Ultrasound Evaluation of Shoulder Pathology

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Disclosures:
• Consultant: Bioclinica
• Advisory Board: Philips
• Book Royalties: Elsevier

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Outline:
• Rotator cuff tears:
  – Primary and secondary signs
  – Pitfalls
• Miscellaneous pathology

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%)

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

de Jesus, 2009; 192:1701
AJR 1998; 171:229
Radiology 2004; 230:234
Rotator Cuff Tears:

- Patients < 40 years old
  - Not common
  - Partial, articular, anterior
  - Associated labral pathology
- Degenerative tears
  - Posterior aspect of supraspinatus
  - May extend anterior or posterior

Supraspinatus: normal

Supraspinatus Insertion


Supraspinatus Tears: extent

Rim- rent Tear, PASTA lesion

Partial Articular

Partial Bursal

From: Fundamentals of Musculoskeletal Ultrasound

Supraspinatus Tears: extent

Intrasubstance

Full thickness

From: Fundamentals of Musculoskeletal Ultrasound

Partial-thickness Tear:

- Usually hypoechoic / anechoic
  - May see hyperechoic fiber stump*
- Articular, bursal, or intrasubstance
- Associated cortical irregularity
- Little if any tendon volume loss
  - Unless bursal location

van Holsbeeck et al. Radiology 1995; 197:443
**Supraspinatus Tears: rim-rent**


**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**

- Long Axis
- Short Axis

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**Bursal Partial-thickness Tear: supraspinatus**

- Long Axis
- Short Axis
**Bursal Partial-thickness Tear: supraspinatus**

**Small Full-thickness Tear:**
- Hypoechoic / anechoic:
  - Articular to bursal surface
- Volume loss: minimal or absent
  - If present: suggests full-thickness or bursal partial-thickness tear

**Full-thickness Tear: supraspinatus**

**Large Full-thickness Tear:**
- Hypoechoic / anechoic disruption of tendon fibers (1-3 cm)
- Articular to bursal surface
- Fluid or granulation tissue
- Volume loss of tendon substance

**Full-thickness Tear: full-width**
- Full-thickness tear
- Entire width of tendon torn
- May extend into adjacent tendons
- Usually with significant retraction
  - Supraspinatus non-visualization
- Muscle atrophy
Full-thickness Tear: supraspinatus

Intra-substance Tear:
- Hypoechoic or anechoic
- Well defined
- Does not extend to articular or bursal surface
  - Isolated greater tuberosity extension

*Note lack of cartilage interface sign*
Tendinosis

- 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

Fatty Infiltration and Muscle Atrophy

- Supraspinatus and infraspinatus
  - Infraspinatus: only variable to predict cuff healing*
- Associations:
  - Chronic, large, anterior supraspinatus tears
- Ultrasound:
  - Moderate to good correlation with MRI
  - Improved reliability with extended field-of-view

*Khoury et al. AJR 2008; 190:1105.
*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

Tendons

Atrophy: supraspinatus and infraspinatus

Short Axis (extended field-of-view)

Teres Minor

Supraspinatus   Infraspinatus

No Atrophy

Short Axis (extended field-of-view)

Supraspinatus   Infraspinatus

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

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
Tendon Volume Loss

Full-thickness Tear: supraspinatus

Secondary Findings of Rotator Cuff Tears:
- Volume loss of tendon substance
- Cortical irregularity

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

Humerus

Deltoid

Subscapularis Tendon

Tendon Tear: cortical irregularity

Cortical Irregularity: no significance
Secondary Findings of Rotator Cuff Tears:
- Volume loss of tendon substance
- Cortical irregularity
- Effusion (articular & bursal)

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

Principal Findings of Rotator Cuff Tears:
- Volume loss of tendon substance
- Cortical irregularity
- Effusion (articular & bursal)
- Cartilage interface sign

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

Small Full-thickness Tear: supraspinatus

Joint Effusion and Bursal Fluid

Short Axis
Long Axis

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

Incomplete Evaluation of Supraspinatus:
- Scan entire width of greater tuberosity
- Most tears occur anteriorly
- Include biceps on transverse image as landmark

Musculotendinous Junction:
- Subscapularis: several distinct tendons
- Appears as hypoechoic area extending into tendon
- Heterogeneous to lesser tuberosity
Musculotendinous Junction: subscapularis

Subacromial-subdeltoid Bursa:
- Hyperechoic synovium may appear similar to tendon fibers
- Hyperechoic thickness that extends beyond greater tuberosity is synovium and not cuff fibers

Subacromial-subdeltoid Bursa:

Bursal Thickening Simulating Intact Cuff

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

Infraspinatus Tear:
- Isolated tear: rare, trauma
- Part of massive cuff tear:
  - If supraspinatus tear, look for extension
  - Tear extends over middle facet >1.3 cm from rotator interval on transverse image

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

Partial-thickness Articular Tear: subscapularis

Focal Full-thickness Tear: subscapularis

Subscapularis Tear: full-thickness

Pfirrmann et al. Radiology 1999; 213:709
Subscapularis Tear: full-thickness

Long Axis Contralateral side

Lesser Tuberosity

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 Cuff: retear

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

PDw fat-sat coronal

Open arrow = bioabsorbable suture anchor

Long Axis

Post-operative cuff: recurrent tear

PDw fat-sat sagittal

Open arrow = suture

Short Axis

Arthroplasty: Intact Cuff

Arthroplasty: Cuff Tear

Long Axis

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

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

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
  Farin et al. Skeletal Radiol 1996; 25:551

Calcific Tendinosis
- Formative: Defined, shadow
- Resorptive: Amorphous, little shadow

Subscapularis: calcific tendinosis

Miscellaneous Pathology:
- Biceps brachii tendon
- Subacromial-subdeltoid bursa
- Acromioclavicular joint

Biceps Tendon:
- Glenohumeral joint effusion:
  - Collects around biceps tendon
  - Tendon sheath communication
  - Seen in 97% with joint effusion
  - Abnormal: > 1 mm
  Zubler et al. Eur Radiol 2011; 21:1858
**Shoulder Joint Recesses**
- Long head biceps tendon sheath
- Posterior recess:
  - Image with shoulder in external rotation
- Axillary recess
- Subscapularis recess

**Biceps Tendon Sheath**
- Intra-articular body
  - Echogenic
  - Possible shadowing
  - Single or multiple
  - Associated with glenohumeral joint osteoarthritis

**Biceps Tendon:**
- Tenosynovitis
  - *Unlike joint effusion:*
    - Focal distention
    - Hyperemia with color Doppler
    - Pain with transducer pressure
    - No effusion in posterior recess

**Inflammatory Tenosynovitis: biceps tendon**

**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 2011; 197:942

**Biceps Tendon:**
- Full-thickness tear:
  - Non-visualization proximally
  - Bicipital groove filled with fluid / granulation tissue
  - Distal retracted tendon stump
  - Ultrasound: 88% sensitivity, 97% accuracy
  Skendzel J, et al. AJR 2000; 197:942

**Pitfall Alert!**
**Pseudo Biceps Tendon**
- Biceps brachii long head
- Complete retracted tear
- Visible “fibers” in groove
  - Collapsed tendon sheath
  - Aponeurotic expansion of supraspinatus
- Look for distal retracted tendon and absent tendon in rotator interval

**Aponeurotic Expansion of Supraspinatus Tendon**
- Up to 49% of shoulders
- Cleft: coronal plane
- Origin: supraspinatus
- Distal: pectoralis or bicipital groove

**Biceps Tendon:**
- Full-thickness tear
  - Non-visualization proximally
  - Bicipital groove filled with fluid / granulation tissue
  - Distal retracted tendon stump
  - Ultrasound: 88% sensitivity, 97% accuracy
  Skendzel J, et al. AJR 2000; 197:942

**Biceps Tendon**
- Subluxation
- Dislocation

**Lesser Tuberosity**

**Humerus**

**Bicipital Groove**

**Long Axis**

**Short Axis**

**Short Axis: distal**
Biceps Tendon Subluxation

Biceps Tendon Dislocation

Biceps Tendon: Dislocation into subscapularis tendon

Miscellaneous Pathology:
- Biceps brachii tendon
- Subacromial-subdeltoid bursa
- Acromioclavicular joint

Subacromial-subdeltoid Bursa:

- Normal:
  - Thin hypoechoic layer: fluid, synovium
  - Hyperechoic: bursal walls and peribursal fat
- Abnormal: >1 mm thick*
  - Fluid: anechoic
  - Synovial tissue: hypoechoic to hyperechoic

*Invest Radiol 1985;20:311

Note: Subacromial-subdeltoid Bursa (light blue)
Subacromial-subdeltoid Bursa: fluid

Coronal

Coronal T2w

Subacromial-subdeltoid bursa: anterior

Proximal

Distal

Sagittal

Subacromial-subdeltoid bursa (SASD) vs. subscapularis recess (SSR) vs. subcoracoid bursa (SCB)

Anterior

Posterior

Subacromial-subdeltoid Bursa and Biceps Tenosynovitis

Transverse

Coronal

Calcific Bursitis
Impingement Syndrome

- Cuff impingement
- Subacromial enthesophyte or acromioclavicular joint osteophyte
- Associated tendon degeneration and tear

Impingement: bursal fluid

- Abnormal pooling of subacromial-subdeltoid bursal fluid
- Lateral acromion:
  - Coronal plane, active arm elevation
  - Not visible in neutral position, no cuff tear
- Thickened tendon or bursa
  - Possible snapping of thickened bursa
  - “Gathering” of bursa: may be asymptomatic

1Farin et al. Radiology 1990; 176:845
2Daghir A et al. Skeletal Radiol 2012; 41:1047

Impingement Test

Impingement Syndrome

Impingement: supraspinatus

Impingement: supraspinatus
Miscellaneous Pathology:
- Biceps brachii tendon
- Subacromial-subdeltoid bursa
- Acromioclavicular joint

Acromioclavicular Joint:
- Osteoarthritis: common by age 40
  - Thick capsule >2 mm
  - Narrow, irregular, osteophytes
- Trauma:
  - Wide, possible subluxation
  - Thick capsule >2 mm
- Cyst versus geyser sign
  - Geyser: joint fluid tracking through ACJ via full-thickness rotator cuff tear
Take-home Points

• Must follow a protocol
• Most cuff tears: supraspinatus
  – Use rotator interval and facets as landmarks
• Cortical irregularity: important indirect sign
  – Supraspinatus tears
• Dynamic: impingement, biceps
• Joint effusion: biceps tendon sheath

See www.jacobsonmskus.com for syllabus and other educational material
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