Ultrasound of Upper Extremity Pathology with MRI Correlation

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Outline:
- Tendons:
  - Rotator cuff and lateral epicondyritis
- Ligaments:
  - Ulnar collateral ligament (elbow)
  - Gamekeeper’s thumb
- Nerves:
  - Cubital tunnel syndrome
  - Carpal tunnel syndrome
- Inflammatory arthritis
- Soft tissue foreign bodies

Ultrasound Appearance:
- Tendon: hyperechoic, fibrillar
- Muscle: relatively hypoechoic
- Bone cortex: hyperechoic, shadowing

Anisotropic Effect
- Tendon is artifactually hypoechoic
- Sound beam is not perpendicular to fibers
- Tendon, ligament > muscle

Tendon Abnormalities:
- Tendinosis: hypoechoic, swollen
- Partial-thickness tear: hypoechoic with anechoic focus or clefts
- Full-thickness tear: discontinuity
  - Dynamic imaging: retraction

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
Supraspinatus Insertion


Supraspinatus Tears: extent

From: Fundamentals of Musculoskeletal Ultrasound

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
Articular Partial-thickness Tear: supraspinatus

Bursal Partial-thickness Tear: supraspinatus

Full-thickness Tear: supraspinatus

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

3Khoury et al. AJR 2008; 190:1105.
4Nazarian et al. 2008; 190:27.
Atrophy: supraspinatus and infraspinatus

Short Axis (extended field-of-view)

Tendinosis

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

Calcific Tendinosis

- Tendon metaplasia: hydroxyapatite deposition
- Two phases:
  - Formative: well-defined, dense shadow
  - Resorptive: amorphous
- Percutaneous US-guided lavage/aspiration


*Radiology 2004; 230:234

Subscapularis: calcific tendinosis

Calcific Tendinosis: lavage/aspiration

Lateral Elbow

Common extensor tendon (E)
Radial collateral ligament (arrows)
Annular ligament (arrowhead)
Lateral ulnar collateral ligament (curved arrow)


Epicondylitis:
- Common flexor and extensor tendons
- Abnormal hypoechogenicity
  - Mucoid degeneration, tendinosis
- Anechoic: partial-thickness tear
- No inflammatory cells*

Potter, Radiology 1995; 196:43

Common Extensor Tendon: elbow
- Often called “tennis elbow” or “lateral epicondylitis” or “epicondylitis” or ……
- All terms are misnomers
- Those inflicted usually do not play tennis (professionally or correctly)
- It is not inflammatory
- It is not a primary problem of the epicondyle
Common Extensor Tendon: tendinosis

Note: normal radial collateral ligament (white arrow)

Common Extensor Tendon: partial tear

Long Axis

Tendon Fenestration

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T1w Coronal post-gadolinium
T2w Coronal post-gadolinium

Ulnar Collateral Ligament Tear

Ulnar Collateral Ligament: laxity

With valgus stress
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Gamekeeper’s Thumb

- Injury of the ulnar collateral ligament (UCL) of the thumb
  - Historically, chronic injury in Scottish gamekeepers
  - Frequently, due to acute MCP joint hyperabduction
  - Skier’s thumb: up to 86% of thumb base injuries

Ulnar Collateral Ligament: thumb

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Stener Lesion:

- Displaced proximal stump of torn UCL
  - Interposed adductor aponeurosis
  - Hypoechoic & round: proximal to MCP
  - At proximal edge of adductor aponeurosis
- No tissue spanning MCP joint
- “Yo-yo on a string” sign
- Ultrasound: 100% accuracy

*Melville D. et al. Skeletal Radiology 2013; 42:667*
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Nerve Entrapment

- US findings:
  - Nerve enlargement proximal to entrapment
    - Best appreciated transverse to nerve
  - Abnormally hypoechoic
    - Especially the connective tissue layers
  - Variable enlargement or flattening at entrapment site

**Ulnar Nerve: anatomy**

- Behind medial epicondyle of humerus:
  - Cubital tunnel retinaculum or Osborn’s fascia
- Distal to epicondyle:
  - True cubital tunnel
  - Between ulnar and humeral heads: flexor carpi ulnaris
  - Under arcuate ligament


**Ulnar Nerve: dislocation**

- 20% of asymptomatic volunteers
- Dynamic imaging:
  - Dislocates in anterior to medial epicondyle of humerus in elbow flexion
  - Reduces in extension (normal MRI)
- Transducer pressure may inhibit movement


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Carpal Tunnel Syndrome:
- Proximal median nerve swelling
  - Area: circumferential trace
  - Normal: <9 mm²
  - Borderline: 9 – 12 mm²
  - Abnormal: > 12 mm²
    - 12.8 mm² = moderate (83% sens, 95% spec)
    - 14.0 mm² = severe (77% sens, 100% spec)

Klauser AS et al. Sem Musculoskel Rad 2010; 14:487
Ooi et al. Skeletal Radiol 2014; 43:1387

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Inflammatory Arthritis: role
- Identify synovitis and erosions
  - Prior to initiating treatment
- Determine activity: hyperemia
- Aspirate or inject
- Follow-up after therapy
  - Decreased hyperemia
  - Decreased synovial thickness

Synovitis: dorsal wrist
Sagittal Plane: Radiocarpal and Mid-carpal Joints
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Radiography:

- Non-radiopaque objects: wood, plastic
- Glass: opaque
  - Regardless of tint or color
  - Visualization requires optimized positioning and technique

Radiology 1998; 206:45
Soft Tissue Foreign Bodies

- Wood and plastic: not radiopaque on radiographs
- All soft tissue foreign bodies are initially hyperechoic

Radiology 1998; 206:45

Sonography:

- All foreign bodies: initially hyperechoic
  - Organic matter: less echogenic over time
- Most echogenic if ultrasound beam perpendicular to surface of foreign body

Radiology 1998; 206:45

US: foreign body echogenicity

Soft Tissue Foreign Bodies

- Hypoechoic halo: foreign body response
- Smooth and flat: reverberation
- Irregular and small radius of curvature: shadowing

Radiology 1991; 181:231

Wooden Foreign Body: finger

Foreign Body: wood
Foreign Body: wood

Take Home Points

- Rotator cuff: US is equal to MRI
- Common extensor tendon: anatomy
- UCL elbow: dynamic evaluation
- Gamekeeper: dynamic, Stener
- Ulnar nerve: dynamic evaluation
- Carpal tunnel: nerve enlargement and edema
- Inflammatory arthritis: focus on synovitis
- Foreign bodies: high resolution

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