MR IMAGING OF THE ROTATOR CUFF

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MR IMAGING OF THE ROTATOR CUFF

LEARNING OBJECTIVES

• Review relevant anatomy/MR imaging planes
• Review MR appearance of rotator cuff tears
• Discuss problem rotator cuff tears
• Discuss mimics of rotator cuff tear
• “What the surgeon wants to know”
  – The radiology report
MR IMAGING ROTATOR CUFF TECHNIQUE

- Coil-dedicated shoulder
- Slice thickness – 3-4 mm
- Matrix – 256x192 or higher to 512
- FOV – 14-16 cm
- Patient position
  - External rotation vs neutral
  - ABER
- Contrast - Indirect or Direct
MR IMAGING ROTATOR CUFF
OUR TECHNIQUE

• Axial T2 FS FSE, Axial GRE
• Coronal oblique PD and FS FSE T2
• Sagittal oblique T1 and FS FSE T2
MR ARTHROGRAPHY TECHNIQUE

- 12-16cc (I put in less 8-12cc) mixture of contrast and gadolinium (10:10:0.1)
- Axial, oblique sagittal and oblique coronal FS T1-weighted images
- Additional fluid sensitive sequences
MR IMAGING PLANES

• Axial
  – Assess subscapularis, biceps tendon

• Coronal oblique
  – Parallel to supraspinatus tendon
  – Assess all tendons

• Sagittal oblique (FSE T2)
  – 90° to coronals
  – Assess all tendons
INFRASPINATUS ANATOMY

IS tendon curves forward

Large footprint – 3.3 cm

Overlaps SS -12 to13 mm

MR IMAGING PLANES

• Axial
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• Coronal oblique
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• Sagittal oblique (FSE T2)
  – 90° to coronals
  – Assess all tendons
Parallel to Tendon
Coronal Anatomy
Coronal Anatomy
Coronal Anatomy
Coronal Anatomy
MR IMAGING PLANES

- **Axial**
  - Assess subscapularis, biceps tendon
- **Coronal oblique**
  - Parallel to supraspinatus tendon
  - Assess all tendons
- **Sagittal oblique (FSE T2)**
  - $90^\circ$ to coronals
  - Assess all tendons/muscle bulk
Sagittal Imaging
Sagittal Imaging
Sagittal Anatomy
Sagittal Anatomy
Sagittal Anatomy
Sagittal Anatomy
Sagittal Anatomy
Scapular ratio
Occupation ratio
Should be at least 50%
Tangent sign
Supraspinatus above this line
INFRASPINATUS
The Three Stooges!
<table>
<thead>
<tr>
<th>MRI ROTATOR CUFF TEARS</th>
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<td><strong>SENSITIVITY</strong></td>
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<td>MR FTT</td>
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ROTATOR CUFF TEARS

ETIOLOGY

- Impingement
- Overuse
- Aging
- Chronic inflammatory disease
- Acute trauma
- Instability
IMPINGEMENT SYNDROME

• Clinical – not radiologic diagnosis
  – Pain with abduction and external rotation
  – Pain with elevation and internal rotation
    (Neer impingement sign)
  – Probably not as important as previously

• Mechanical causes
  – Acromial shape, position
  – AC joint osteophyte
  – Thick coracoacromial ligament
  – Instability
IMPINGEMENT SYNDROME
ROTATOR CUFF TEARS
NEER STAGING

- Stage I (<25 y/o)
  - Edema / hemorrhage
- Stage II (25-40 y/o)
  - Fibrosis / thickening
- Stage III (>40 y/o)
  - Partial / Complete Tear
ACROMIAL SHAPE

- Shape
  - Type I
  - Type II
  - Type III
- Lateral Downsloping
- Anterior Downsloping
- Os acromiale
ACROMIAL SHAPE

- Increase in number increases risk of tear
- Type I - flat
- Type II – curved
- Type III – hooked
- Assess on sagittal images
- Not reproducible
ACROMIAL SHAPE

- Increase in number increases risk of tear
- Type I - flat
- Type II - curved
- Type III - hooked
- Assess on sagittal images
- Not reproducible

TYPE 1
ACROMIAL SHAPE

- Increase in number increases risk of tear
- Type I - flat
- Type II - curved
- Type III - hooked
- Assess on sagittal images
- Not reproducible

TYPE 1
ACROMIAL SHAPE

TYPE 2
ACROMIAL SHAPE

TYPE 2
ACROMIAL SHAPE

TYPE 3
ACROMIAL SHAPE

TYPE 3
SUBACROMIAL SPUR
AC JOINT OSTEOPHYTES
CORACOACROMIAL LIGAMENT
OS ACROMIALE

Increased risk rotator cuff tear?

Best seen on axial images

Post-traumatic etiology

High signal intensity in cleft more likely symptomatic
OS ACROMIALE

Incidence 1.3% - 15%
Bilateral 33% - 62%
Fuses normally age 20-25
Symptomatic os acromiale
Cysts in the greater and lesser tuberosity have a high association with rotator cuff pathology; Posterior “cysts” do not.

Decreased space between the humeral head and acromial undersurface also associated with rotator cuff pathology:
- Normal >7mm
- 5-7mm abnormal
- <4/5 mm rotator cuff tear
Normal

Rotator cuff tear
ROTATOR CUFF TEAR
FULL THICKNESS

- Communication between joint and subacromial/subdeltoid bursa
- Increased fluid signal intensity in focus of tendon defect
  - At tendon attachment
  - Critical zone
CT and Ultrasound

Coronal CT

US findings of tear – Hypoechogenicity that replaces hyperechoic normal tendon

Greater tuberosity
CT and Ultrasound
ROTATOR CUFF TEAR
FULL THICKNESS

• Important associated findings/descriptors
  - Which tendons involved (portion of superior cuff)
  - Size of tear
  - Quality of the remainder of the cuff
  - Retraction of musculotendinous junction
  - Muscle atrophy
  - Fluid subacromial/subdeltoid bursa
  - Fluid (intramuscular ganglion) along tendon
ROTATOR CUFF TEAR
FULL THICKNESS

- Which tendons involved/Size of tear
  - Supraspinatus/Infraspinatus (Superior Cuff)
  - Subscapularis
  - 0-2cm mild; 2-3cm moderate;
    3-4cm large; >4cm massive
Full Thickness Tear
Full Thickness Tear

LOOK AT THE ANTERIOR LEADING EDGE
Full Thickness Tear
Full Thickness Tear
The Three Stooges!
The Three Stooges!
Full Thickness Tear

T2

T1 GD
ROTATOR CUFF TEAR
FULL THICKNESS

- Retraction of musculotendinous junction
  - Normal at 12:00
  - Retraction overcalled, in my experience
  - Defines ease of primary repair
- Muscle atrophy
  - Goutallier scale (muscle vs. fat content)
  - Volume (fill > 50%/60% supraspinatus fossa)
  - Intrinsic fat content
ACUTE BRACHIAL NEURITIS
PARSONAGE TURNER SYNDROME

T1

T2
ACUTE BRACHIAL NEURITIS
PARSONAGE TURNER SYNDROME

T1

T2
ACUTE BRACHIAL NEURITIS
PARSONAGE TURNER SYNDROME

T1

T2
SUPRASCAPULAR NERVE IMPINGEMENT

- Suprascapular Notch
  - Supraspinatus/ Infraspinatus innervation
- Spinoglenoid Notch
  - Infraspinatus innervation
- Atrophy of SSM and ISM
- Look for mass in region of suprascapular notch
Spinoglenoid Notch Entrapment

Infraspinatus atrophy

T2

T1
Spinoglenoid Notch Entrapment

Infraspinatus atrophy
Spinoglenoid Notch Entrapment

Infraspinatus atrophy
QUADRILATERAL SPACE SYNDROME

- Axillary nerve compression
- Fibrous band
- Pain, paresthesia
- Atrophy of deltotid and teres minor
- Weightlifters
QUADRILATERAL SPACE SYNDROME

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QUADRILATERAL SPACE SYNDROME
QUADRILATERAL SPACE SYNDROME

T1

T2

T1
Subscapularis Tear

- Abnormal lift-off test on physical examination
- Look for abnormalities of lesser tuberosity
- Uncommon (under-recognized) – 5%-27% of all tears
  - LHBT dislocation (49%)
- Look for on axial and sagittal planes
  - Coronals anteriorly also helpful
- Devastating to surgeon if missed
- Easy to miss on arthroscopy (Only superior 25% of tendon visible on routine arthroscopy)
SUBSCAPULARIS TEARS
SUBSCAPULARIS TEARS
SUBSCAPULARIS TEARS
SUBSCAPULARIS TEAR
EXTRAARTICULAR BICEPS DISLOCATION
EXTRAARTICULAR BICEPS DISLOCATION
Subscapularis Tear

LHBT into delamination of subscapularis
Subscapularis Tear

LHBT into delamination of subscapularis
Normal Subscapularis

- Multipennate tendon
- Inferior 1/3 muscular

Look at sagittals!!

- Medial to LHBT groove
- Oval black tendon
Subscapularis tears are commonly missed
Look for high signal in footprint medial to LHBT groove

Skeletal Radiol (2013)
SUBSCAPULARIS TEAR
ROTATOR CUFF TEAR PARTIAL THICKNESS

- Twice as common as full thickness
- Intrasubstance - most common but not seen on arthroscopy
- Articular side - more common (3-4 to 50X)
- Bursal Side - least common
  - Poor response to conservative treatment
- Increased detection
  - Contrast
  - ABER
- Significant if >50% of tendon thickness
Intrasubstance Tear

T2
Intrasubstance Tear
Small Partial Undersurface Tear
Small Partial Undersurface Tear
Small Partial Undersurface Tear
Large Partial Undersurface Tear

T1 GD CORONAL

T2 CORONAL
Large Partial Undersurface Tear

T1 GD CORONAL

T2 CORONAL
Large Partial Undersurface Tear

T1 GD CORONAL

T2 CORONAL
Large Partial Bursal Tear
Large Partial Bursal Tear
Large Partial Bursal Tear
Large Partial Bursal Tear

T2 CORONAL
Large Partial Bursal Tear
Large Partial Bursal Tear

T2 CORONAL
Intratendinous Ganglion/Cyst
Intratendinous Ganglion/Cyst
Intratendinous Ganglion/Cyst
RIM RENT TEAR

- Seen in young patients
- Usually anterior
- Intrsubstance vs partial undersurface
- PASTA (partial articular side tendon avulsion) /PAINT (posterior articular surface intratendinious tear)
• Seen in young patients
• Usually anterior
• Intrusubstance vs partial undersurface
• PASTA (partial articular side tendon avulsion) /PAINT (posterior articular surface intratendinous tear)
Intrasubstance vs Partial US Value of ABER

MR ARTHROGRAPHY
POST-OPERATIVE SHOULDER MR IMAGING

• Metal artifact decreased with STIR and increased bandwidth
• Surgical repair does not create a watertight seal
• Full thickness retear discontinuity with high signal/gad (arthrogram) particularly if >10mm
• Partial thickness tear fluid/gad (arthro)
• Other complications: deltoid tear/dehiscence, osteonecrosis (AVN), anchor displacement
Normal post-operative rotator cuff
Recurrent Partial RCT
Recurrent Partial RCT
ABNORMALITIES THAT CAN MIMIC ROTATOR CUFF TEAR

- Tendinosis/Magic angle
- Calcific tendonitis
- Adhesive capsulitis
- Subacromial bursitis
INCREASED TENDON SIGNAL SHORT TE SEQUENCES

- Magic angle
- Connective tissue between fascicles
- Tendon overlap (internal rotation)
- Degeneration (tendinosis)
- Tear
- Partial volume
- Injection
PD CORONAL
TENDINOSIS

PD CORONAL

T2 CORONAL
<table>
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<th>Long TE</th>
<th>Pathology</th>
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<td>Black</td>
<td>Tendon Overlap</td>
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<tr>
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<td>Magic Angle</td>
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<td></td>
<td></td>
<td>No Morphologic Abnormality</td>
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<tr>
<td>Grey</td>
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<td>Tendinopathy</td>
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<td></td>
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<td>Morphologic Abnormality</td>
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<td></td>
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<td>Partial tear</td>
</tr>
<tr>
<td>Grey</td>
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<td>Tear</td>
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ABNORMALITIES THAT CAN MIMIC ROTATOR CUFF TEAR

- Tendinosis/Magic angle
- Calcific tendonitis
- Adhesive capsulitis
- Subacromial bursitis
CALCIFIC TENDINITIS

- Rotator cuff most common site
- Tendinopathy
- Primary or secondary disorder?
- Calcium hydroxyapatite deposition in tendon
- Concretion - low T1 and T2 but best seen on GRE sequences
- Most common supraspinatus (95%)
- Variable surrounding edema
- May erode cortex/ invade marrow
CALCIFIC TENDINITIS
CALCIFIC TENDINITIS
CALCIFIC TENDINITIS
CALCIFIC TENDINITIS

T1

T2
CALCIFIC TENDINITIS
ABNORMALITIES THAT CAN MIMIC ROTATOR CUFF TEAR

- Tendinosis/Magic angle
- Calcific tendonitis
- Adhesive capsulitis
- Subacromial bursitis
ADHESIVE CAPSULITIS

- Clinical mimic of cuff tear
- Associated with diabetes
- Capsule thickened
- Thickened coracohumeral ligament
- Replacement anterior interval fat and thickened coracohumeral ligament
- Thickened axillary region
- Abnormal enhancement
ADHESIVE CAPSULITIS

- Clinical mimic of cuff tear
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- Abnormal enhancement
ADHESIVE CAPSULITIS

T2
ADHESIVE CAPSULITIS
ADHESIVE CAPSULITIS

T1GD
ABNORMALITIES THAT CAN MIMIC ROTATOR CUFF TEAR

- Tendinosis/Magic angle
- Calcific tendonitis
- Adhesive capsulitis
- Subacromial bursitis
SUBACROMIAL/SUBDELTOID BURSITIS
WHAT THE SURGEON WANTS TO KNOW: RADIOLOGY REPORT

- Rotator cuff tear full thickness
  - Location/size *(Superior Cuff)* (0-2cm mild; 2-3cm moderate; 3-4cm; large; >4cm massive); Subscapularis tears easy to miss
  - Retraction musculotendinous junction (overcalled and NOT the defect)
  - Quality of the remainder of the cuff
  - Muscle atrophy and how severe
- Partial thickness tear
  - Location and size (> or < 50% thickness of tendon)
WHAT THE SURGEON WANTS TO KNOW: RADIOTHERAPY REPORT

- Associated abnormalities/causes of similar symptoms
  - Os acromiale
  - Tendinopathy
  - Calcific tendinosis
  - Adhesive capsulitis
  - Subacromial/subdeltoid bursitis
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SPECIAL THANK YOU

- Mark Anderson MD
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