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


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 Musculoskeletal Radiol 2008; 12: 107
Outline: instability

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

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.
  – Fluoroscopy
  – Ultrasound
  – ? Effect on rotator interval interpretation

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

Technique:

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

  ¹ Skeletal Radiol 2010; 39:575
  ²AJR 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

**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
Shoulder Joint: **anatomy**

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

**Glenohumeral Ligaments**

- Superior GHL
- Middle GHL
- Biceps Long Head

**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 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
**Buford Complex:**
- Normal variant
- Absence of anterosuperior labrum
- Thickened, cord-like middle glenohumeral ligament

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

**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

**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

Remote Labral Tears

Hill-Sachs Impaction Fracture

Bankart Variants:
- GLAD Lesion
- Perthes Lesion
- ALPSA Lesion

*Radiographics 1997; 17:664
Bankart Variants

- GLAD:
  - GlenoLabral Articular Disruption
- Perthes:
- ALPSA:
  - 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

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

* AJR 2002; 178:233

* AJR 2002; 178:233
Perthes Lesion

ABER Position:
- Abduction, External Rotation
  - 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:
- Anterior Labroligamentous Periosteal Sleeve Avulsion*
- Torn anteroinferior labrum
- Intact periosteum: medial displacement

Radiographics 1997; 17:657

Image from Resnick’s Internal Derangements of Joints 1998

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

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

Labral Cyst + Infraspinatus Atrophy

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

*Radiology 1994; 193:431
**Posterosuperior Impingement**

- Labral tear
- IST tear

**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

**Humeral Avulsion Glenohumeral Ligament**

**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

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

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 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.jacobsonmakus.com
Twitter handle: @jjacobson