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
- 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 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)**
  - $90^\circ$ to coronals
  - Assess all tendons
MR IMAGING PLANES

- Axial
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Parallel to Tendon
Coronal Anatomy
Coronal Anatomy
Coronal Anatomy
MR IMAGING PLANES

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- **Coronal oblique**
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- **Sagittal oblique (FSE T2)**
  - 90° to coronals
  - Assess all tendons/muscle bulk
Sagittal Anatomy
Sagittal Anatomy
Sagittal Anatomy
Sagittal Anatomy

- Image 1: Sagittal view showing anatomical structures with yellow ellipses.
- Image 2: Detailed anatomical view with numbered labels: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11.
Scapular ratio
Occupation ratio
Should be at least 50%
Tangent sign
Supraspinatus above this line
SUBSCAPULARIS
SUPRASPINATUS
INFRASPINATUS
The Three Stooges!
<table>
<thead>
<tr>
<th>Test Type</th>
<th>Sensitivity</th>
<th>Specificity</th>
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<td>MR FTT</td>
<td>80%-100% (92%)</td>
<td>88%-97% (93%)</td>
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<tr>
<td>MR PTT</td>
<td>35%-87% (64%)</td>
<td>71%-83% (92%)</td>
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<td>MR IAr FTT</td>
<td>80%-100%</td>
<td>78%-100%</td>
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<tr>
<td>MR IAr PTT</td>
<td>50%-71%</td>
<td>88%</td>
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<td>MR DAr FTT</td>
<td>96%</td>
<td>99%</td>
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<tr>
<td>MR DAr PTT</td>
<td>80%-84%</td>
<td>96%-97%</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
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

TYPE 1
ACROMIAL SHAPE

• Increase in number increases risk of tear

• Type I - flat
• Type II - curved
• Type III - hooked

Assess on sagittal images

TYPE 1
ACROMIAL SHAPE

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- Not reproducible
ACROMIAL SHAPE

TYPE 2
ACROMIAL SHAPE

TYPE 2
ACROMIAL SHAPE

TYPE 3
ACROMIAL SHAPE

TYPE 3
SUBACROMIAL SPUR
SUBACROMIAL SPUR
AC JOINT OSTEOPHYTES
AC JOINT OSTEOPHYTE
CORACOACROMIAL LIGAMENT
ACROMIAL DOWNSLOPING
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
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
ROTATOR CUFF TEAR
FULL THICKNESS

• Important associated findings/descriptors
  - Which tendons involved
  - 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
  - Subscapularis
  - 0-2cm mild; 2-3cm moderate; 3-4cm large; >4cm massive
Full Thickness Tear
Full Thickness Tear
T2
The Three Stooges!
The Three Stooges!
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
ACUTE BRACHIAL NEURITIS
PARSONAGE TURNER SYNDROME
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
Spinoglenoid Notch Entrapment

Infraspinatus atrophy

T2

Infraspinatus atrophy

T1
Spinoglenoid Notch Entrapment

Infraspinatus atrophy
QUADRILATERAL SPACE SYNDROME

- Axillary N. Compression
- Fibrous band
- Pain, paresthesia
- Atrophy of deltoid and/or teres minor
- Weightlifters
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QUADRILATERAL SPACE SYNDROME

T1

T2

T1
QUADRILATERAL SPACE SYNDROME
SUBSCAPULARIS TEAR

• Abnormal lift-off test on physical exam
• Look for abnormalities of lesser tuberosity
• Uncommon – 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
SUBSCAPULARIS TEARS
SUBSCAPULARIS TEARS
SUBSCAPULARIS TEAR
SUBSCAPULARIS TEAR
SUBSCAPULARIS TEAR
ROTATOR CUFF TEAR
PARTIAL THICKNESS

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

T2 CORONAL
Large Partial Bursal Tear

T2 CORONAL
Large Partial Bursal Tear

T2 CORONAL
RIM RENT TEAR

- Seen in young patients
- Usually anterior
- Intrasubstance vs partial undersurface
- PASTA (partial articular side tendon avulsion) /PAINT (posterior articular surface intratendinous tear)
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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: deltid tear/dehiscence, osteonecrosis (AVN), anchor displacement
Normal post-operative rotator cuff
Post-operative rotator cuff retear
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 fasicles
- Tendon overlap (internal rotation)
- Degeneration (tendinosis)
- Tear
- Partial volume
- Injection
TENDON OVERLAP

[Image of tendons labeled Supraspinatus and Infraspinatus]
TENDON OVERLAP
TENDINOSIS

PD CORONAL

T2 CORONAL
TENDINOSIS

PD CORONAL

T2 CORONAL
TENDINOSIS

PD CORONAL

T2 CORONAL
<table>
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<tr>
<td>Grey</td>
<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>No Morphologic Abnormality</td>
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<td>Tendinopathy</td>
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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
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ADHESIVE CAPSULITIS

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

T2WI
ADHESIVE CAPSULITIS

T1GD
ABNORMALITIES THAT CAN MIMIC ROTATOR CUFF TEAR

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

- Rotator cuff tear full thickness
  - Location/size (0-2cm mild; 2-3cm moderate; 3-4cm; large; >4cm massive)
  - 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: RADIOLOGY REPORT

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

- Mark Anderson MD
- Donald Flemming MD
- Mark Kransdorf MD