Ultrasound of the Elbow

Jon A. Jacobson, M.D.

Professor of Radiology
Director, Division of Musculoskeletal Radiology
University of Michigan
Disclosures:

• Consultant: BioClinica
• Advisory Panel: GE, Philips
• Book Royalties: Elsevier

Note: all images from the textbook Fundamentals of Musculoskeletal Ultrasound are copyrighted by Elsevier Inc.
Pathology:

- Joint effusion and bursa
- Tendon abnormalities
- Ligament abnormalities
- Nerve abnormalities
- Soft tissue masses
Joint Effusion:

- Olecranon recess
- Displaced hyperechoic fat pad by anechoic / hypoechoic fluid
- Best place to look with US*
- More sensitive than radiographs*

De Maeseneer, Invest Radiology 1998; 33:117
Olecranon Recess: joint effusion
Joint Effusion: anterior elbow

Radial Recess

Capitellum  Radius

Sagittal: lateral

Transverse

Sagittal: medial

Coronoid Recess

Trochlea  Ulna
Complicated Fluid vs. Synovium

- Both may appear hypo- or isoechoic

Findings that suggest effusion:
- Displacement with transducer pressure
- Joint recess collapse w/ joint movement
- Negative flow on color Doppler imaging
- Swirling with transducer pressure
Olecranon Recess

Synovitis: seronegative arthritis

Complex Fluid: septic
Septic Joint: Coccidiomycosis

Longitudinal

Sagittal T1w + gado

Capitellum

Radial Head
Synovial Hypertrophy and Erosions

Capitellum

RH

Humerus
Synovial Chondromatosis

Sagittal T2w Post-IV gado

Triceps
Ulna
Humerus

Sagittal

Post-IV gado
Annular Recess

Synovitis

Intraarticular Body

Radial Head
Intraarticular body

- Olecranon, coronoid, annular recess
- Calcified & ossified bodies: hyperechoic with shadowing
- Surrounded by joint fluid: intraarticular
- Movement during real-time US excludes osteophyte

Frankel, Radiology 1998; 206:41
Intra-articular Body: elbow joint
Synovial Fold Syndrome

- Normal capsular tissue
  - Hyperechoic, triangular
- Abnormal:
  - Thickened > 3 mm
  - Heterogeneous
  - Adjacent synovitis
Olecranon Bursitis:

- Over olecranon
- Anechoic or hypoechoic
- Well-defined
- Heterogeneous: complicated fluid
Olecranon Bursitis

Infection

Traumatic
Olecranon Bursitis: Gout

Transverse
Olecranon Bursitis: rheumatoid arthritis

Note erosion (white arrow)
Olecranon Bursitis: dynamic imaging
Pathology:

- Joint effusion and bursa
- Tendon abnormalities
- Ligament abnormalities
- Nerve abnormalities
- Soft tissue masses
Tendon Abnormalities:

- Tendinosis: hypoechoic, swollen
- Partial-thickness tear: anechoic focus, no retraction
- Full-thickness tear: discontinuity
  - Dynamic imaging: retraction
Biceps Brachii Tendon: tendinosis

Anterior Approach

Medial Approach
Biceps Brachii Tendon: tendinosis

Medial Approach

Radius

Ulna

Dorsal Flexion Pronation Position
Biceps Brachii Tendon: complete tear

Proximal biceps stump
Long Axis
Distal biceps stump
Normal
Biceps Brachii Tendon: complete tear

Long Axis

Short Axis

Radial Tuberosity

Radial Head
Biceps Brachii Tendon: complete tear non-retracted

Longitudinal: dynamic imaging
Kalume Brigido M. Eur Radiol 2009; 19:1817
Biceps Brachii Tendon: non-retracted tear

Transverse

Intact Bicipital Aponeurosis or Lacertus Fibrosus (white arrows)
Biceps Brachii Tears:

• Diagnosis of full-thickness tear versus partial-thickness tear:
  – 95% sensitivity
  – 71% specificity
  – 91% accuracy

• Shadowing: important indirect sign of tendon retraction

da Gama Lobo et al., Am J Roentgenol 2013; 200:158
Biceps Brachii Tendon: partial tear (short head)

Longitudinal:
Retracted superficial short head (yellow arrows)
Hypoechoic but intact deep long head (white arrows)
Biceps Tendon Tears: dynamic imaging

Partial Tear

Complete Tear
Biceps Brachii: short head tear

Yellow arrows = short head
White arrows = fluid around long head
Biceps Brachii: short head tear

Yellow arrows = tear of short head
White arrows = intact long head
Biceps Brachii: short head tear

Yellow arrows = tear of short head
White arrows = intact long head
Biceps Brachii Tendon: repaired

Anterior

Lateral
Bicipitoradial Bursa

- Surrounds distal biceps
  - Does not communicate to elbow joint
  - No distal biceps tendon sheath
- If distended:
  - Mechanical, inflammatory
  - Characteristic “U” shape
  - Average: 1.8 – 2.5 cm in size
  - May displace deep branch of radial nerve

Skaf AY, Radiology 1999; 212:111
Bicipitoradial Bursitis

Long Axis to Biceps

Sagittal T2w
Bicipitoradial Bursitis

Short Axis to Biceps

Axial T2w
Bicipitoradial Bursitis

Long Axis to Biceps: Lateral Approach
Triceps Tear:

- Muscle injury: contusion
  - Mixed echogenicity hemorrhage
- Distal tendon injury
  - Usually partial-thickness tear
  - Superficial aspect of tendon
  - Avulsion fracture of olecranon
Hematoma: triceps

Longitudinal
Triceps Tear: partial thickness tear

- Superficial layer torn
  - Long and lateral heads
- Intact deep layer (medial head)
- Associated enthesophyte bone fragment
  - 1 – 2 cm in size
  - 2.5 – 4 cm retraction
  - No donor site

J Ultrasound Med 2011; 30:1351
Triceps Tendon: partial tear + avulsion
Triceps Tendon: partial tear + avulsion

Long Axis (Sagittal Plane)
Ankylosing Spondylitis

Long Axis
Muscle Injury: DOMS

- Delayed onset muscle soreness
- Type 1 muscle strain
- Pain after intense physical activity:
  - Microtrauma: inflammation and edema
  - Onset: day 1, peak day 2-3, resolves day 7
  - Possible increased creatine kinase
- Upper extremity: triceps, biceps, brachialis
- Muscle enlargement with Increased echogenicity

DOMS: delayed onset muscle soreness

Triceps Brachii: medial head

Deltoid
Epicondylitis:

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

Potter, Radiology 1995; 196:43
Connell, AJR 2001; 176:777
Common Extensor Tendon: elbow

- Often called “tennis elbow” or “lateral epicondylitis” or “epicondylosis” 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: epicondylitis
Common Extensor Tendon: epicondylitis

Note: normal radial collateral ligament (white arrow)
Common Extensor Tendinosis + RCL Tear

Radial Head
Common Flexor Tendon: tendinosis

Medial Epicondyle

Patient #1

Patient #2
Pathology:

- Joint effusion and bursa
- Tendon abnormalities
- Ligament abnormalities
- Nerve abnormalities
- Soft tissue masses
Collateral Ligament Tear

- Partial tear: hypoechoic, thickened
- Complete tear: anechoic fluid tracking through ligament defect
- Dynamic examination: stress

Miller et al. Skeletal Radiol 2004; 33:386
Ulnar Collateral Ligament: partial tear
Ulnar Collateral Ligament

• Valgus stress: 30 degrees elbow flexion
  – Unlock the olecranon
  – Stress the UCL anterior band
• Gravity stress is adequate, equal to Telos
• Ultrasound measurements:
  – Reliable and precise

1 Harada M et al. J Sho Elb Surg 2014; 23:561
Ulnar Collateral Ligament: partial tear
Ulnar Collateral Ligament: valgus stress

- >1 mm asymmetric gapping = 87% accuracy in diagnosis of UCL tear
  - MR arthrography accuracy = 88%
  - US + MR arthrography: accuracy = 98%
- Asymmetric joint space widening with stress:
  - Normal: 1.3 mm or less
  - Partial tear: 1.2 – 3.0 mm
  - Full thickness tear: 2.8 – 4.8 mm

Roedl JB et al. Radiology 2016
Ulnar Collateral Ligament: laxity

Symptomatic

With valgus stress

2.1 mm

Contralateral

With valgus stress

2.0 mm

3.0 mm

4.7 mm
Ulnar Collateral Ligament: laxity

With valgus stress

T2w fat sat
Ulnar Collateral Ligament: complete tear
Radial Collateral Ligament Tear:

- Abnormal hypoechogenicity
- Can be difficult to demonstrate
- Lateral ulnar collateral ligament tear or thickening:
  - Associated with lateral epicondylitis

Bredella et al. AJR 1999; 173:1379
Radial Collateral Ligament Complex: injury

Radial Collateral Ligament

Annular Ligament

Lateral Ulnar Collateral Ligament
Pathology:

- Joint effusion and bursa
- Tendon abnormalities
- Ligament abnormalities
- Nerve abnormalities
- Soft tissue masses
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: cubital tunnel syndrome

- Hypoechoic and enlarged
  - > 9 mm² area¹
  - Ratio greater than 2.8 compared to proximal²
- Mild hypoechogenicity alone: may be normal
- Causes:
  - Idiopathic, overuse, joint process
  - Anconeus epitrochlearis: compression
    - Normal variant accessory muscle

¹Thoirs K et al. J Ultrasound Med 2008; 27:737
²Yoon JS et al. Muscle Nerve 2008; 38:1231
Cubital Tunnel Syndrome

Short Axis

Long Axis

Arcuate Ligament

FCUh

FCUu
Anconeus Epitrochlearis

- Normal variant: 34% of population
- Roof of cubital tunnel:
  - Residual muscle
  - In absence of normal attrition forming Osborn fascia
- Secondary ulnar nerve entrapment
- Diagnose in elbow extension!

Sem Musculoskel Radiol 2000; 14:814:473
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

Okamoto, J Hand Surg Br 2000; 25:499
Technique: ulnar nerve subluxation

Short Axis
Isolated Ulnar Nerve Dislocation

Ulnar Nerve

Medial Epicondyle Apex

Short Axis
Ulnar Nerve Transposition

Subcutaneous

Submuscular
Snapping Triceps Syndrome

- Abnormal condition:
  - Medial head of triceps
  - Snaps over medial epicondyle of elbow with elbow flexion
  - Associated with ulnar nerve dislocation

Radiology 2001; 220:601
Snapping Triceps Syndrome: *dynamic imaging*
Radial Nerve: deep branch

- **Supinator syndrome:**
  - Motor deficits (wrist, finger extension)
  - Abnormal electrodiagnostic studies
  - Nerve enlargement: entrapment
- **Radial tunnel syndrome:**
  - Pain, no motor deficits, normal EMG
  - Muscle denervation on MRI
  - No nerve enlargement

Ferdinand BD et al. Radiology 2006; 240:161
Radial tunnel

- Radial nerve: deep branch
  - Originates from radial nerve between brachioradialis and brachialis
  - Passes between deep and superficial layers of supinator muscle
  - Exits as posterior interosseous nerve

Jacobson JA. et al. Sem Musculoskel Rad 2010; 14:473
Supinator Syndrome: deep br. radial nv.
Supinator Syndrome

Transverse

Brachioradialis

Superficial Br.

Deep Br.

Radial Head

Normal

Abnormal

RH
Nerve Transection: radial nerve

• Neuroma formation:
  – Disorganized and tangled nerve end
  – Normal response to nerve transection
  – US important to determine if symptomatic

Provost, J Clin Ultrasound 1997; 25:85
Humerus Fracture: radial nerve neuroma
Humerus Fracture: intact radial nerve

Longitudinal

Transverse
Pathology:

- Joint effusion and bursa
- Tendon abnormalities
- Ligament abnormalities
- Nerve abnormalities
- Soft tissue masses
Ganglion Cyst (elbow): aspiration

18-gauge needle

Lavage

Post-aspiration
Epitrochlear Lymph Nodes: hyperplastic

T2w

Gado
Cat scratch disease = infection

- Animal scratch: usually a cat
  - Bartonella henselae
- Child or adolescent:
  - Most common
- Elbow:
  - Lymphadenopathy
  - Epitrochlear lymph node (medial)
Take-home Points:

- Joint: aspirate if concern for infection
- Biceps and triceps:
  - Anatomy explains partial-thickness tears
- Nerves: don’t forget to look
- Dynamic imaging
  - Ulnar nerve dislocation, snapping triceps
  - Ulnar collateral ligament evaluation