

"MRI Arthrography of Shoulder Instability"

Wednesday, May 2nd, 2018 - 7:30 am

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MR Arthrography of Shoulder Instability

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University of Michigan*



Disclosures:

- Consultant: BioClinica
- Advisory Board: GE, Philips
- Book Royalties: Elsevier
- Unpaid consultant for regular and sugar-free Red Bull products
- Not relevant to this talk

Outline: instability

- General Concepts
- MR Arthrography Technique
- Anatomy and Variants
- Pathologic Conditions

Glenohumeral Instability: *mechanics*

- Static stabilizers:
 - Labrum and joint capsule
 - Osseous structures
- Dynamic stabilizers:
 - Rotator cuff
 - Long head of biceps brachii tendon
 - Scapulothoracic muscles

Braun et al. JBJS Am 2009; 91:966.

Glenohumeral Instability: *associations*

- External impingement:
 - Subacromial: bursal-sided rotator cuff tear
 - Subcoracoid: subscapularis
- Internal impingement:
 - Posterosuperior: labral and cuff tear
 - Anterosuperior: biceps pulley and subscapularis

Semin Musculoskelet Radiol 2008; 12: 107

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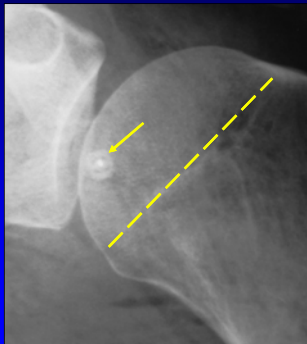
Contrast or no contrast?

- Labral tear: sensitivity
 - MRI: 93%
 - MR arthrogram: 96%
 - CT arthrogram: 87 - 93%

AJR 1993; 161:1229
AJR 2012; 198:635

Shoulder Arthrogram: step #1

- Medial margin of humeral head
- Hub over needle
- Center needle in fluoroscopy beam
- Do not start medial to humeral head



RadioGraphics 2003; 23:337

Shoulder Arthrogram: step #1

- Advance needle to humeral head
 - ✓ Needle deflects medial
 - ✓ Needle remains AP

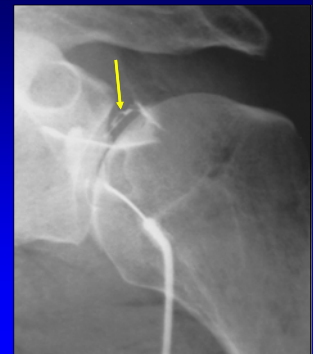


Shoulder Arthrogram: step #2

- Test injection
 - Ropivacaine or saline
 - Low resistance to flow
 - Rotate or slightly move needle back during injection
 - Joint or bursa location

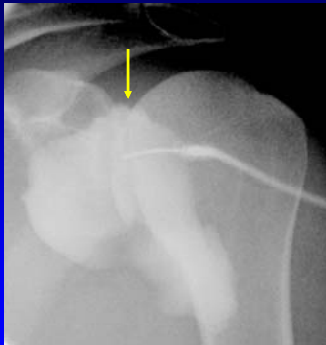
Shoulder Arthrogram: step #3

- Iodinated contrast
- Confirm intraarticular location
- Must see contrast between glenoid and humeral head
- Arm traction



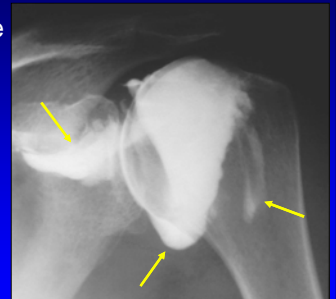
Shoulder Arthrogram: step #3

- You do not want to see this!
- Bursal injection
- No contrast between glenoid and humeral head



Shoulder Arthrogram: step #4

- Inject gadolinium mixture
- 12 - 16 cc total in joint
- Normal recesses:
 - ✓ Subscapularis recess
 - ✓ Axillary recess
 - ✓ Long head of biceps



Technique:

- Rotator interval approach
 - Less pain, quicker, 1.5 inch 22 ga.
 - Fluoroscopy¹
 - Ultrasound²
 - ? Effect on rotator interval interpretation

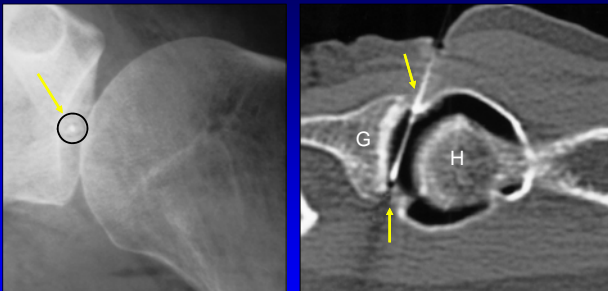
¹ AJR 2004; 182:329
² EJR 2010; 74:E29

Technique:

- Posterior glenohumeral recess approach
 - Avoid contrast placement in anterior structures
 - Fluoroscopy or ultrasound-guidance¹
- Consider a tailored approach²
 - Use approach away from suspected pathology

¹ Skeletal Radiol 2010; 39:575
² AJR 2001; 177:217

Shoulder Arthrogram: don't do this!



If patient oblique and aim for "clear space" =
"labrum shish kabob"

Technique: *general*

- Gadolinium dilution + iodinated contrast*
 - 20 cc syringe
 - 9 cc of iodinated contrast
 - 9 cc of saline
 - 0.1 cc Gadolinium (2 - 10 mmol/liter)

*AJR 1994; 163:621

Technique: morbidity

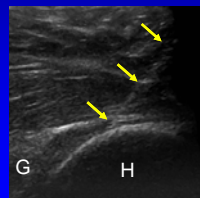
- Post-arthrogram pain
 - May peak at 2 -3 days after injection
- May relate to synovitis
- Decreased morbidity
 - No epinephrine

Shoulder Joint: MRI protocol

- T1-weighted, fat saturation: 3 planes
- Include T2w:
 - Coronal-oblique plane
 - Extra-articular pathology: bursal tear, tumor
 - Differentiate hyaline cartilage from Gadolinium
- ABER view

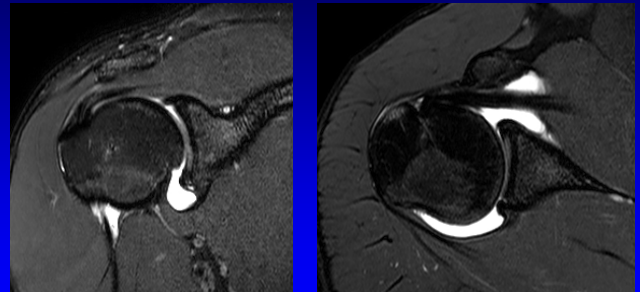
Saline MR Arthrography

- If contrast allergy
- Ultrasound-guided saline injection*
 - Posterior glenohumeral recess
 - In plane
 - Do NOT position in internal rotation
- T2-weighted fat-sat MRI



*AJR 1993; 161:1229

T2w fat-sat MRI Saline Arthrogram



Outline: instability

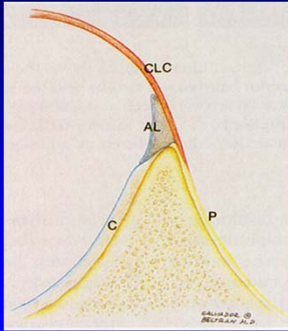
- General Concepts
- MR Arthrography Technique
- **Anatomy and Variants**
- Pathologic Conditions

Shoulder Joint: anatomy

- Labrum:
 - Triangular (anterior), rounded (posterior)
 - Usually symmetric: anterior – posterior
 - Sublabral linear increased intensity:
 - transitional fibrocartilage zone + hyaline cartilage undercutting

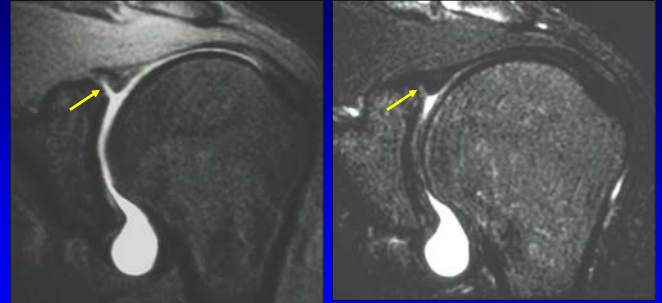
Radiology 1995; 196:33

Normal Anteroinferior Labrum



Radiographics 1997; 17:660

Hyaline Cartilage Undercutting

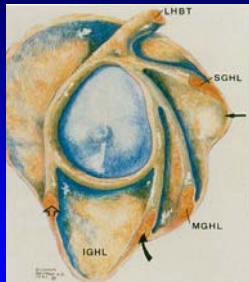


Coronal-obl T1w fat-sat

Coronal-obl T2w

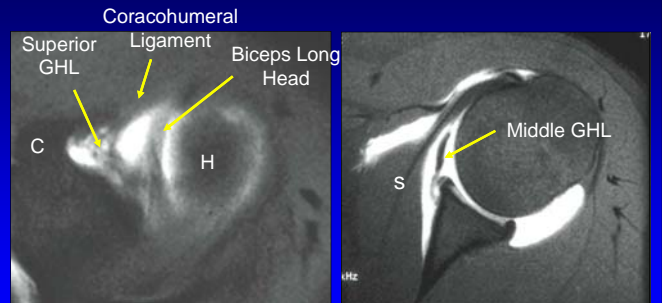
Shoulder Joint: *anatomy*

- Glenohumeral ligaments
 - Superior: forms "V" with biceps
 - Middle: parallels subscapularis
 - Inferior:
 - Anterior and posterior bundles
 - Outlines the axillary recess



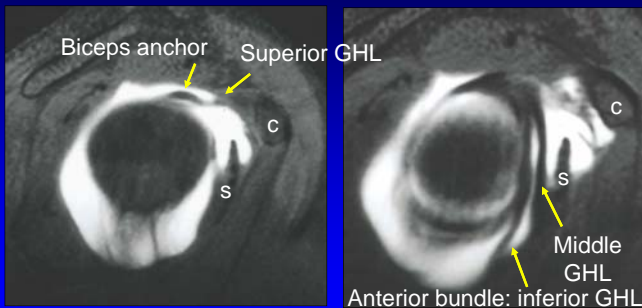
Radiographics 1997; 17:1403

Glenohumeral Ligaments



Axial T1w fat-sat

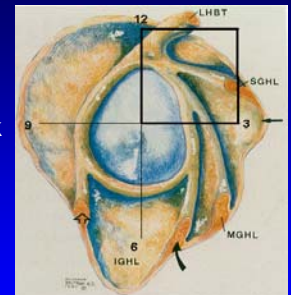
Glenohumeral Ligaments



Sagittal-oblique T1w fat-sat

Shoulder: *variants*

- Upper anterior quadrant:
 - Between 11 & 3 o'clock
 - Isolated abnormalities: likely variants



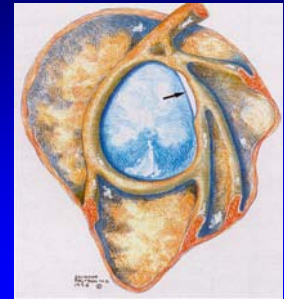
*Radiographics 1997; 17:656

Shoulder: normal variants

- Sublabral hole or foramen
- Sublabral recess or sulcus
- Buford complex

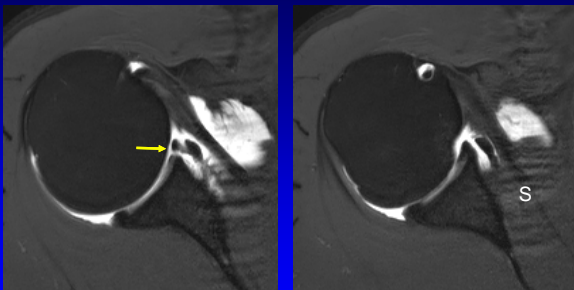
Sublabral Hole or Foramen

- Normal variant:
 - Anterosuperior labrum: 1 - 3 o'clock
- Labrum not attached to glenoid*
- Contrast between labrum and glenoid



*Radiology 1996; 199:537

Sublabral Hole or Foramen

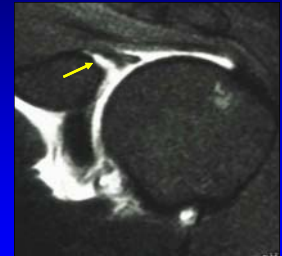


Axial: superior

Axial: more inferior

Sublabral Recess or Sulcus:

- Normal variant:
 - At biceps insertion
- Synovium-lined recess
- Contrast between biceps-labral complex and glenoid
- May communicate with sublabral hole



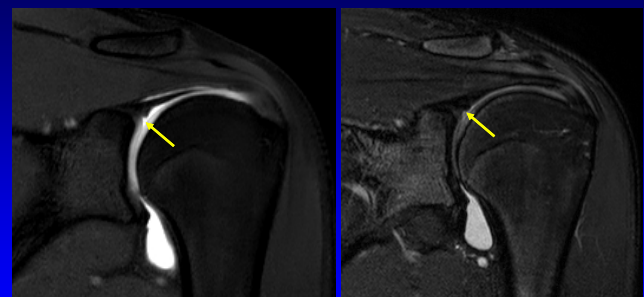
*AJR 1998; 171:235

Other Sublabral Clefts / Recesses:

- Labral-chondral junction
- Seen in up to 61% of patients
- Up to 3 mm deep
- Smooth, medially curved
- Anterosuperior, anteroinferior, posterosuperior

Skeletal Radiol 2013; 42:353

Sublabral Cleft or Recess

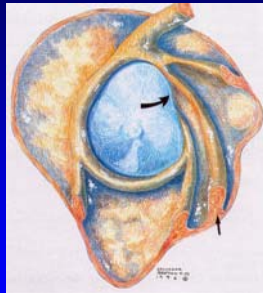


T1w fat-sat

T2w fat-sat

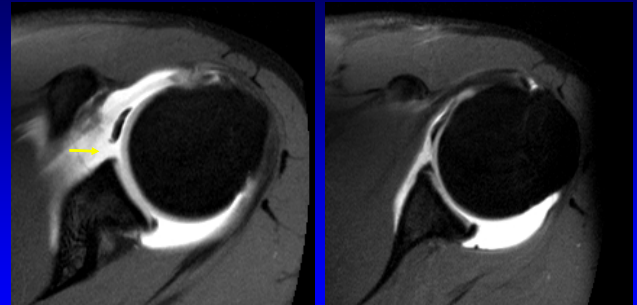
Buford Complex:

- Normal variant
- Absence of anterosuperior labrum
- Thickened, cord-like middle glenohumeral ligament



AJR 1996; 166:869
Radiographics 1997; 17:660

Buford Complex



Axial: superior

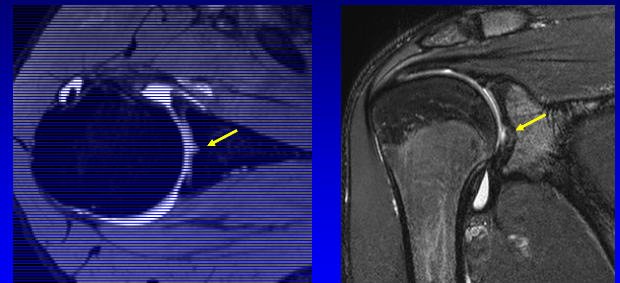
Axial: more inferior

Bare Spot of the Glenoid Fossa

- Focal cartilage defect
- Glenoid: usually central
- Up to 2% of shoulders
- Not seen under 10 years: acquired ?

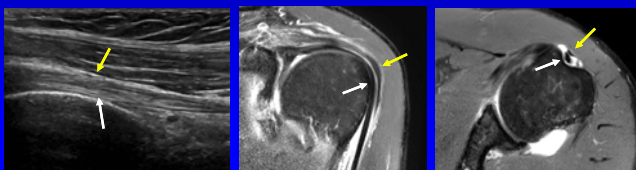
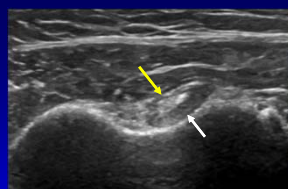
Pediatr Radiol 2010; 40:1190

Bare Spot of Glenoid Fossa



Aponeurotic Expansion of Supraspinatus Tendon

- Up to 49% of shoulders
- Cleft: coronal plane
- Origin: supraspinatus
- Distal: pectoralis or bicipital groove



Moser et al. Skeletal Rad 2015; 44:223

Outline: instability

- General Concepts
- MR Arthrography Technique
- Anatomy and Variants
- Pathologic Conditions

Pathology:

- SLAP tears
- Bankart tears and variants
- Glenohumeral ligament tears

SLAP Tear:

- Superior labrum anterior, posterior tear
- 9 types
- Type 2: most common
 - 3 subtypes
 - Anterior, posterior, and anteroposterior

Jin et al. AJR 2006; 187:887

SLAP Tears:

- Type 1: superior labral fraying
- Type 2: long head of biceps avulsion
- Type 3: bucket-handle, sparing biceps
- Type 4: bucket-handle, involving biceps

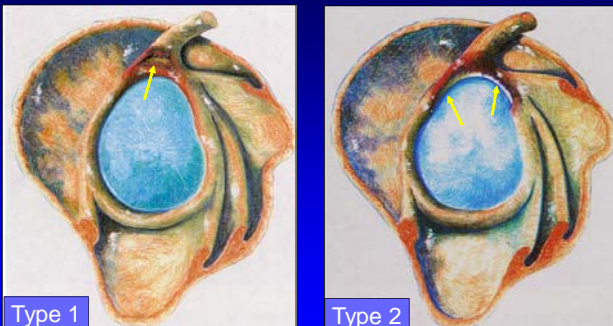
Radiographics 1997 17:657

SLAP Tears:

- Type 5: anteroinferior extension
- Type 6: unstable radial flap
- Type 7: middle glenohumeral ligament
- Type 8: posteroinferior extension
- Type 9: complete concentric avulsion
- Types 10 – 25:
 - Just kidding!

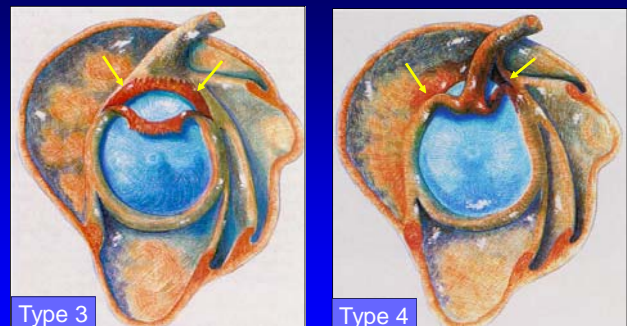
Shankman, Skeletal Radiol 1999; 28:365

SLAP Tears

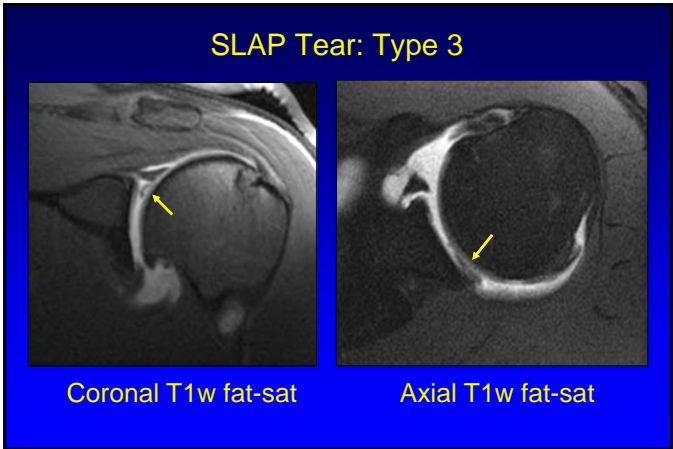
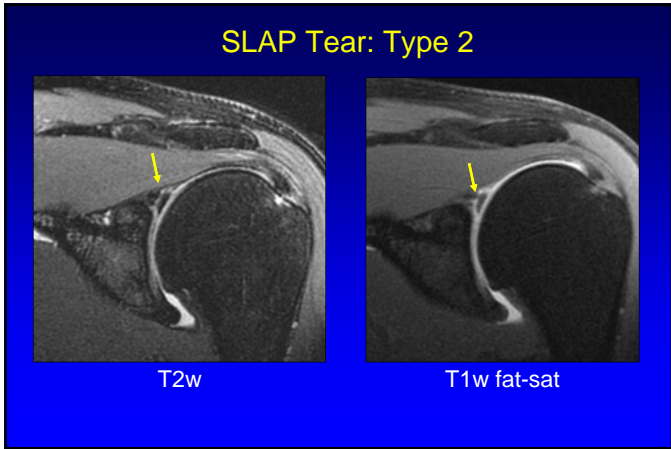
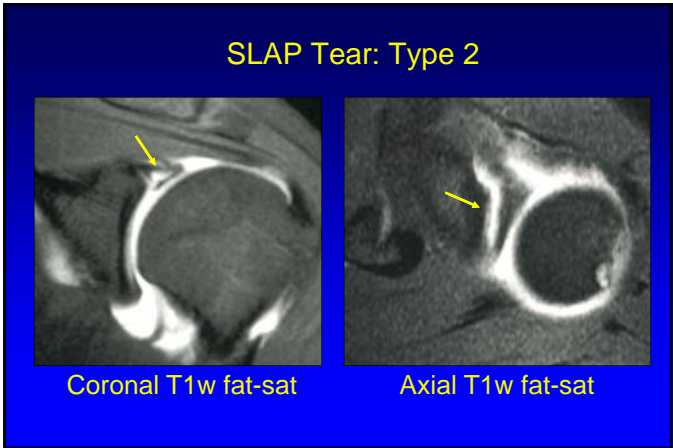
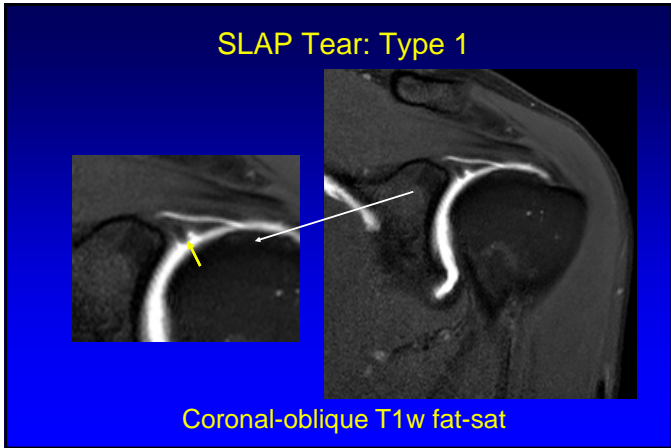


Radiographics 1997; 17:670

SLAP Tears



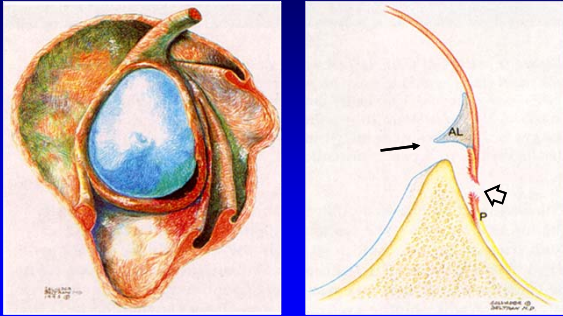
Radiographics 1997; 17:670



- Pathology:
- SLAP tears
 - Bankart tears and variants
 - Glenohumeral ligament tears

- Bankart Lesion:
- Anteroinferior labral tear*
 - Avulsion: anterior inferior glenohumeral ligament & labral complex
 - Ruptured periosteum allows anterior displacement
- *Radiographics 1997; 17:657

Bankart Lesion

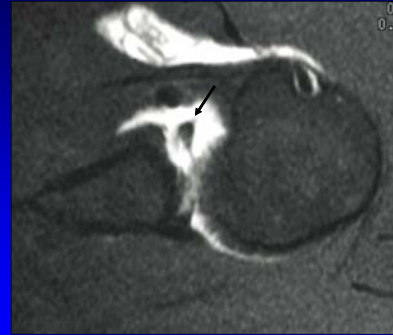


*Radiographics 1997; 17:664

Bankart Lesion

Medial

Lateral



Axial T1w fat-sat

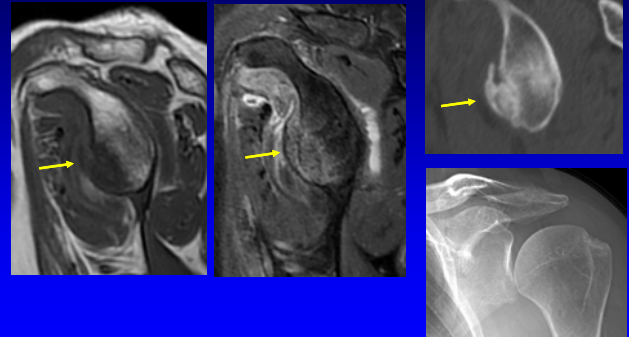
Remote Labral Tears



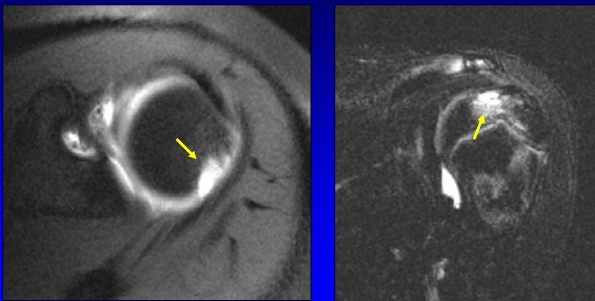
Axial T1w fat-sat

Axial T1w fat-sat

Bony Bankart Lesion



Hill-Sachs Impaction Fracture



Axial T1w fat-sat

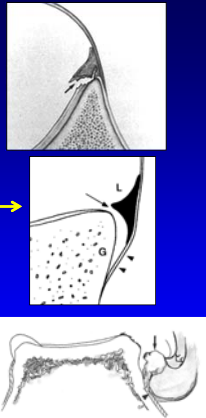
Coronal-obl T2w fat-sat

Bankart Variants:

- GLAD Lesion
- Perthes Lesion
- ALPSA Lesion

Bankart Variants

- GLAD:
 - GlenoLabral Articular Disruption
- Perthes:
 - Anterior Labroligamentous Periosteal Sleeve Avulsion

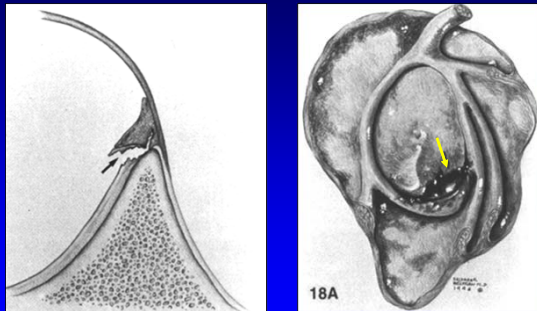


GLAD Lesion:

- GlenoLabral Articular Disruption
- Superficial anteroinferior labral tear
- Articular cartilage damage
- Anterior bundle of IGHL intact (partial)
- Intact periosteum: little displacement

*Radiographics 1997; 17:657

GlenoLabral Articular Disruption

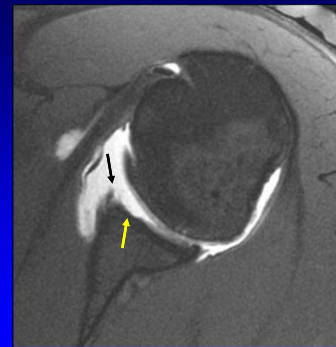


*Radiographics 1997; 17:664

GLAD Lesion

Medial

Lateral



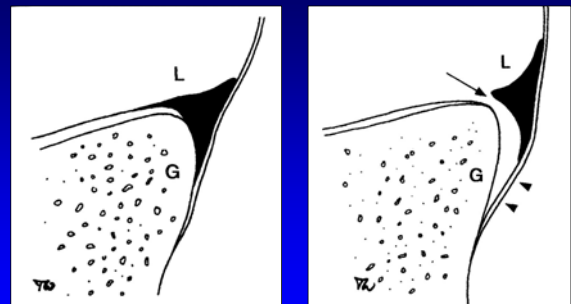
Axial T1w fat-sat

Perthes Lesion:

- Anteroinferior labral tear
- Stripped scapular periosteum
- Intact periosteum: little displacement
- Abduction-external rotation: helpful

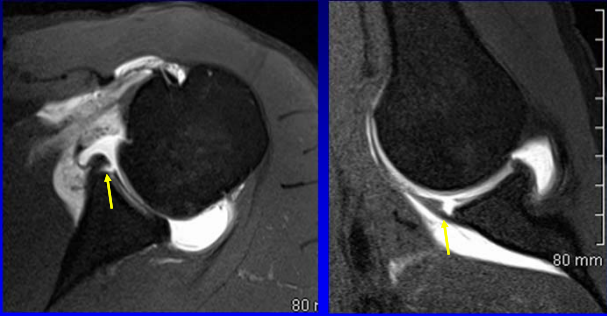
* AJR 2002; 178:233

Perthes Lesion



*AJR 2002; 178:233

Perthes Lesion



ABER Position:

- **AB**duction, **E**xternal **R**otation
 - Hand behind head
 - Oblique axial to glenoid: along humerus
- Increases sensitivity: ant labral tears
 - 48% (MR arthro) to 89% (+ABER)*
- Re-scout, extra time

*AJR 1997; 169:837

ALPSA Lesion:

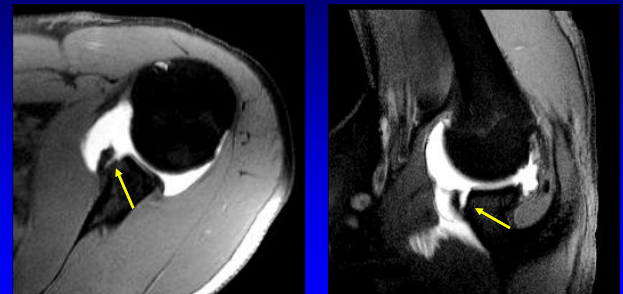
- **A**nterior **L**abroligamentous **P**erosteal **S**leeve **A**vulsion*
- Torn anteroinferior labrum
- Intact periosteum: medial displacement



Radiographics 1997; 17:657

Image from Resnick's Internal Derangements of Joints 1998

Anterior Labroligamentous Periosteal Sleeve Avulsion (ALPSA)

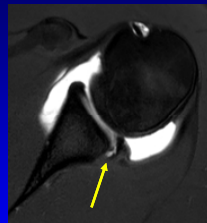


Axial T1-w fat-sat

ABER

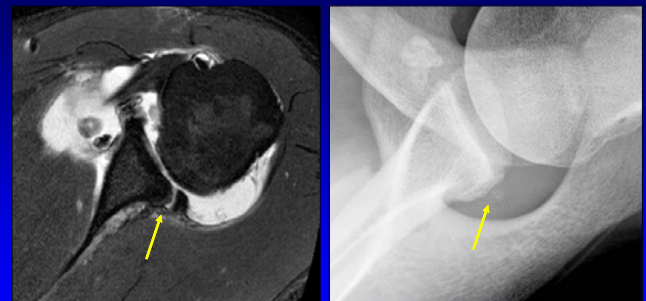
Posterior Labral Tears

- Part of SLAP types 8 and 9
- Isolated tear
 - Posterior glenoid deficiency
- Posterior subluxation
- Bennett Lesion
 - Calcification: posterior glenoid rim



* AJR 2002; 178:233

Bennett Lesion



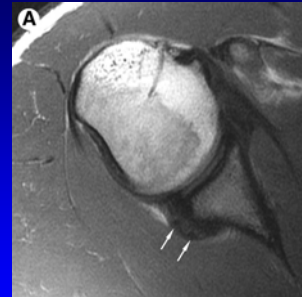
Axial T1w fat sat

Axillary radiograph

GIRD

- Glenohumeral internal rotation deficit
- Cause:
 - Posterior capsule fibrosis and scar
 - Posterior muscle tightness
- Findings:
 - Posterosuperior impingement
 - Low signal, thick posterior capsule
 - Peel back or avulsion SLAP tear

Glenohumeral Internal Rotation Deficit (GIRD)



MRI: Axial PD-w

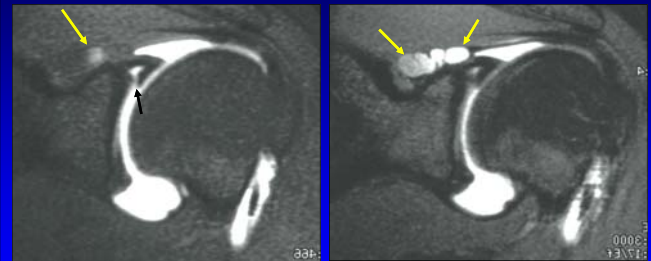
From: Sanders et al. Semin Roentgen 2010; 45: 160

Paralabral Cyst

- Associated with labral tear: >90%
- Suprascapular nerve compression
 - Spinoglenoid notch: infraspinatus
 - Suprascapular notch: supra- and infraspinatus
 - Early denervation: edema, T2w
- May not fill with intra-articular gadolinium: need T2w

Radiology 1994; 190:653

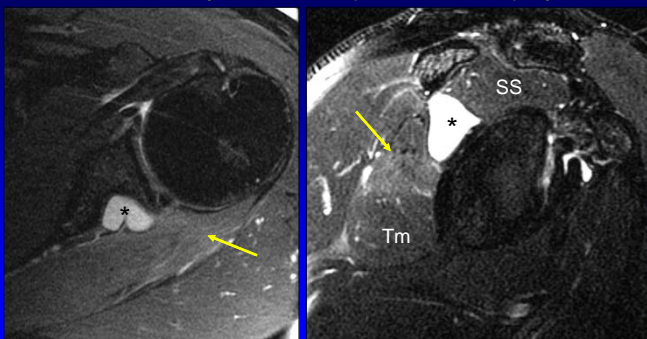
Labral Cyst



Coronal-obl T1w fat-sat

Coronal-obl T2w

Labral Cyst + Infraspinatus Atrophy



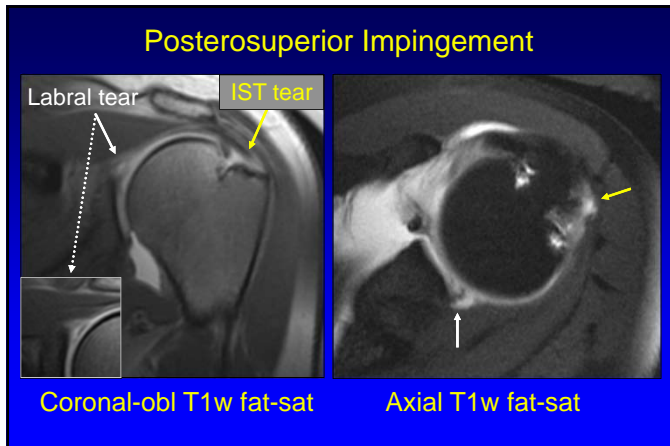
Axial T2w fat-sat

Sagittal-oblique T2w

Posterosuperior Impingement:


- Posterosuperior labral tear
- Infraspinatus tear: partial-thickness
- Humerus cortical irregularity / edema deep to infraspinatus

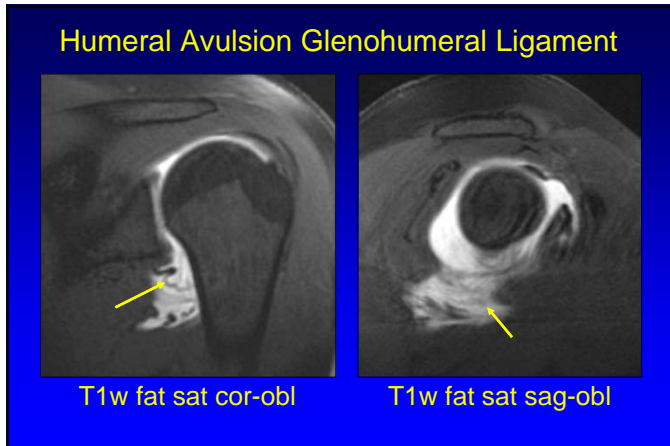
*Radiology 1994; 193:431



- ### Pathology:
- SLAP tears
 - Bankart tears and variants
 - Glenohumeral ligament tears

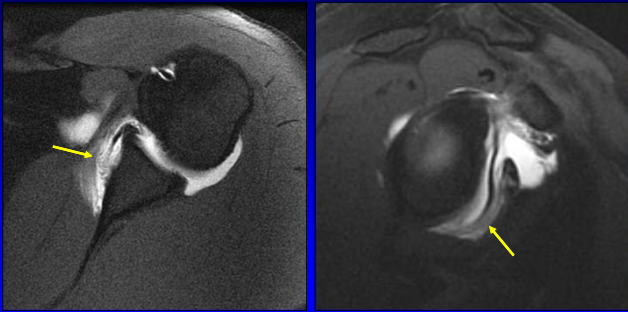
- ### HAGL Lesion:
- Humeral Avulsion of the Glenohumeral Ligament
 - Avulsion of anterior capsule at humerus
 - Subscapularis tear or avulsion
 - Biceps dislocation, Hill-Sachs deformity
- Skeletal Radiol 1996; 25:743

- ### HAGL Lesion:
- MR arthrographic findings:
 - Irregular axillary pouch
 - Disrupted / lax inferior glenohumeral lig.
 - Inferior contrast extravasation
 - BHAGL:
 - HAGL + bony avulsion fracture at humerus
- 
- Bui-Mansfield AJR 2002; 179:649



- ### Middle Glenohumeral Ligament Tear:
- Discontinuous, lax, or irregular
 - Capsular rupture
 - Inferior glenohumeral ligament tear
 - *Pitfall*: normal variants
- Beltran et al, Skeletal Radiol 2002; 31:253

Tear: middle glenohumeral ligament



T1w fat sat cor-obl

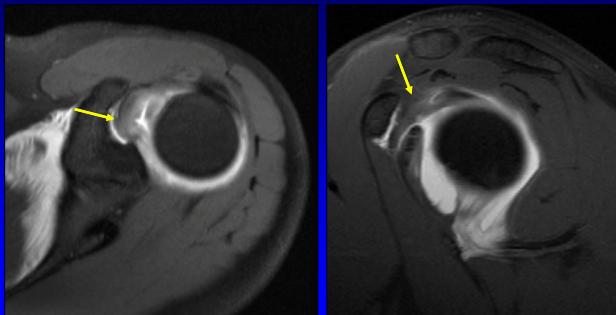
T1w fat sat sag-obl

Superior Glenohumeral Ligament:

- Discontinuous, lax, or irregular
- Capsular rupture
- Associated coracohumeral ligament tear
- Biceps pulley injury
- Biceps tendon dislocation

Beltran et al, Skeletal Radiol 2002; 31:253

Injury: superior glenohumeral ligament

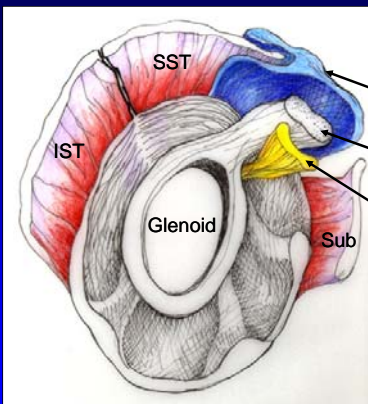


T1w fat sat axial

T1w fat sat sag-obl

Rotator Interval Tear:

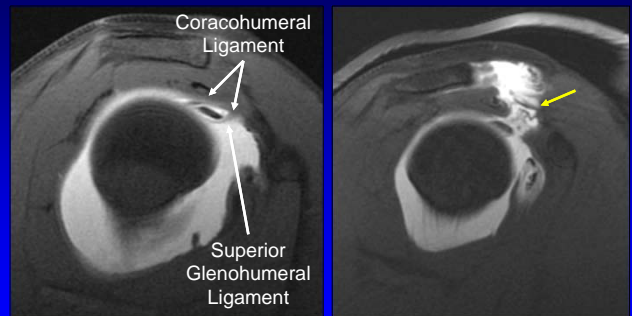
- Capsular tear at rotator interval
- Contrast in subacromial-subdeltoid bursa
 - Simulates full-thickness cuff tear
- Contrast extension through rotator interval



Rotator Interval

- Coracohumeral Ligament
- Biceps Tendon
- Superior Glenohumeral Ligament

Rotator Interval and Biceps Pulley



Normal

Tear

Take Home Points

- Normal variants: inner upper quadrant
- SLAP: cleft in labrum
- Sulcus: partial cleft under normal labrum
- Bankart: displaced anteroinferior tear
- Bankart variants: non-displaced



Syllabus on line and other educational material:
www.jacobsonmskus.com

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