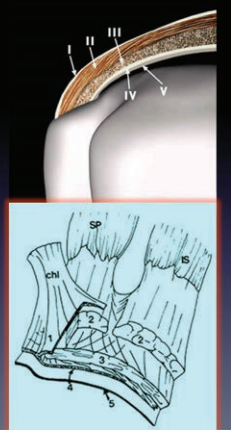
Rotator cuff footprint Articular cartilage

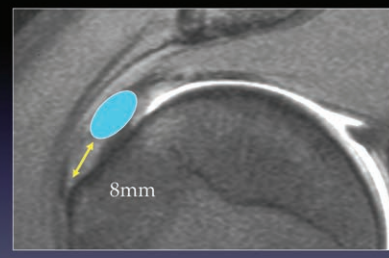




Anatomy: Five layers

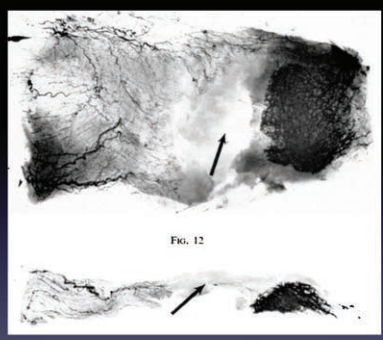
I: Coracohumeral ligament
II: Rotator cuff tendons
III: Deep tendon layer
IV: Perpendicular collagen fibers and deep band of CHL:
Transverse band
Rotator cable
Pericapsular band
V: Shoulder Capsule



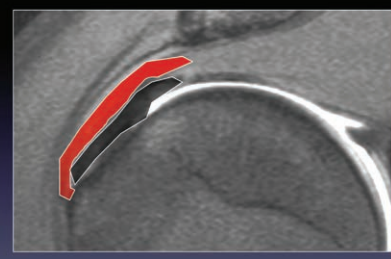


The "Critical Zone"

Codman, 1934



The microvascular pattern of the rotator cuff.
Rathburn JB, McNabb I
JBJS 1970; 52B:540

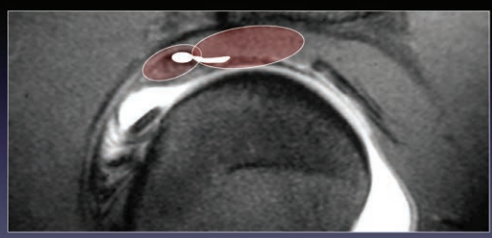


Decreased vascularity articular side fibers

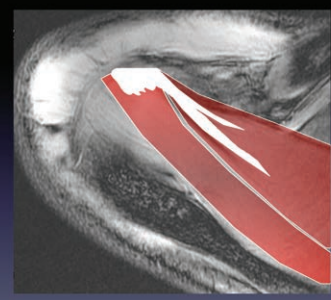
Uhthoff, Loehr, 1986

Anterior and Posterior Musculotendinous Anatomy of the Supraspinatus

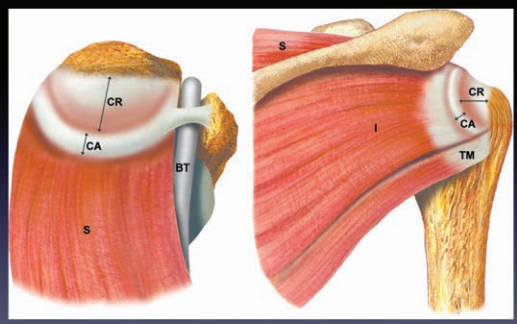
Anterior belly Posterior belly



Anterior and Posterior Musculotendinous Anatomy of the Supraspinatus



Anterior tendon stress>Posterior



Cable and Crescent

Burkhart et al. Arthroscopy 1993;9:611-616

Rotator Cable:

Deep fibrous extension of the coracohumeral ligament
Thickening of the cuff (From biceps to TM)

Rotator Crescent:

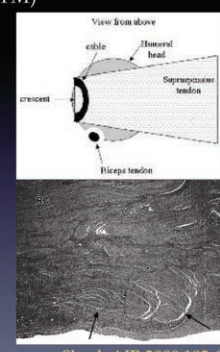
Thinner cuff tissue medial to cable
(Poor blood supply)

Bursal side:

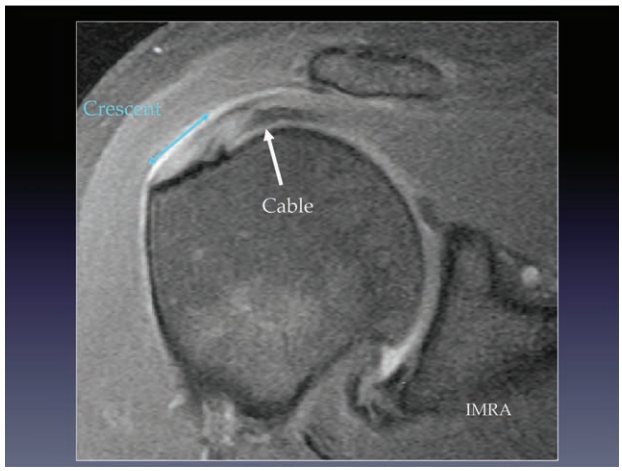
-Thicker collagen bundles
-Parallel orientation
-Greater tensile strength

Articular side:

-Thinner
-More random orientation
-50% less tensile strength

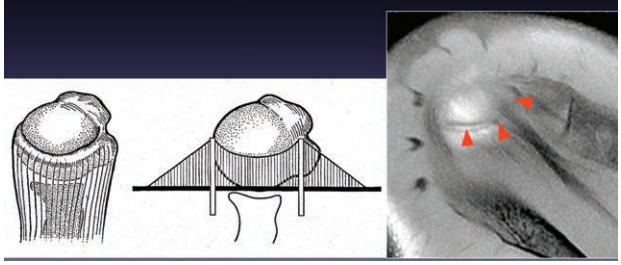


Sheah AJR 2009 193:679



Rotator Crescent and Cable

Configuration compared to the appearance of a suspension bridge.
Cable: 2.6 times thicker than crescent
Most RC tears tend to occur in the crescent



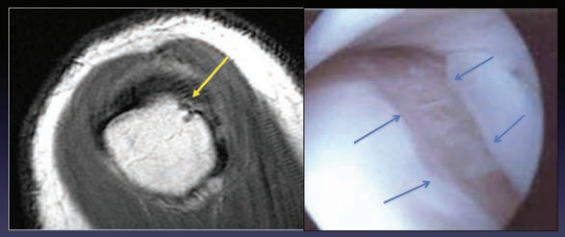
Cable dominant

- Older patients
- Stress of the crescent by tha cable
- Crescent is not under tension
- Crescent tears may not be biomechanically significant
- Tears in the cable are biomechanically important

Crescent dominant

- Younger patients
- No stress of the crescent by the cable
- Aging transition from crescent dominant to cable dominant pattern as the crescent begins to thin and the cable asume increasing loads

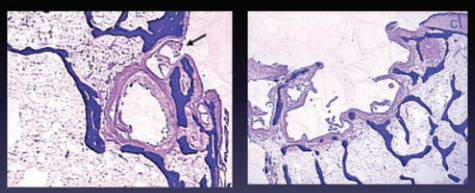
Bare Area (De Palma)



Posterosuperior humeral head
Not covered by cartilage
Increases with age
Frequent site for cyst formation

Cystic Lesions in the Posterosuperior Portion of the Humeral Head on MR Arthrography: Correlations with Gross and Histologic Findings in Cadavers

Jin et al. *AJR* 2005; 184:1211-1215



Normal variant rather than being an abnormal change or vascular channel.

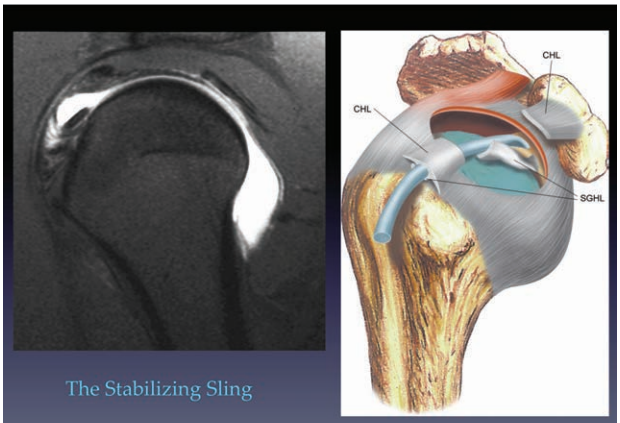
Biomechanics

A. Passive (Static) Stabilizing Mechanisms

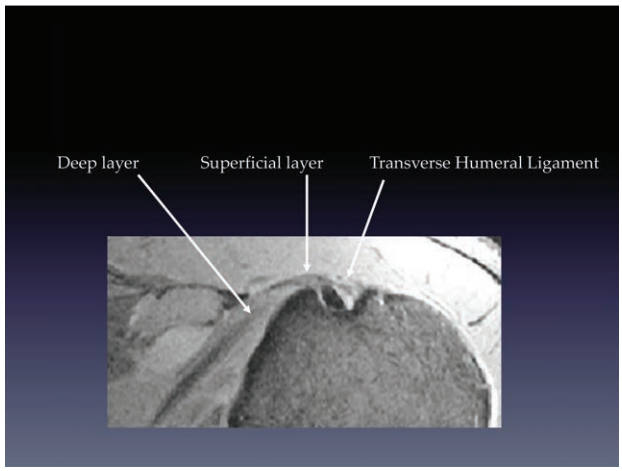
- Size, shape and tilt of the glenoid fossa
- Negative intracapsular pressure
- Adhesion and cohesion of articular surfaces
- Capsulolabral ligamentous complex

B. Active (Dynamic) Stabilizing Mechanisms

- Long Head of Biceps Tendon
- Rotator Cuff



The Stabilizing Sling



Rotator Cuff Biomechanics

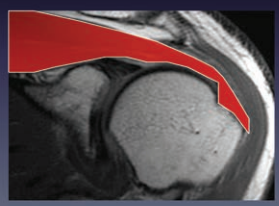
- Shoulder motion
  - Glenohumeral joint
  - Scapulothoracic "joint"
  - Acromioclavicular joint
  - Sternoclavicular joint

Scapulothoracic Coordination

- Synchronization with:
  - Latissimus dorsi
  - Pectoralis major
  - Serratus anterior
- 2:1 glenohumeral/scapulothoracic motion during abduction

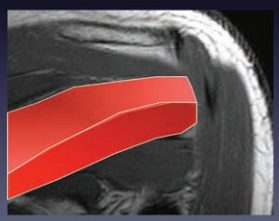
Supraspinatus muscle

- Initiates abduction and external rotation
- Maintains power during abduction like the deltoid



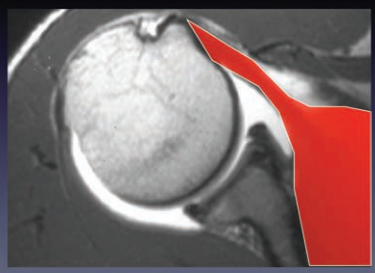
Infraspinatus and Teres Minor muscles

- External rotation
  - Infraspinatus acts wit the arm in neutral position
  - Teres minor acts with the arm in 90^0 of abduction



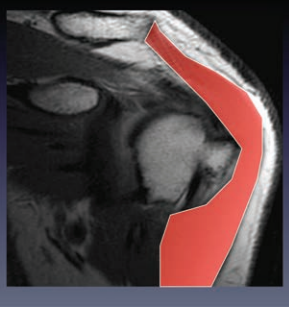
Subscapularis muscle

- Internal rotation

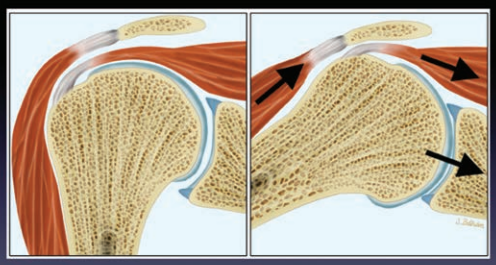


Deltoid muscle

Shoulder elevation

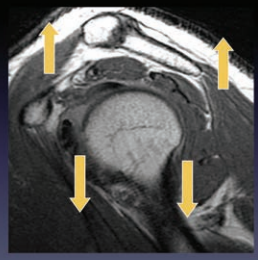


Abduction and Compression



Deltoid and supraspinatus both contribute to abduction equally.
As the arm is abducted the resultant joint reaction force is directed towards the Glenoid. This 'compresses' the humeral head against the Glenoid and improves the stability of the joint when the arm is abducted and overhead. [Parsons et al. J Orthop Res. 2002]

Rotator Cuff resist upward force of the Deltoid

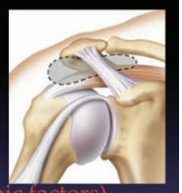


Net Humeral Joint Reaction Force

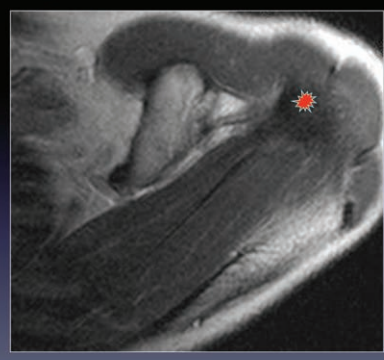
- The combination of the magnitude and direction of all vectors generated by the RC muscles and deltoid muscle

Rotator Cuff Disease

- Vascular, Degenerative factors
  - Age
  - Inflammatory arthritis
  - Steroid injections
- Impingement (Anatomic / Mechanic factors)
- Crystal deposition disease
- Osteoarthritis
- Acute trauma



Tendon degeneration



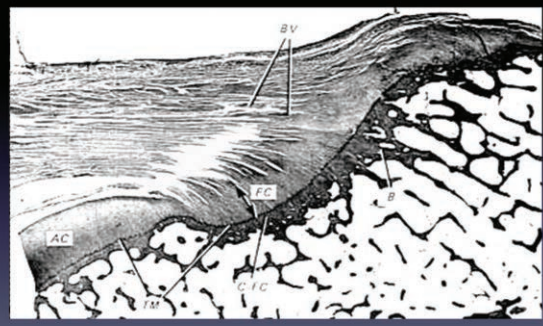
Ogata S.Clin Orthop Relat Res 1990
Kjellin I.Radiology 1991

…after the deep fibers of the cuff rupture they retract because they are under tension even with the arm is in rest.This tension causes the so called "zipper phenonenon"

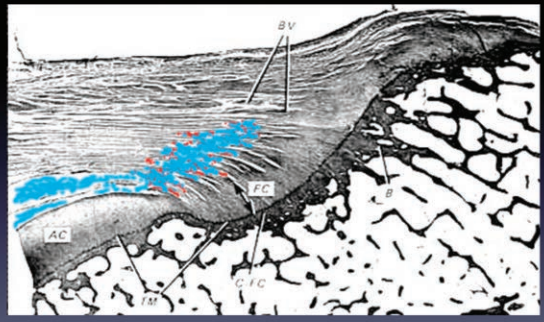
…failure of part of the cuff causes an increased load on the remaining fibers so more parts of the cuff can fail with smaller loads than initially and the tear progress as if a zipper were being opened…

Matsen et al "The Shoulder" Philadelphia: WB Saunders;1998

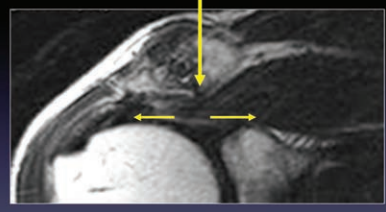
"Zipper phenomenon"



Lytic enzymes from joint fluid prevent healing



Compression



Tension

Age-related tendon changes

- Decreased fibrocartilage at the cuff insertion
- Decreased vascularity,loss of cellularity and disruption of bone attachment
- Collagen degeneration lead to impairment in biochemical properties
- Changes in RC tendons with age similar to other tendons.Degenerative changes lead to decrease tendon strength

Subcoracoid Impingement

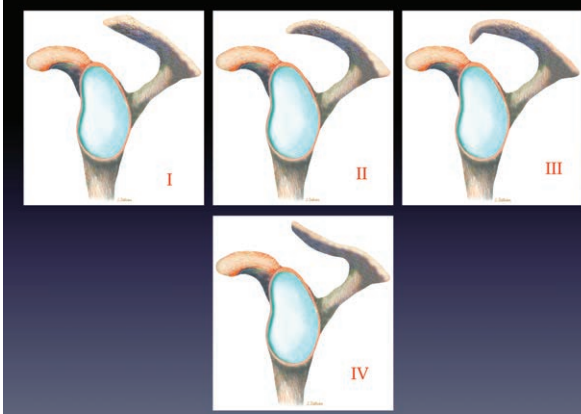
Impingement of the coracoid process against the humerus (usually the lesser tuberosity) in a coracoid impingement position (humerus is flexed, adducted and internally rotated).

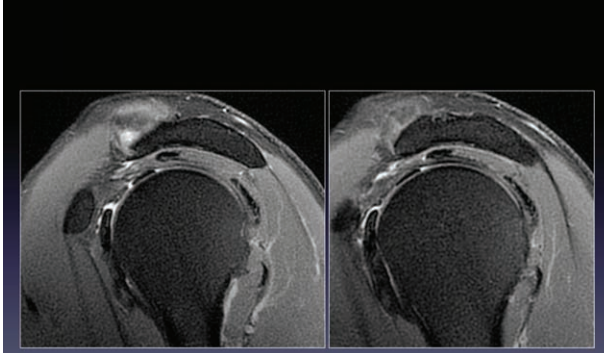
Impingement Syndrome: Types

- Primary Extrinsic (Neer Hypothesis of Mechanical Impingement)
  - Abnormalities in coracoacromial arch or AC joint (osteophytes >5mm).
  - Decreased coracohumeral space (Subcoracoid imping.)
- Secondary Extrinsic: To rotator cuff dysfunction or sacpulothoracic instability
- Internal: Articular surface side (Posterosuperior and anterosuperior imping. syndromes)

Primary Impingement

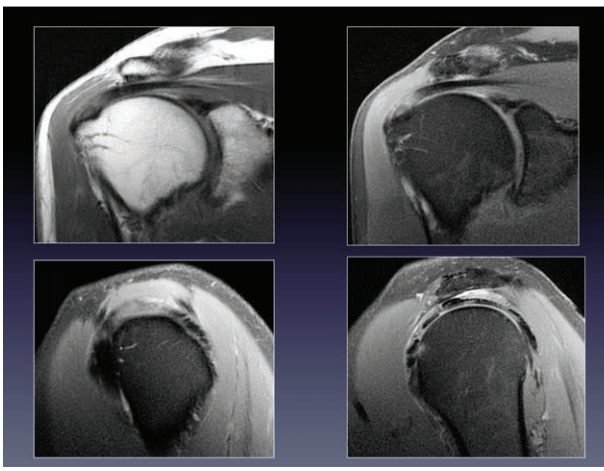
- Pain caused by contact between the rotator cuff and the coracoacromial arch
- Uncommon in young individuals.Congenital (abnormalities of the anterior acromion,os acromiale). Posttraumatic.
- More frequent in older patients. Critical zone. Anterior half of the supraspinatus,1 cm. medial to the insertion (89% cuff tears)

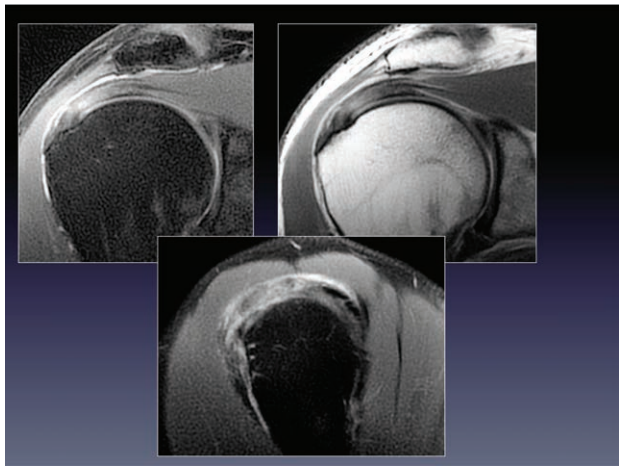




Rotator Cuff Tendinosis: MR Criteria

- Increased intratendinous SI on PD or T2W without tendon disruption
- Homogeneous or heterogeneous,focal or diffuse
- Tendon enlargement
- Total or partial loose of peribursal fat plane
- SA-SD bursitis





Partial Thickness Rotator Cuff Tears

- Articular surface
- Bursal surface
- Intrasubstance

High grade >50%
Medium grade = 50%
Low grade < 50%

Classification

- Ellman,Snyder (Tear depth)
- Grade 1
  < 25% (< 3 mm.)
- Grade 2
  25-50% (3-6 mm)
- Grade 3
  > 50% (> 6 mm)

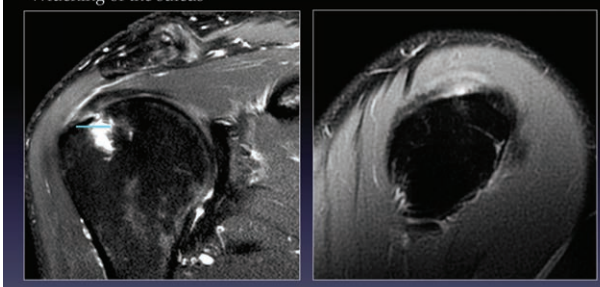
Codman, 1934. Rim rent tear

PASTA Lesion (Snyder)
(Partial Articular Supraspinatus Tendon Avulsion)

Rim-rent tear: Partial articular surface Supraspinatus tear at the insertion.
Tuite et al. Skeletal Radiology 1998;27:237-243

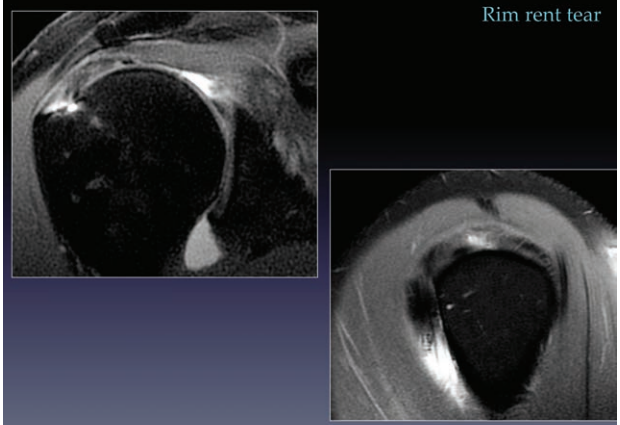
Rim rent tear

Widening of the sulcus

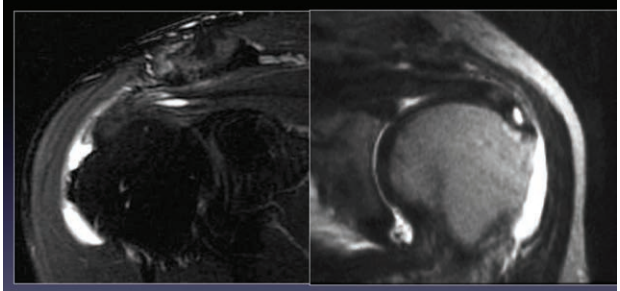


Sano et al.J Bone Joint Surg Br 1998

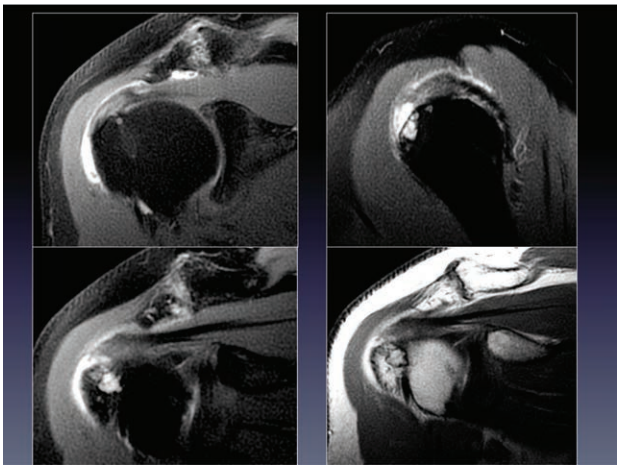
Rim rent tear

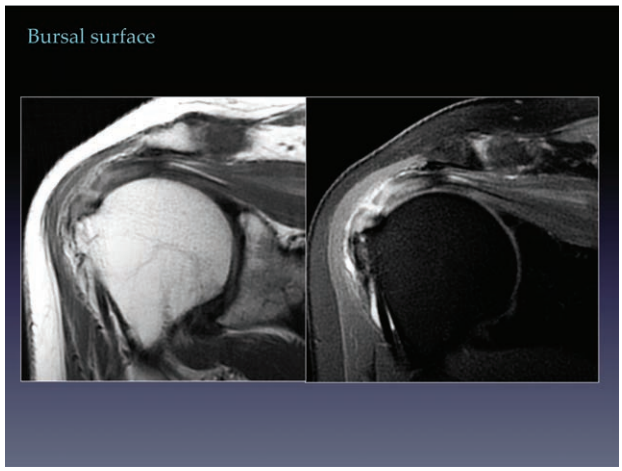


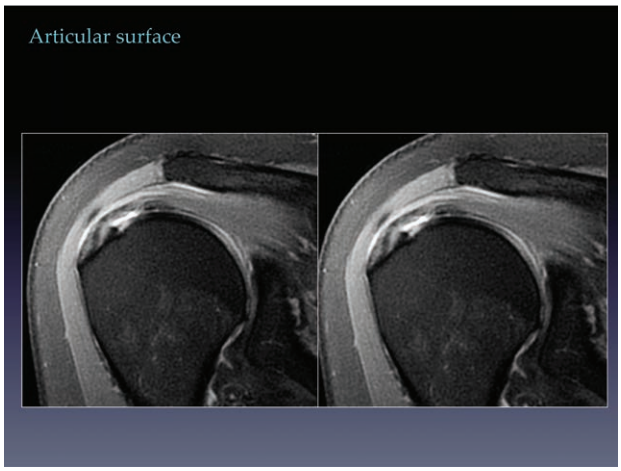
Partial RC Tears

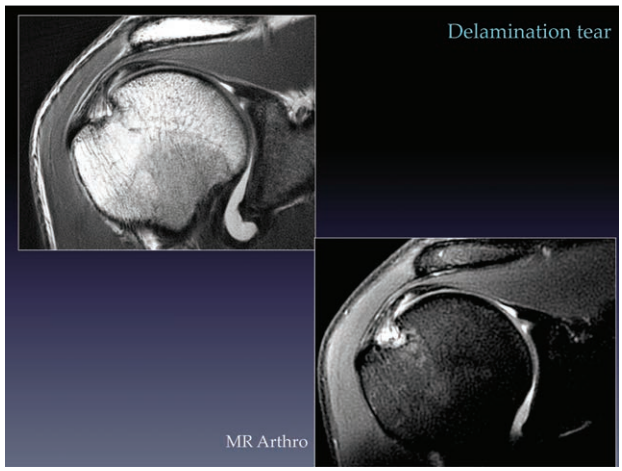


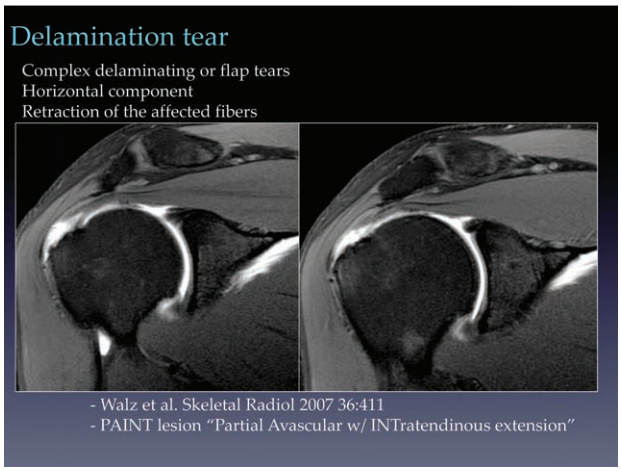
Bursal Intrasubstance

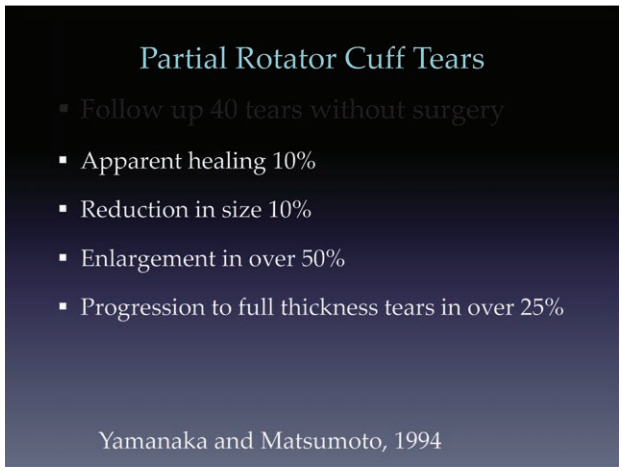


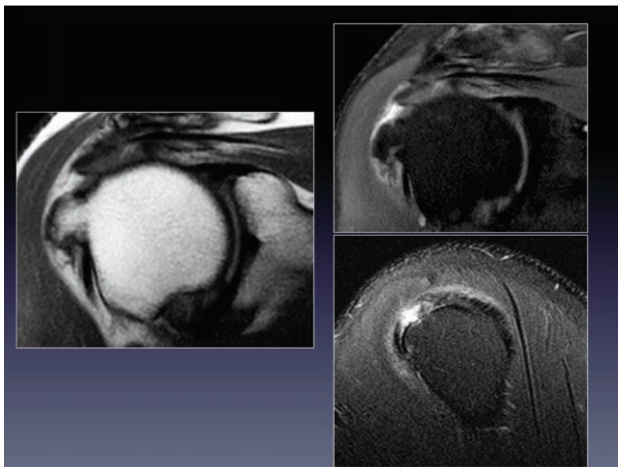

Bursal surface

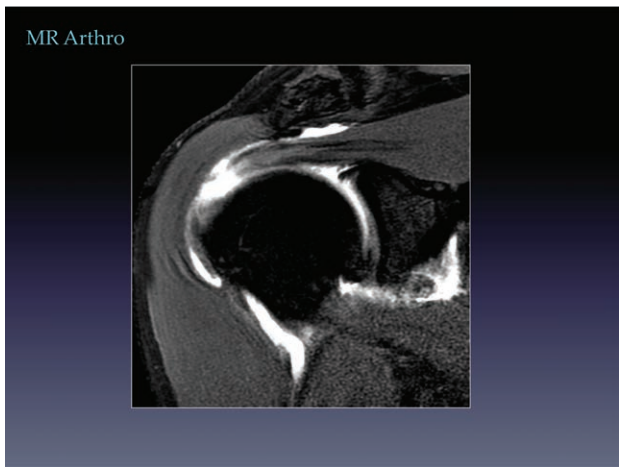

Articular surface

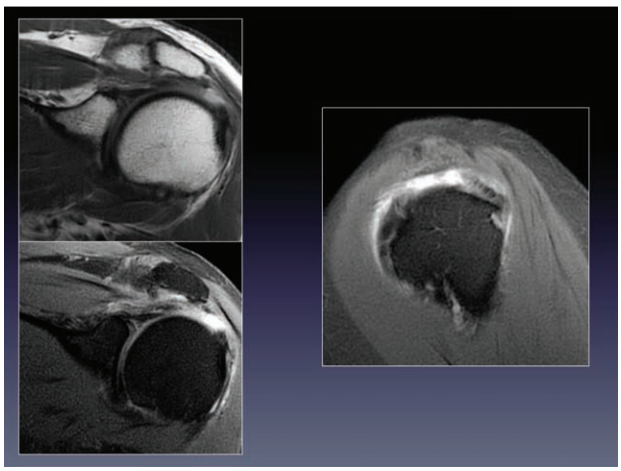

Delamination tear
MR Arthro

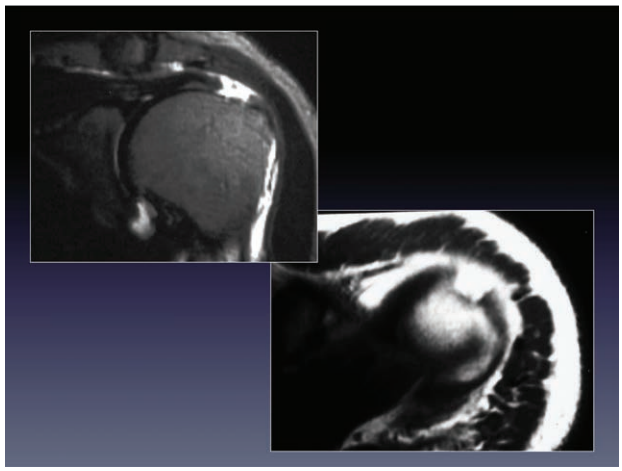

Delamination tear
Complex delaminating or flap tears
Horizontal component
Retraction of the affected fibers
- Walz et al. Skeletal Radiol 2007 36:411
- PAINT lesion "Partial Avascular w/ INTratendinous extension"


Partial Rotator Cuff Tears
Follow up 40 tears without surgery
Apparent healing 10%
Reduction in size 10%
Enlargement in over 50%
Progression to full thickness tears in over 25%
Yamanaka and Matsumoto, 1994




MR Arthro





Classification of Full Thickness Rotator Cuff Tears

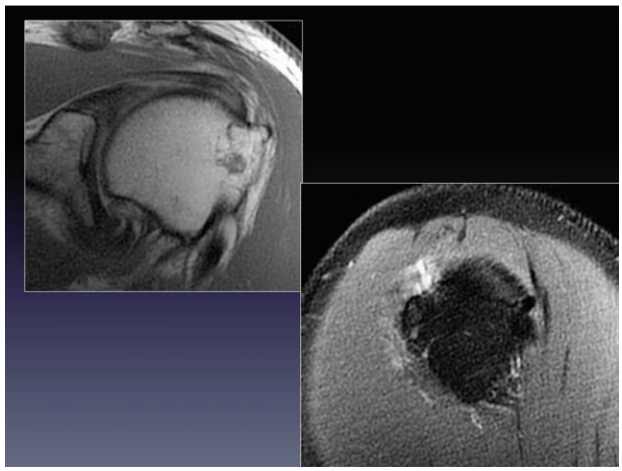
Burkhart et al. J Am Acad Orthop Surg 2006; 14: 333-346

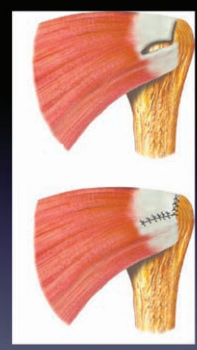
The geometric classification of rotator cuff tears: a system linking tear pattern to treatment and prognosis.
Arthroscopy. 2010 Mar;26(3):417-24. Epub 2009 Dec 29.
Davidson J, Burkhart SS.

- Type 1: Crescent-shaped
- Type 2: L or U-shaped
- Type 3: Massive, contracted, immobile
- Type 4: End stage rotator cuff arthropathy tears (irreparable)

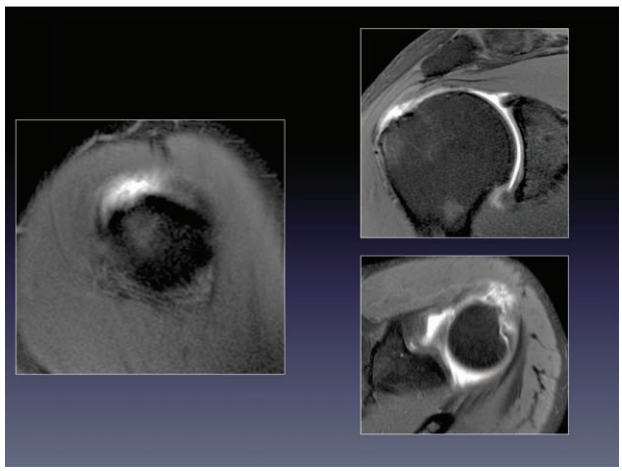
Type 1
Crescent-shaped tear

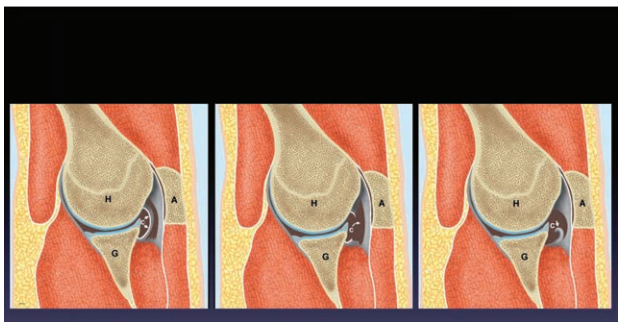
Type 2
U-shaped tear





Type 2
L-shaped tear





Type A Type B Type C

Lee et al. Horizontal Component of Partial RCT
Radiology 2002;224;470-476