

Ultrasound of Upper Extremity with MRI Correlation

Jon A. Jacobson, MD, FACR

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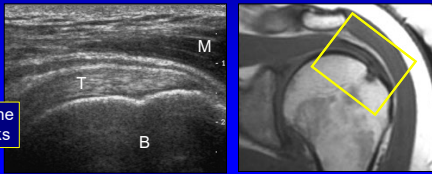
Outline:

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

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Ultrasound Appearance:

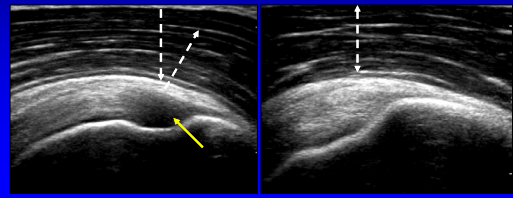
- Tendon: *hyperechoic*, fibrillar
- Muscle: relatively *hypoechoic*
- Bone cortex: *hyperechoic*, shadowing



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Anisotropic Effect

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



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Tendon Abnormalities:

- Tendinosis: hypoechoic, increased size
- Partial-thickness tear: hypoechoic with anechoic focus or clefts
- Full-thickness tear: discontinuity
 - Dynamic imaging: retraction

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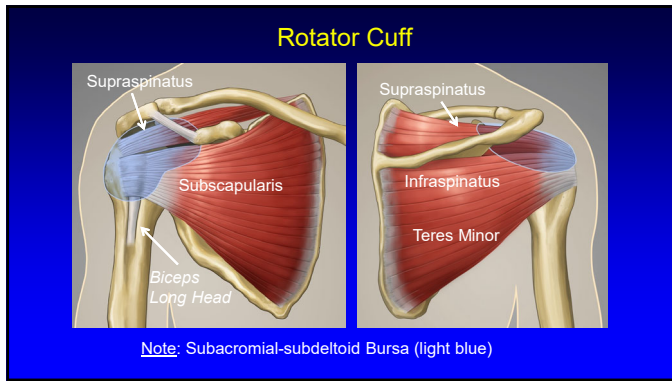
Rotator Cuff Tear:

- 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%)

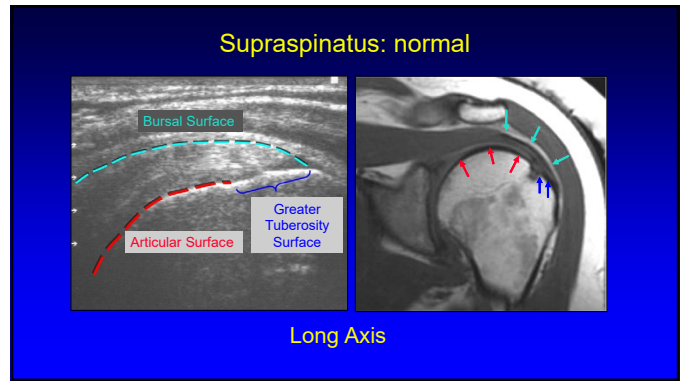


de Jesus, 2009; 192:1701

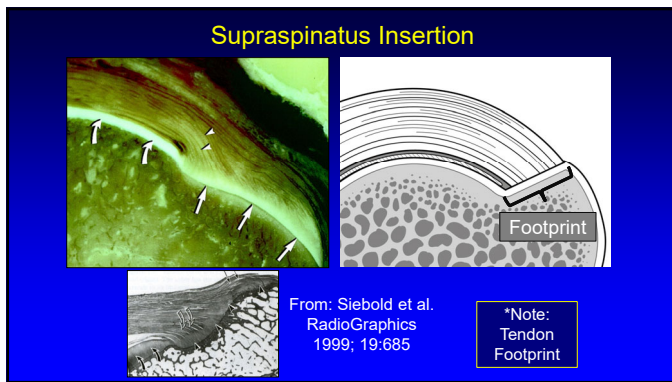
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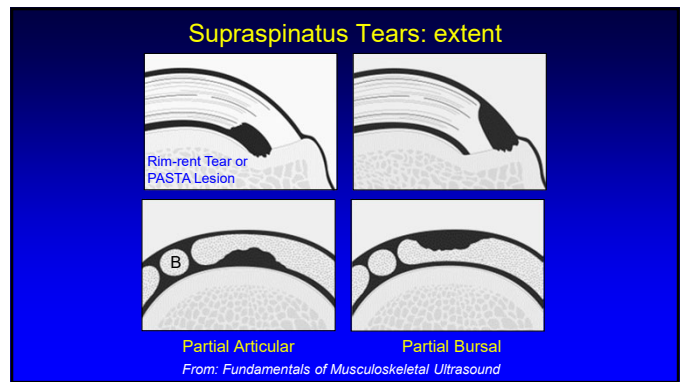
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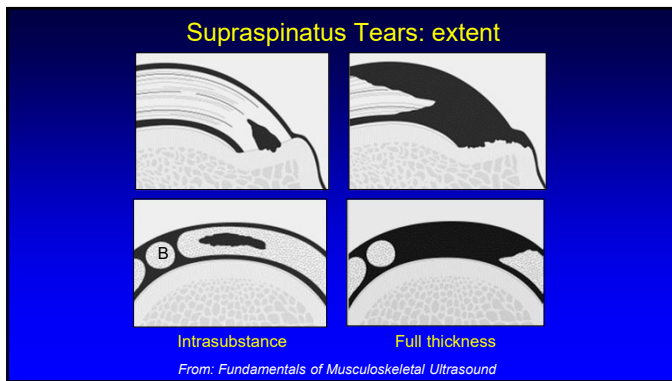
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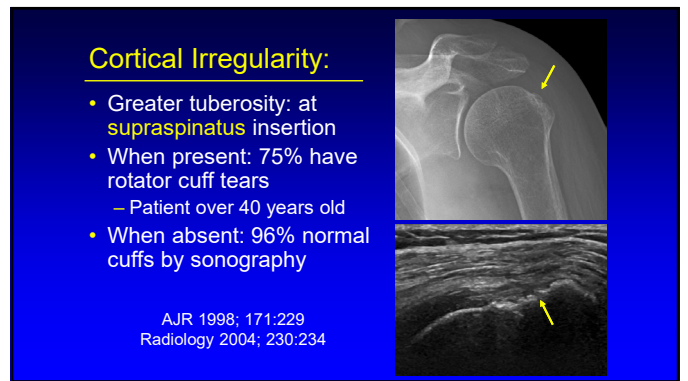
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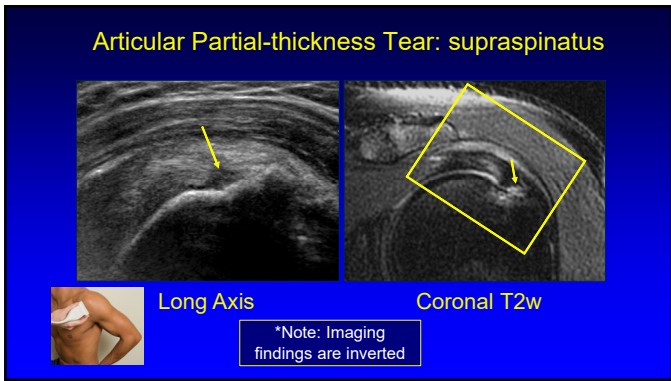
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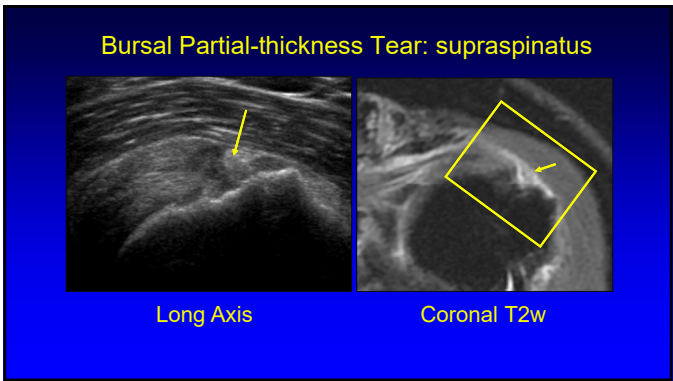
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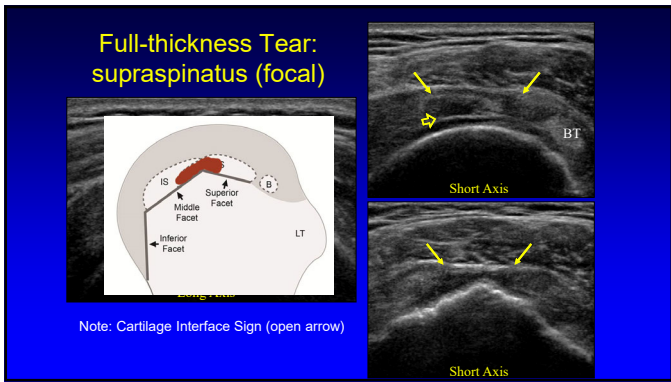
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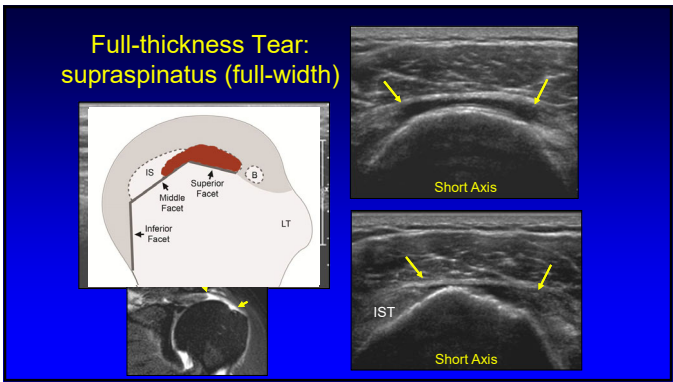
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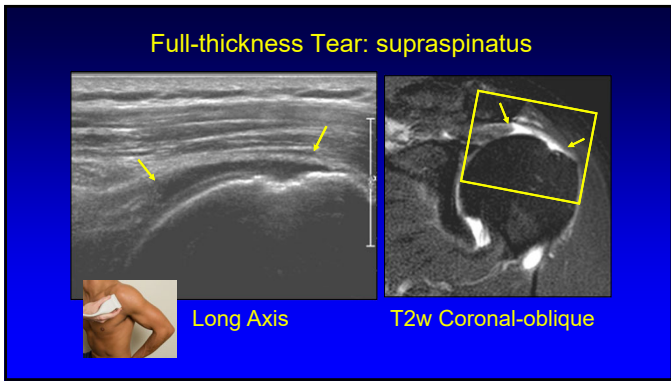
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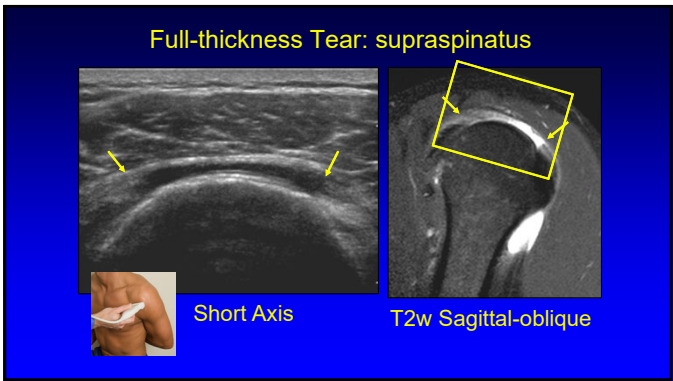
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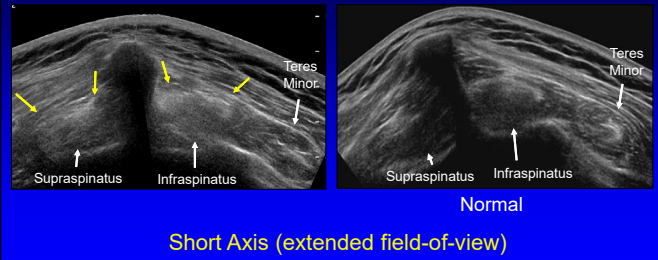
Fatty Infiltration and Muscle Atrophy

- Supraspinatus and infraspinatus
 - Infraspinatus: only variable to predict cuff healing¹
- Associations:
 - Chronic, large, anterior supraspinatus tears²
- Ultrasound:
 - Moderate to good correlation with MRI³
 - Improved reliability with extended field-of-view⁴

¹Chung et al. Am J Sports Med; 2013; 41:16764
²Hodler et al. Radiology 2005; 237:584.
³Khoury et al. AJR 2008; 190:1105.
⁴Nazarian et al. 2008; 190:27.

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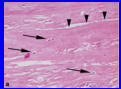
Atrophy: supraspinatus and infraspinatus



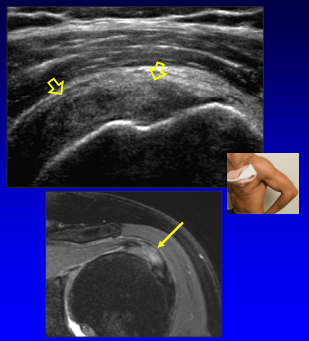
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Tendinosis

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



From: Hodler J, et al. J MRI; 2010; 32:165

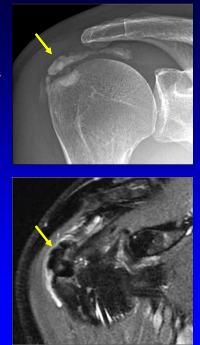


*Radiology 2004; 230:234

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Calcific Tendinosis/Tendinitis

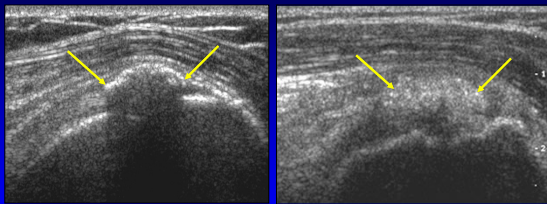
- Tendon metaplasia: calcium hydroxyapatite deposition
- Two phases:
 - Formative: well-defined, dense shadow
 - Resorptive: amorphous
- Percutaneous US-guided lavage/aspiration



Uthoff. J Am Acad Ortho Surg 1997; 5:183

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Calcific Tendinosis/Tendinitis

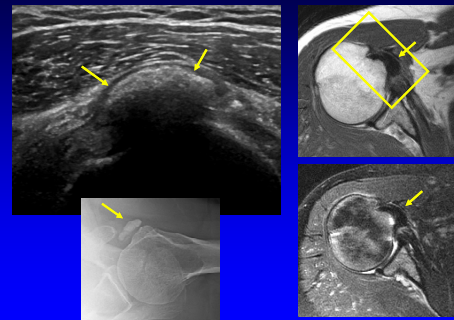


Formative
Defined, shadow

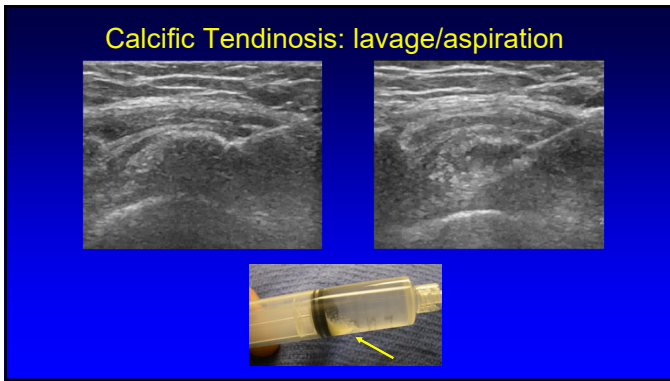
Resorptive
Amorphous, little shadow

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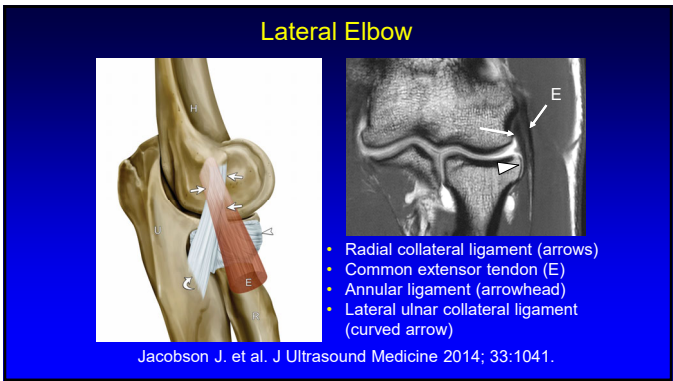
Subscapularis: calcific tendinosis



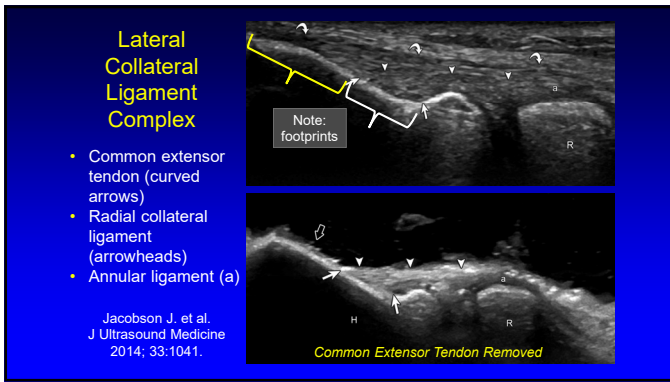
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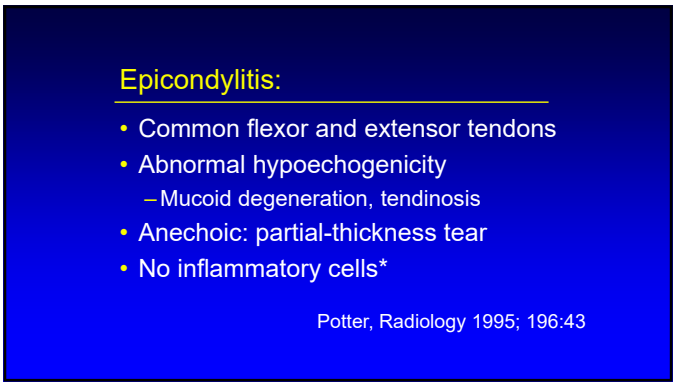
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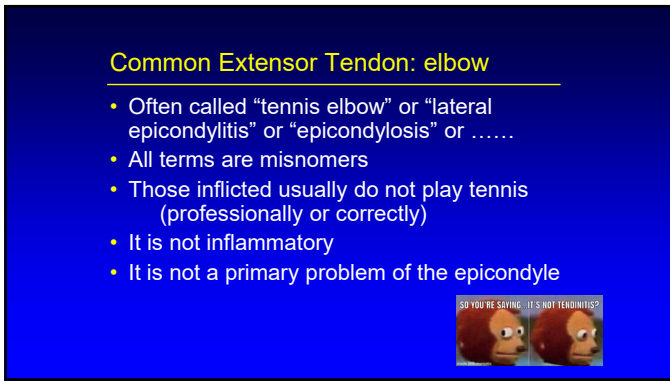
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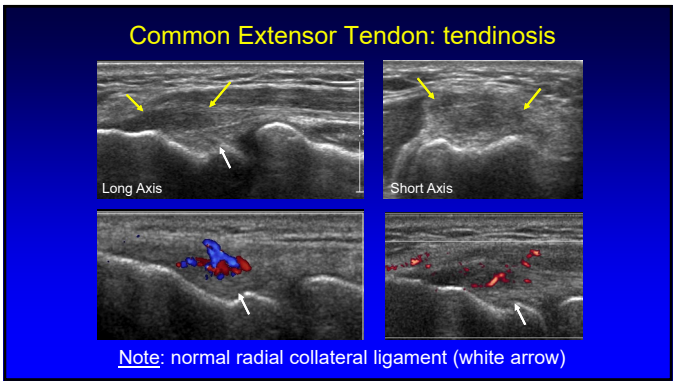
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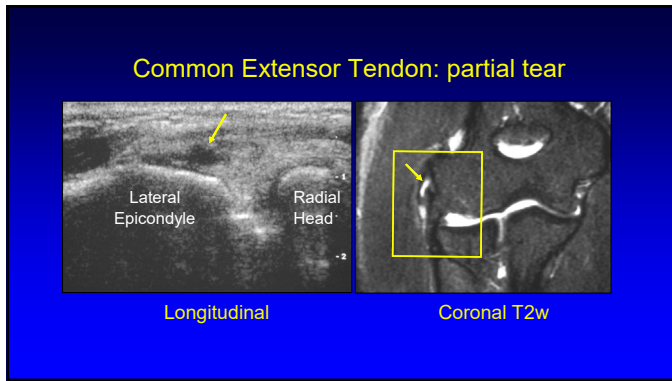
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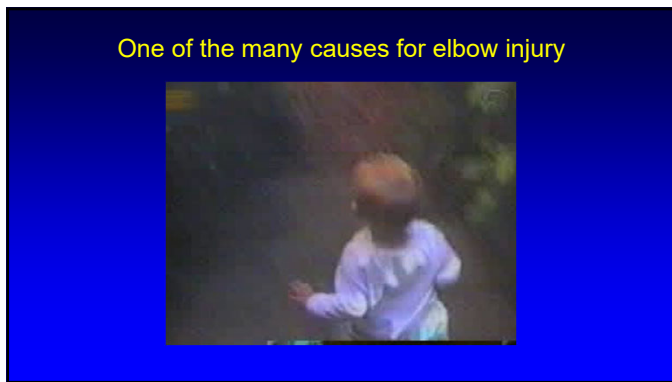
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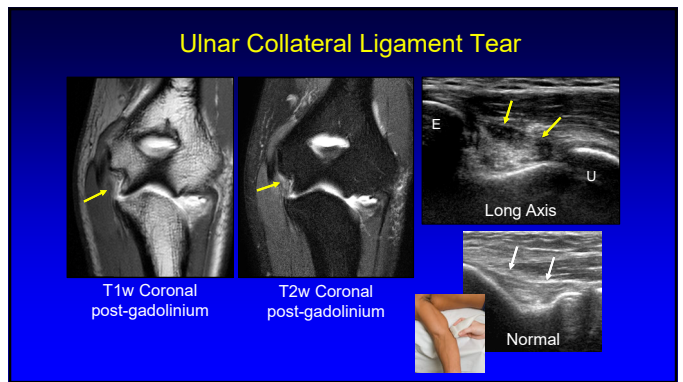
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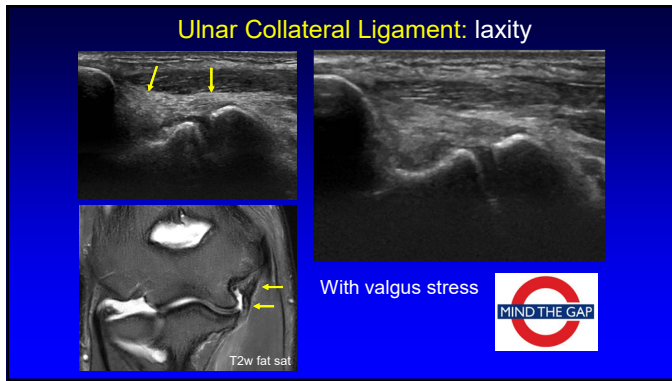
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- ### Ulnar Collateral Ligament
- Valgus stress: 30 degrees elbow flexion
 - Unlock the olecranon
 - Stress: UCL anterior bundle
 - Gravity stress is adequate, equal to Telos¹
 - Ultrasound measurements:
 - Reliable and precise²
-
- Ulnar Collateral Ligament: partial tear
- ¹Harada M et al. J Sho Elb Surg 2014; 23:561
²Bica D et al. J Ultrasound Med 2015; 34:371

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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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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

Acute Mechanism

Chronic Mechanism

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Ulnar Collateral Ligament: thumb

1st Metacarpal

Proximal Phalanx

MC

PP

Note: sliding of adductor aponeurosis with isolated interphalangeal joint flexion

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Ulnar Collateral Ligament: thumb

1 Normal

2 Sprain

3 Partial Tear

4 Nondisplaced Complete Tear

5 Displaced Complete Tear (Stener Lesion) (+ fracture)

RadioGraphics 2006;26:1007

RadioGraphics

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UCL: tears

Partial-thickness tear

Full-thickness tear

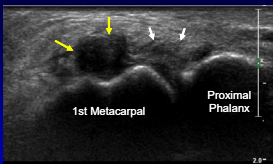
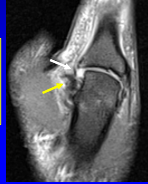
Normal

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Stener Lesion

- Displaced proximal stump of UCL
 - Hypoechoic & round
 - Proximal to MCP joint
 - At proximal edge of adductor pollicis aponeurosis
- No tissue spanning MCP joint
- "Yo-yo on a string" sign
- Ultrasound: 100% accuracy*

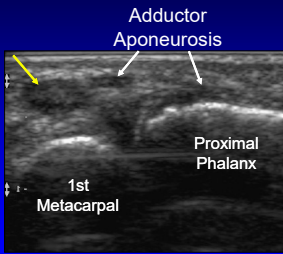
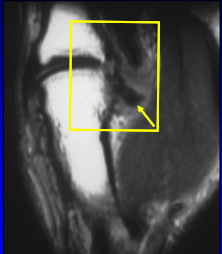
*Melville D. et al. Skeletal Radiology 2013; 42:667

Yellow arrows:
Stener
White arrows:
aponeurosis

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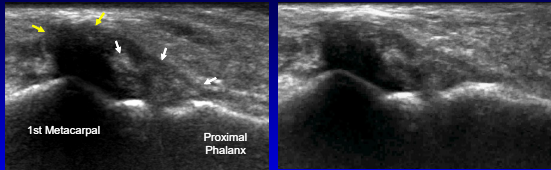
Stener Lesion


"Yo-yo on String" Coronal

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Stener Lesion: dynamic



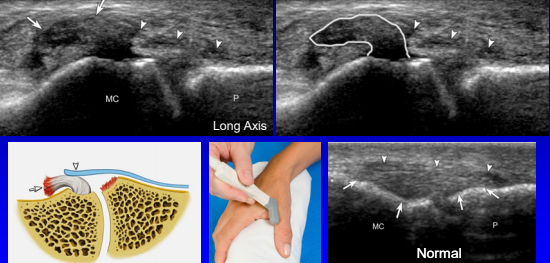
White arrows = adductor aponeurosis
Yellow arrows = Stener lesion



Normal

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Stener Lesion



From: Melville D. et al. Skeletal Radiology 2013; 42:667

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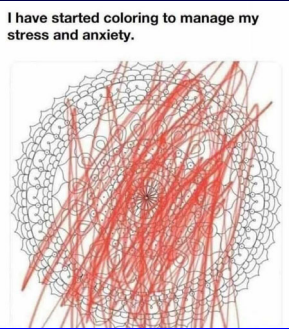
Stener Lesion



From: Melville D. et al. Skeletal Radiology 2013; 42:667

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I have started coloring to manage my stress and anxiety.



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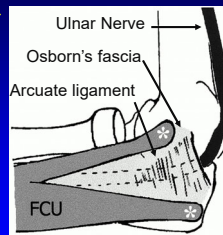
Nerve Entrapment

- 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

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Ulnar Nerve: anatomy

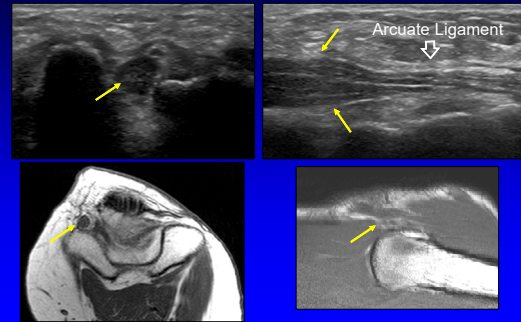
- Behind medial epicondyle of humerus:
 - Cubital tunnel retinaculum or Osborn's fascia
- Distal to epicondyle:
 - True cubital tunnel
 - Between ulnar and humeral heads; flexor carpi ulnaris
 - Under arcuate ligament



Martinoli, C. et al. Radiographics 2000;20:S199-S217 **RadioGraphics**

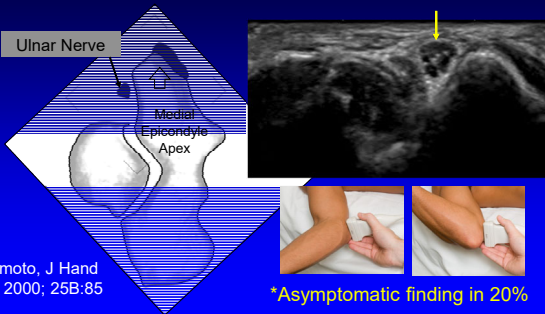
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Cubital Tunnel Syndrome



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Isolated Ulnar Nerve Dislocation



Okamoto, J Hand Surg 2000; 25B:85

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Carpal Tunnel Syndrome:

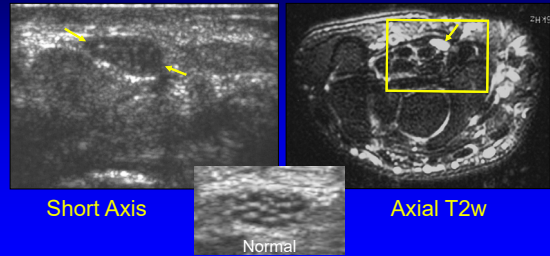
- Proximal median nerve swelling
 - Area: circumferential trace
 - Normal: $<9 \text{ mm}^2$
 - Borderline: $9 - 12 \text{ mm}^2$
 - Abnormal: $> 12 \text{ mm}^2$
 - 12.8 mm^2 = moderate (83% sens, 95% spec)
 - 14.0 mm^2 = severe (77% sens, 100% spec)



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

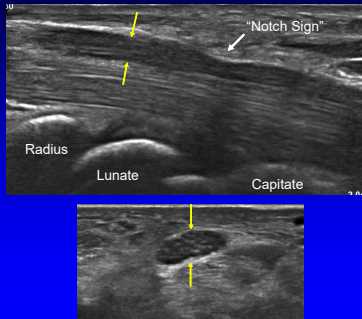
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Carpal Tunnel Syndrome: proximal



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Carpal Tunnel Syndrome



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Outline:

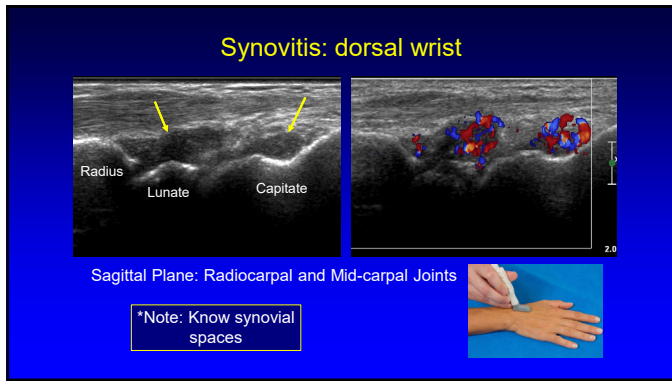
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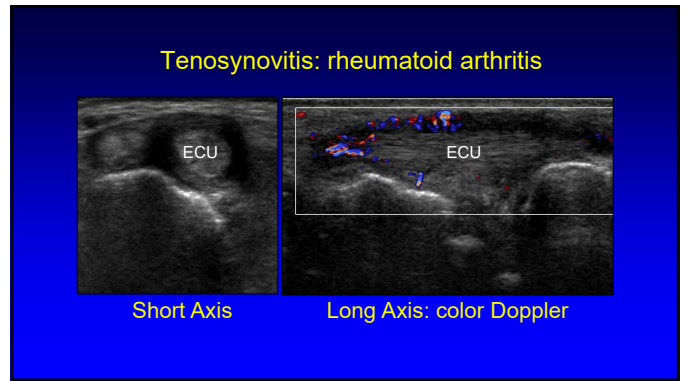
Inflammatory Arthritis: role

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

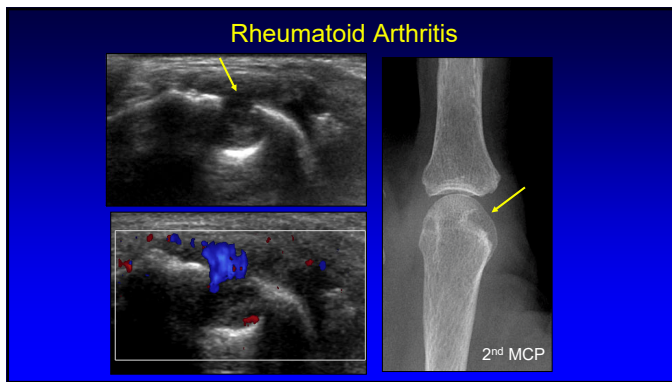
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Soft Tissue Foreign Bodies

- Wood and plastic: not radiopaque on radiographs
- Echogenicity: initially hyperechoic
 - Pitfall: anisotropy
- Halo: hypoechoic inflammation
- Artifact
 - Smooth and flat: reverberation
 - Irregular surface: shadowing

Radiology 1998; 206:45

Septic tenosynovitis

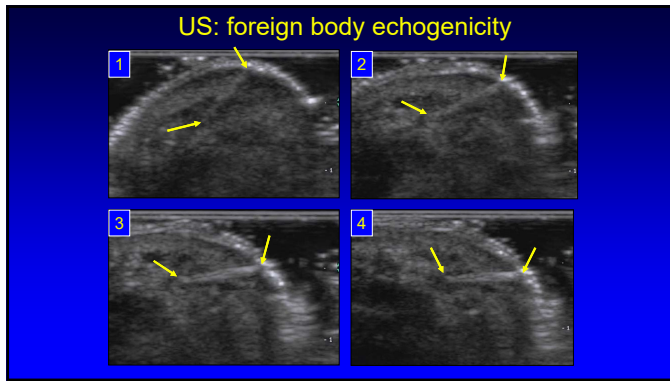
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Glass Foreign Body

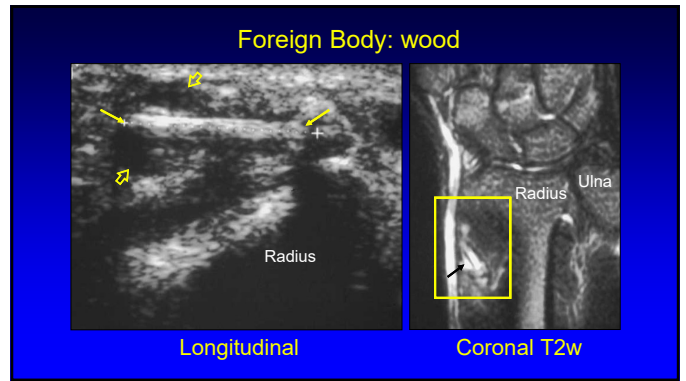
- Glass:
 - Opaque
 - Regardless of tint or color

Radiology 1998; 206:45

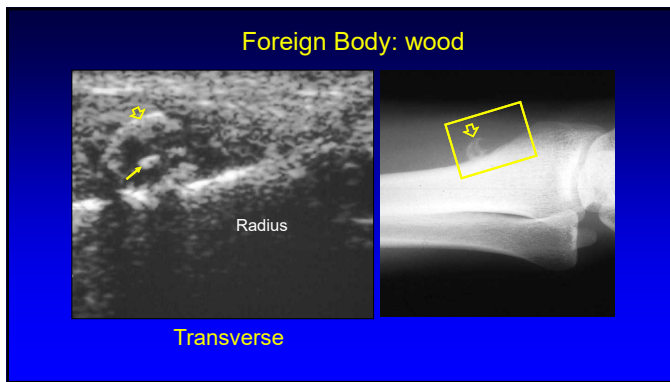
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Take Home Points

- 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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Thank you!

Syllabus on line and other educational material:
www.jacobsonmskus.com

Twitter handle: @jjacobsn

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