MRI of the Rotator Cuff with Ultrasound Correlation

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Disclosures:
• Consultant: BioClinica
• Book Royalties: Elsevier
• Grant: RSNA

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Outline:
• Anatomy
• Imaging
• Reporting
• Pitfalls

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• Anatomy
• Rotator cuff tears
• Post-operative cuff
• Calcific tendinosis

Rotator Cuff

Note: Subacromial-subdeltoid Bursa (light blue)
Rotator Cuff: pathogenesis

- Extrinsic:
  - Repetitive microtrauma: microtears
  - Subacromial impingement
- Intrinsic:
  - Degeneration: predispose to tear
  - Avascular region: critical zone
- Usually over age of 40 years

Rotator Cuff Tear:

- Meta-analysis: 65 articles
- Full-thickness tears:
  - MRA, MRI, US = in sensitivity (92 – 95%)
  - MRA more specific
- Partial-thickness tears:
  - MRA most sensitive (86%) and specific
  - MRI (64%), US (67%)
**Tendinosis: supraspinatus**

- PDw Coronal-obl
- T2w Coronal-obl

- PDw + FS Coronal
- Long Axis

**Tendinosis: supraspinatus**

- PDw + FS Sagittal
- Short Axis

**Rotator Cuff: MRI**

- Tendon tear
  - T1w and PDw: increased signal
  - T2w: fluid signal
    - Some tears: low or intermediate signal
    - Intra-articular contrast in tendon
    - Abnormal morphology
    - Possible tendon thinning
    - Bursal and full-thickness

**Full-thickness Tear: supraspinatus**

- T2w FS Coronal
- T2w FS Sagittal

**Rotator Cuff Tears: ultrasound**

- Most tears are hypoechoic / anechoic
- Larger tears: deltoid dips into tendon gap
- Massive tear: non-visualization
- Adjacent cortical irregularity:
  - Important indirect sign of tear
  - Supraspinatus
  - If > 40 years old

Radiology 2004; 230:234
Small Full-thickness Tear: supraspinatus

Cortical Irregularity:
• Greater tuberosity: at supraspinatus insertion
• When present: 75% have rotator cuff tears
• When absent: 96% normal cuffs by sonography

Rotator Cuff Tear: Location
• Which tendon?
• Proximal versus distal at attachment?
• Anterior or posterior (supraspinatus)
• Most tendon tears:
  – Supraspinatus
  – Partial-thickness: anterior at rotator interval
  – Degenerative: posterior aspect

Rotator Cuff Tear: Extent
• Partial-thickness:
  – Interstitial
  – Articular
  – Bursal
• Full-thickness, incomplete:
  – Extends to two surfaces
• Full-thickness, complete:
  – Entire tendon discontinuous
  – Full width

Radiology 2004; 230:234
Supraspinatus Tears: extent

- Partial Articular
- Partial Bursal

Articular Partial-thickness Tear: supraspinatus

- Long Axis
- Sagittal T2w

Bursal Partial-thickness Tear: supraspinatus

- Long Axis
- Coronal T2w
Bursal Partial-thickness Tear: supraspinatus

Long Axis  Coronal T2w

Full-thickness Tear: supraspinatus

Long Axis  T2w Coronal-oblique

Full-thickness Tear: supraspinatus

Short Axis  T2w Sagittal-oblique

Full-thickness Tear: supraspinatus

Short Axis  T2w Sagittal-oblique

Full-thickness, Complete Tear: supraspinatus

T1w + fat sat  T1w + fat sat

MR arthrogram

Massive Tear: supraspinatus

PDw Coronal-oblique
Rotator Cuff Tear: Extent

- Intrasubstance
  - Does not contact articular or bursal surface
  - May contact greater tuberosity

Interstitial Tear: supraspinatus

PDw FS Coronal  T1w Sagittal

Rotator Cuff Tear: Location

- Young patients: <40 years
  - 56% of cuff tears involved the footprint
    - 50%: PASTA or rim-rent: anterior
    - 34%: interstitial tears, posterior supraspinatus
    - 38%: SLAP or labral tears

Eur Radiol 2011; 21:1477

Rotator Cuff Tear: Location

- Older patients: 65 years +/- 10 years
  - Degenerative tears
  - Most common: 15 – 16 mm posterior to biceps tendon
  - Center of rotator crescent
  - Full-thickness and larger tears

JBJS 2010; 92:1088

Rotator Cuff Tear: Fatty atrophy

- Related to extent and chronicity of rotator cuff tear
  - Poor surgical outcome
- MRI
  - Fatty infiltration, decreased size
- Ultrasound
  - Increased echogenicity, decreased size

JBJS 2012; 94:e83
Rotator Cuff Tear: *Fatty atrophy*

- **Supraspinatus**
  - Scapular ratio < 50%
  - Abnormal tangent sign
- **Infraspinatus**
  - Even without infraspinatus tear
  - Related to loss of depressor capability or suprascapular nerve

Cheung S, Arthroscopy 2011

Supraspinatus Atrophy: scapular ratio

![Normal](image1) ![Atrophy](image2)

From: Morag et al. Radiographics 2006; 26:1045

Supraspinatus Atrophy: tangent sign

![Normal](image3) ![Atrophy](image4)

From: Morag et al. Radiographics 2006; 26:1045

Supraspinatus and Infraspinatus Atrophy

![T1w Sagittal-obl](image5) ![T1w Coronal-obl](image6)

From: Morag et al. Radiographics 2006; 26:1045

Infraspinatus Atrophy

![Short Axis](image7) ![Long Axis](image8)

Atrophy: supraspinatus and infraspinatus

![Short Axis (extended field-of-view)](image9)
**Rotator Cuff Tear: Impingement**

- Four acromion types:
  - 1: flat
  - 2: curved downward
  - 3: hooked
  - 4: curved upward
- Rotator cuff tears: associated with
  - Types 2 & 3, spur, os acromiale

**Acromion Types**

1. Flat
2. Curved downward
3. Hooked
4. Curved upward

**Outline:**

- Anatomy
- Rotator cuff tears
- Post-operative cuff
- Calcific tendinosis

**Postoperative Cuff**

- Intact cuff:
  - Thinner than normal, increased T2w signal
  - Improvement: 6 months – 3 years
- Recurrent tear:
  - 3 – 54%: does not correlate with symptoms
  - Often very large
  - Unequivocal defect or discontinuity

*Crim, AJR 2010; 195: 1361*

**Postoperative Cuff**

- Partial tear repair:
  - Articular <50% and bursal: debridement
  - Articular >50%: repair or convert to full tear
- Full-thickness repair:
  - Trans-osseous fixation + trough
  - Decorticated tuberosity + direct apposition
- Suture anchors:
  - Metal, plastic, bioabsorbable
  - Single, multiple, single or double row

**Double-row Fixation: Supraspinatus Tendon**

Post-operative cuff: intact

Post-operative cuff: intact

Post-operative cuff: intact

Open arrow = bioabsorbable suture anchor

Post-operative cuff: recurrent tear

Outline:

- Anatomy
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- Calcific tendinosis
Calcific Tendinosis

- Calcium hydroxyapatite deposition
- Metaplasia
- Lower incidence of cuff tears if present
- Low to intermediate signal
  - May be difficult to see in low signal tendon
- Adjacent high signal / enhancement
- May erode into bone

Flemming, AJR 2003; 181:965

Tendon Calcification:

- Degenerative: thin, linear deposit
- Calcific tendinosis:
  - Formative: well-defined, dense shadow
  - Resorptive:
    - Globular, amorphous
    - Variable shadow
    - Best success with aspiration


Degenerative Calcification

Calcific Tendinosis

Formative
  - Defined, shadow
Resorptive
  - Amorphous, little shadow

Calcific Tendinosis

Calcium Hydroxyapatite: subscapularis

Axial T1w
Sag Oblique T2w
Calcium Hydroxyapatite: subscapularis

HADD: intraosseous extension

Calcific Tendinosis: lavage/aspiration

Patient #1

Patient #2

Calcific Tendinosis

3 weeks after lavage and aspiration
Take Home Points

• Cuff tears:
  – Understand anatomy, facets, footprint
  – Standardize nomenclature for tears
  – Pitfall: shoulder rotation

• Post-operative cuff:
  – Understand type of surgery
  – Call tear when obvious defect

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