Musculoskeletal Ultrasound:
Upper Extremity Dynamic Imaging

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Fundamentals of Musculoskeletal Ultrasound are copyrighted
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Dynamic Imaging:
- Shoulder
- Elbow
- Wrist and Hand

Shoulder:
- Biceps brachii tendon dislocation
- Impingement
- Adhesive capsulitis
- Acromioclavicular joint subluxation
- Paralabral cyst assessment
- Intra-articular bone fragment

Biceps Brachii Tendon:
- Subluxation:
  - Partially perched on lesser tuberosity
- Dislocation:
  - Empty bicipital groove
  - Simulates biceps tendon tear
  - Associated subscapularis tears

Farin et al. Radiology 1995; 195:845
Biceps Tendon: dislocation

Humerus

Transverse Axial Obl T2w

Longitudinal Sagittal Obl T2w

Biceps Tendon: Dislocation into subscapularis tendon

Deltoid

Lesser Tuberosity

Longitudinal Sagittal Obl PDw

Biceps Tendon Dislocation

Biceps Tendon Dislocation
Rotator Interval Tear
- Abnormal hypoechoogenicity, non-visualization
- Abnormal supraspinatus, superior glenohumeral ligament, subscapularis
- Biceps instability
  - "Chondral Print Sign"*
  - Intracapsular instability

*Zappia M et al. Skeletal Radiol 2016: 45:35

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
- At coracoid:
  - Axial plane, active elevation internal rotation

1Farin et al. Radiology 1990: 176:845
2Stallenberg et al. AJR 2006: 187:894

Subacromial-subdeltoid Bursa (blue)

Impingement Test

Impingement Syndrome
Impingement: supraspinatus

Subacromial Impingement

- Thickened tendon or bursa
  - Possible snapping of thickened bursa
  - "Gathering" of bursa: may be asymptomatic
- Superior movement of humeral head
  - Possible contact between humerus and acromion

1Daghir A et al. Skeletal Radiol 2012; 41:1047
2Bureau N et al. AJR 2006; 187:216

Impingement: supraspinatus

Subacromial Impingement: anterior

Impingement: osseous

Joint Effusion: subscapularis recess
Adhesive Capsulitis:
- Frozen shoulder
- Gradual limitation in motion
- Incidence 2 – 5%
- Diabetic (insulin dependent): 30%
- Associations: female, trauma, >40 years old, diabetes, immobilization, thyroid disease, stroke, MI, autoimmune disease

Griesser, et al, JBJS 2011; 93:1727

Adhesive Capsulitis:
- Supraspinatus tendon does not slide beneath acromion with lateral elevation of arm
- Sensitivity 91%, specificity 100%, accuracy 92%


Adhesive Capsulitis
Longitudinal Arm Elevation

Acromioclavicular Joint:
- Dynamic evaluation:
  - Clinical sign “cross-arm”
  - Ipsilateral hand to opposite shoulder: pain
- Normal:
  - Maneuver: ACJ narrows <1 mm, no pain
  - Rest: widens back to normal (up to 5 mm)

Acromioclavicular Joint: abnormal
- Dynamic:
  - ACJ narrows > 1 mm
  - Extruded capsule and disc
  - Osteoarthritis
- Rest:
  - ACJ widens > 5 mm: trauma
**Acromioclavicular Joint**

- Osteoarthritis
- Prior Trauma

**AC joint: subluxation**

**Paralabral Cysts:**
- Periarticular shoulder cyst
- May cause pain simulating rotator cuff tear
- Associated with labral tears

Tung et al. AJR 2000; 174:1707

**Posterior Labral Tear and Cyst**

- Axial
- Axial T1w post-gado

**Labral Tear and Labral Cyst**

- Axial
- Axial T1w post-gado
Pitfall: suprascapular vein dilation

Snapping Lesser Tuberosity Fragment

Dynamic Imaging:
- Shoulder
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Elbow:
- Ulnar nerve dislocation
- Snapping triceps syndrome
- Ulnar collateral ligament tear
- Posterolateral rotary subluxation
- Distal biceps brachii tear

Ulnar Nerve Dislocation
- Occurs in elbow flexion
- Reduces in extension
- Nerve irritation, predisposes to injury
- Found in 20% asymptomatic volunteers

Okamoto, J Hand Surg 2000; 25B:85

Cubital Tunnel Anatomy:
- Space between medial epicondyle and olecranon process
- Contains ulnar nerve

Okamoto, J Hand Surg 2000; 25B:85
Technique: ulnar nerve subluxation

Ulnar Nerve Dislocation

Extension | Partial Flexion | Flexion

Isolated Ulnar Nerve Dislocation

Ulnar Nerve Translocation

Subcutaneous | Submuscular

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
Anconeus Epitrochlearis: Subluxation

Short axis to ulnar nerve (white arrow)

Snapping Triceps Syndrome

- Ulnar nerve and medial triceps dislocate over apex of medial epicondyle
- Ulnar nerve and medial triceps remain in contact with each other
- Palpable snap felt through transducer

Radiology 2001; 220:601

Snapping Triceps Syndrome: dynamic imaging

Ligament Evaluation:

- Abnormal ligament:
  - Hypoechoic, anechoic
- Complete tear (dynamic imaging)
  - Discontinuity
  - Joint space widening

Ulnar Collateral Ligament: complete tear

Ulnar Collateral Ligament: partial tear

Normal
**Ulnar Collateral Ligament**

- Valgus stress: 30 degrees elbow flexion
  - Unlock the olecranon
  - Stress the UCL anterior band
- Gravity stress is adequate, equal to Telos¹
- Ultrasound measurements:
  - Reliable and precise²


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**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

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**Ulnar Collateral Ligament: partial tear**

**Ulnar Collateral Ligament: laxity**

- Symptomatic: 2.1 mm
- Contralateral: 2.0 mm

**Ulnar Collateral Ligament: complete tear**

With valgus stress

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T2w fat sat
**Biceps Brachii:**

- **Tear:**
  - Tendon fiber disruption: hypoechoic
  - Tendon retraction
  - Interposed fluid
- **Pitfall:**
  - Partial-thickness vs. full-thickness

Miller, AJR 2000; 175:1081

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**Biceps Brachii Tendon:**

- **Complete Tear**
  - Longitudinal
  - Transverse

**Normal**

- Longitudinal: dynamic imaging

Kalume Brigido M. Eur Radiol 2009; 19:1817

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**Biceps Brachii Tendon:**

- **Partial Tear (Short Head)**
  - Retracted superficial short head (yellow arrows)
  - Hypoechoic but intact deep long head (white arrows)
  - Longitudinal

Radius

Shadowing
Biceps Tendon Tears: dynamic imaging

Partial Tear

Complete Tear

Radial Head: posterolateral rotatory subluxation

Lateral Ulnar Collateral Ligament

Radiocapitellar Joint

Radial Collateral Ligament Complex: injury

Radial Collateral Ligament

Annular Ligament

Varus Stress

Lateral Ulnar Collateral Ligament

Dynamic Imaging:
- Shoulder
- Elbow
- Wrist and Hand

Wrist and Hand:
- Tendon abnormalities:
  - ECU dislocation
  - Boxer knuckle
  - Pulley tear
  - Trigger finger
- Ganglion cyst
- Gamekeeper’s thumb

Extensor Carpi Ulnaris:
- 6th extensor wrist compartment
- Asymptomatic subluxation
  - Supination
  - Up to 50% out of groove
  - No tear or tenosynovitis

Lee KS et al. AJR 2009; 193:651
Dislocation: extensor carpi ulnaris

Boxer Knuckle:
- Damage to the sagittal bands of extensor hood
  - Transverse orientation
- Extensor tendon subluxation or dislocation with finger flexion

Lopez-Ben et al. Radiology 2003; 228:642

Boxer Knuckle

Pulley Tear
- A2 and A4 pulleys: most important
- Sagittal image
  - Bowstringing
  - Hypoechoic edema / hemorrhage
- Dynamic evaluation*

**Trigger Finger:**
- Stenosing tenosynovitis: A1 pulley
- Thick and hypoechoic pulley
- Hyperemia: 91%
- Tendinosis: 48%
- Tenosynovitis: 55%


**Ganglion Cyst: dorsal**
- 70% are located dorsal
- Superficial to scapholunate ligament
- Differentiate from dorsal joint recess
  - ganglion: noncompressible

*Radiology 1994; 193:259*
**Ganglion Cyst:** dorsal

- Sagittal
- Transverse
- * = Dorsal Intercarpal Ligament

**Ganglion Cyst vs Dorsal Recess**

- Ganglion: not compressible
- Recess: compressible
- Sagittal with Wrist Flexion

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**Gamekeeper’s Thumb:**

- Injury to ulnar collateral ligament of 1st MCP joint
- Abnormally hypoechoic & thickened
- Differentiate partial-thickness or non-displaced full-thickness tears from displaced tear (Stener lesion)

**Ulnar Collateral Ligament: thumb**

- Note: sliding of adductor aponeurosis with isolated interphalangeal joint flexion

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**Gamekeeper’s Thumb**

- Partial tear
- Non-displaced full-thickness tear + fracture
- Normal

**Stener Lesion:**

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

*Radiology 1995; 194:65
Stener Lesion: variations

1. Normal
2. Non-displaced tear
3. Displaced Full-thickness Tears

Stener Lesion: dynamic

White arrows = abductor aponeurosis
Yellow arrows = Stener lesion

Extensor Digitorum Brevis Manus
- Anatomic variant: 2-3% of population
  - Bilateral: 54%, males > females
- Clinical: painful dorsal wrist mass
  - Those who perform repetitive movements
- Ultrasound:
  - Muscle: dorsal wrist to extensor hood 2nd or 3rd digits
  - Dynamic: changes shape with finger extension

AJR 2003; 181:1224
Dynamic Imaging: summary

- Dynamic pathologic conditions
  - Limited number
  - Involve specific structures
- Consider ultrasound for any snapping or painful dynamic situation

See [www.jacobonmskus.com](http://www.jacobonmskus.com) for syllabus and other educational material