Ultrasound of the Rotator Cuff

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Outline:
• Anatomy
• Rotator cuff tears:
  – Primary, secondary signs and pitfalls
• Miscellaneous pathology

Technical Considerations
• > 10 Mhz (prefer at least 12 Mhz)
• Supraspinatus: long axis most important plane
  – Less pitfalls, easy recognition of anatomy
  – >90% accuracy long axis alone
• Biceps tendon (intra-articular)
  – Important landmark: complete evaluation

Supraspinatus Tendon: normal
• Hyperechoic and fibrillar echotexture
• Convex superior surface
• Uniform thickness: transverse

1Arend CF et al. J Ultrasound Med 2010, 29-1725
Supraspinatus - Infraspinatus Junction

- Longitudinal:
  - Flattening of greater tuberosity
  - Tendon striations: anisotropy infraspinatus
- Transverse:
  - 1.3 – 2.3 cm posterior to biceps tendon
  - Infraspinatus overlaps supraspinatus
  - Slight volume loss
Supraspinatus – Infraspinatus Junction

Rotator Cuff Tears:
- General comments
- Secondary signs of rotator cuff tear
- Pitfalls in rotator cuff sonography

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 Abnormalities:
- Partial-thickness tear
  - Articular-sided
  - Bursal-sided
- Intrasubstance (or interstitial)
- Full-thickness tear
- Tendinosis

AJR 1998; 171:229
Radiology 2004; 230:234
Supraspinatus: normal

Supraspinatus Insertion


Supraspinatus Tears: extent

From: Fundamentals of Musculoskeletal Ultrasound

Rotator Cuff Tear: Extent

- Partial-thickness:
  - Intersitial
  - Articular
  - Bursal

- Full-thickness, incomplete:
  - Extends to two surfaces

- Full-thickness, complete:
  - Entire tendon discontinuous
  - Full width

Articular Partial-thickness Tear: supraspinatus

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

Long Axis

Coronal T2w

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**Pitfall Alert! Anisotropy**

- Sound beam oblique to tendon fibers
- Artifactually hypoechoic
- Most common location for this error: rim rent area

Supraspinatus: long axis

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**Bursal Partial-thickness Tear: supraspinatus**

Long Axis

Coronal T2w

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**Full-thickness Tear: supraspinatus**

Note: Cartilage Interface Sign (open arrow)

Long Axis

Short Axis

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**Full-thickness Tear: supraspinatus (full-width)**

Short Axis

IST
Large Full-thickness Tear: supraspinatus

Intrasubstance Tear: supraspinatus

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

Tendinosis: supraspinatus

Tendon Tear versus Tendinosis
*both may appear hypoechoic

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

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

Fatty Infiltration and Muscle Atrophy
- Supraspinatus and infraspinatus
  - Infraspinatus: only variable to predict cuff healing¹
- Associations:
  - Chronic, large, anterior supraspinatus tears²
- Ultrasound:
  - Comparable to MRI³
  - Improved reliability with extended field-of-view⁴

³Wall LB et al. JSS 2012; 54.e83.
⁴Nazarian 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

Teres Minor

Short Axis   Long Axis

Supraspinatus Atrophy

C Scapula S

Short Axis   Long Axis

Atrophy: supraspinatus and infraspinatus

Supraspinatus Infraspinatus

Short Axis (extended field-of-view)

Rotator Cuff Tears:

- General comments
- Secondary signs of rotator cuff tear
- Pitfalls in rotator cuff sonography

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

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

Partial-thickness Tear
- Tendinosis
- 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

Cartilage Interface Sign:
- Reflective interface between hypoechoic hyaline cartilage and adjacent fluid
- Indicates articular extension of tear
- Limited value

Supraspinatus: full-thickness tear
Fellow (partial tear); Faculty (full-thickness tear)

Rotator Cuff Tears:
- General comments
- Secondary signs of rotator cuff tear
- Pitfalls in rotator cuff sonography
Incomplete Evaluation of Supraspinatus Internal Rotation

Short Axis US

Incomplete Evaluation of Supraspinatus

Long Axis

Biceps

BT

LT

Short Axis US

Long Axis

Anisotropy: supraspinatus

Long Axis

Short Axis

Bursal Thickening Simulating Intact Cuff

Long Axis

Short Axis

Pseudofibers with Full-thickness Tear

Long Axis

Short Axis

Miscellaneous Cuff Pathology:

• Infraspinatus tendon
• Subscapularis tendon
• Post-operative cuff
• Calcific tendinosis
Infraspinatus: tendinosis

Infraspinatus Tear: full-thickness

Miscellaneous Cuff Pathology:
- Infraspinatus tendon
- Subscapularis tendon
- Post-operative cuff
- Calcific tendinosis

Subscapularis Tear:
- Isolated tear: rare, trauma
- Part of massive cuff tear
- Anterosuperior cuff tear:
  - Supraspinatus and subscapularis borders of the rotator interval

Pfirrmann et al. Radiology 1999; 213:709

Partial-thickness Articular Tear: subscapularis

Focal Full-thickness Tear: subscapularis
Subscapularis Tear: full-thickness
Long Axis Contralateral side

Miscellaneous Cuff Pathology:
- Infraspinatus tendon
- Subscapularis tendon
- Post-operative cuff
- Calcific tendinosis

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: retear
Long Axis Coronal-obl T2w
Post-operative cuff: recurrent tear

PDw fat-sat coronal

Open arrow = bioabsorbable suture anchor

Post-operative cuff: recurrent tear

PDw fat-sat sagittal

Open arrow = suture

Arthroplasty: Intact Cuff

Arthroplasty: Cuff Tear

GT

Miscellaneous Cuff Pathology:
• Infraspinatus tendon
• Subscapularis tendon
• Post-operative cuff
• Calcific tendinosis

Degenerative Calcification
Calcific Tendinosis

- Hydroxyapatite deposition: metaplasia
  - Usually do not have cuff tear
- Appearance:
  - 79% hyperechoic & shadowing
  - No shadow: 7%
- Two phases:
  - Formative
  - Resorptive: painful, tendinitis

Farin et al. Skeletal Radiol 1996; 25:551

Calcific Tendinosis

Formative
Defined, shadow

Resorptive
Amorphous, little shadow

Calcific Tendinosis: supraspinatus

Longitudinal       Transverse

Subscapularis: calcific tendinosis

Calcific Tendinosis: resorptive phase

Patient #1
Patient #2: Intra-osseous invasion

Calcific Tendinosis: supraspinatus
Use of Tendon Anisotropy

Long axis
**Teres Minor Atrophy:**
- Isolated finding: 3%
- Usually without visible pathology in quadrilateral space:
  - Mass, paralabral cyst, etc.
- May relate to variation in origin and length of teres minor innervation

Sofka, Skeletal Radiol 2004; 33:514
Friend, Surg Radiol Anat 2010; 32:243

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**Quadrilateral Space Syndrome**
- Axillary nerve entrapment
- Teres minor, teres major, long head of triceps, and humeral shaft
- Weakness, pain and skin paresthesia
- Post. humeral circumflex art occlusion
- Teres minor and/or deltoid atrophy

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**Take-home Points**
- Must follow a protocol
- Beware: anisotropy
  - Especially at supraspinatus footprint
- Cortical irregularity: important indirect sign
  - Supraspinatus tears, >40 years old
- Fatty infiltration
- Calcific tendinosis

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Syllabus on line and other educational material:
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