Disclosures:

• Consultant: Bioclinica
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Outline:

- Rotator cuff:
  - Cuff tear and tendinosis
  - Secondary signs of cuff tear
  - Calcific tendinosis
  - Post-operative cuff
- Biceps brachii tendon abnormalities
- Subacromial-subdeltoid bursa
Rotator Cuff Ultrasound:

• Accuracies:
  – Full-thickness tear: 96%\textsuperscript{1}
  – Partial-thickness tear: 94%\textsuperscript{2}
  – Equal to MRI: accuracy, size of tear\textsuperscript{3}

• Patients prefer ultrasound over MRI\textsuperscript{4}

\textsuperscript{1}Teefey, JBJS Am 2000; 82:498.
\textsuperscript{2}van Holsbeeck, Radiology 1995; 197:443.
\textsuperscript{3}Teefey, JBJS Am 2004; 86:708.
\textsuperscript{4}Middleton, AJR 2004; 183:1449.
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%)

de Jesus, 2009; 192:1701
Rotator Cuff Tears

- Tears are hypoechoic / anechoic
- Indirect signs at ultrasound:
  - Cortical irregularity: supraspinatus footprint
    - If present on radiographs, 75% have tear
  - Volume loss
- Massive tear: non-visualization

AJR 1998; 171:229
Radiology 2004; 230:234
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 Abnormalities:

Categories:

- Partial-thickness tear
- Full-thickness tear
- Intra-substance tear
- Tendinosis
Supraspinatus: normal

- Bursal Surface
- Greater Tuberosity Surface
- Articular Surface

Long Axis
Supraspinatus Tears: extent

Rim-rent Tear

Partial Articular

Partial Bursal

From: Fundamentals of Musculoskeletal Ultrasound
Supraspinatus Tears: extent

Intrasubstance

Full thickness

From: Fundamentals of Musculoskeletal Ultrasound
Articular Partial-thickness Tear: supraspinatus

Deltoid

Humerus

Long Axis

Coronal T2w
Articular Partial-thickness Tear: supraspinatus

Short Axis Sagittal T2w

Deltoid

Humerus

Short Axis

Sagittal T2w
Articular Partial-thickness Tear: supraspinatus

Long Axis

Sagittal T2w
Bursal Partial-thickness Tear: supraspinatus

Long Axis

Short Axis
Bursal Partial-thickness Tear: supraspinatus

Long Axis

Short Axis
Bursal Partial-thickness Tear: supraspinatus

Long Axis

Short Axis
Bursal Partial-thickness Tear: supraspinatus

Short Axis

Sagittal T2w
Full-thickness Tear: supraspinatus

Note: Cartilage Interface Sign (open arrow)
Full-thickness Tear: supraspinatus

Note: Cartilage Interface Sign (open arrow)
Full-thickness Tear: supraspinatus

Short Axis

IST

Short Axis
Full-thickness Tear: supraspinatus

Long Axis

T2w Coronal-oblique
Full-thickness Tear: supraspinatus

Short Axis

T2w Sagittal-oblique
Large Full-thickness Tear: supraspinatus

Deltoid
Humerus

Long Axis
Coronal T2w
Large Full-thickness Tear: supraspinatus

- Deltoid
- Humerus

Short Axis

Sagittal T2w
Intrasubstance Tear: supraspinatus

*Note lack of cartilage interface sign
Tendinosis or Tendinopathy

- No inflammatory cells
  - Mucoid degeneration, chondroid metaplasia
- Hypoechoic, ill-defined
- Possible increased thickness
- No cortical irregularity*


*Radiology 2004; 230:234
Tendon Tear versus Tendinosis

*both may appear hypoechoic*

**Tear**
- Anechoic
- Well-defined
- Homogeneous
- Thinned
- Bone irregularity*

**Tendinosis**
- Hypoechoic
- Ill-defined
- Heterogeneous
- Swollen
- Smooth cortex

*At supraspinatus tendon footprint in patients over 40 years old*
Tendinosis: supraspinatus tendon

Longitudinal

Coronal-oblique T2w
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Secondary Findings of Rotator Cuff Tears:

- Volume loss of tendon substance
- Cortical irregularity
- Effusion (articular & bursal)
- Cartilage interface sign
Tendon Volume Loss:

- Flat or concave outer margin of supraspinatus*
  - Deltoid muscle dips into tendon gap
- Full-thickness tears
- Bursal sided partial-thickness tears
- Not seen in tendinosis

*Hodler et al. Radiology 1988; 169:791
Full-thickness Tear: supraspinatus

Short Axis
Cortical Irregularity:

- Greater tuberosity: at supraspinatus insertion
- When present: 75% have rotator cuff tears
  - Patient over 40 years old
- When absent: 96% normal cuffs by sonography

AJR 1998; 171:229
Radiology 2004; 230:234
Cortical Irregularity: no significance

Humerus

Long Axis

Short Axis

Subscapularis Tendon
Joint & Bursal Effusions:

- Joint effusion (biceps tendon)
- Subacromial-subdeltoid bursal fluid: >1 mm distention
- If both: 95% positive predictive value for rotator cuff tear

*Hollister et al. AJR 1995; 165:605
Joint Effusion and Bursal Fluid

Short Axis

Deltoid
BT

Long Axis
Joint Effusion:
posterior glenohumeral joint recess
Cartilage Interface Sign:

• Reflective interface between hypoechoic hyaline cartilage and adjacent fluid
• Indicates articular extension of tear
• Limited value
Small Full-thickness Tear: supraspinatus
Fatty Infiltration and Muscle Atrophy

- Supraspinatus and infraspinatus
  - Infraspinatus: only variable to predict cuff healing\(^1\)
- Associations:
  - Chronic, large, anterior supraspinatus tears\(^2\)
- Ultrasound:
  - Moderate to good correlation with MRI\(^3\)
  - Improved reliability with extended field-of-view\(^4\)

\(^1\)Chung et al. Am J Sports Med; 2013; 41:16764
\(^3\)Khoury et al. AJR 2008; 190:1105.
\(^4\)Nazarian et al. 2008; 190:27.
Fatty Infiltration and Muscle Atrophy

- Indistinct tendon-muscle border
- Increased muscle echogenicity
  - Compare to teres minor
- Decreased muscle bulk
  - Compared to teres minor
  - Bone landmark: ridge in scapula
  - Short axis: infraspinatus 2x size
Infraspinatus Atrophy

Short Axis  Long Axis

Teres Minor
Infraspinatus Atrophy

Short Axis

Long Axis
Supraspinatus Atrophy

Short Axis

Long Axis

Scapula
Atrophy: supraspinatus and infraspinatus

Short Axis (extended field-of-view)
No Atrophy

Short Axis (extended field-of-view)
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Calcific Tendinosis

• Hydroxyapatite deposition: dystrophic
  – Usually do not have cuff tear
• Appearance:
  – 79% hyperechoic & shadowing
  – No shadow: 7%
• Two phases:
  – Formative
  – Resorptive: painful

Farin et al. Skeletal Radiol 1996; 25:551
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
Subscapularis: calcific tendinosis
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Post-operative Rotator Cuff:

- Post-op tendon: echogenic & thin*
- Reimplantation trough
- Echogenic sutures & anchors

*Mack et al. AJR 1988; 150:1089
Intact Post-operative Cuff
Post-operative Rotator Cuff:

- **Recurrent tear**: usually large with nonvisualization
- **Focal hypoechogenicity**: equivocal
Post-operative cuff: recurrent tear

Long Axis

PDw fat-sat coronal

Open arrow = bioabsorbable suture anchor
Post-operative cuff: recurrent tear

Short Axis

Open arrow = suture

PDw fat-sat sagittal
Arthroplasty: Intact Cuff

Long Axis

Short Axis
Arthroplasty: Cuff Tear

Long Axis
Outline:

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Biceps Tendon:

- Shoulder joint effusion:
  - Collects around biceps tendon
  - Tendon sheath communication
  - Joint fluid collects dependently
Inflammatory Tenosynovitis: biceps tendon

Long Axis
Biceps Tendon:

- Tendinosis:
  - Hypoechoic
  - Swollen
  - No inflammatory cells (not tendinitis)
  - Possible tenosynovitis
Biceps Tendon:

- Partial-thickness tear:
  - Hypoechoic / anechoic cleft
  - Tenosynovitis
  - Sensitivity: 27%
  - Accuracy: 88%
  - Subluxation / spur
    - Important secondary signs

Skendzel J, et al. AJR 2000; 197:942
Biceps Tendon

- Accessory head: 9 – 23%
- Cleft: coronal plane
- Deep tendon: to labrum
- Superficial tendon: to tuberosities or cuff

Gheno R. et al. AJR 2010; 194:W80
Biceps Tendon

Subluxation

Dislocation

Lesser Tuberosity
Biceps Tendon Subluxation
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Subacromial-subdeltoid Bursa: fluid

Coronal Coronal T2w

Deltoid

Suprasp.
Subacromial-subdeltoid bursa: anterior
Subacromial-subdeltoid Bursa: thickening
Bursal Thickening Simulating Intact Cuff

Long Axis

Short Axis
Calcific Bursitis
Impingement: bursal fluid

- Abnormal pooling of subacromial-subdeltoid bursal fluid
- Lateral acromion\textsuperscript{1}:
  - Coronal plane, active arm elevation
  - Not visible in neutral position, no cuff tear
- At coracoid\textsuperscript{2}:
  - Axial plane, active elevation internal rotation

\textsuperscript{1}Farin et al. Radiology 1990; 176:845
\textsuperscript{2}Stallenberg et al. AJR 2006; 187:894
Impingement Syndrome
Impingement: supraspinatus
Take-home Points

- Must follow a protocol
- Cuff tears: avoid anisotropy
- Cortical irregularity: important indirect sign
  - Supraspinatus tears
- Dynamic: impingement
- Joint effusion: biceps