

# The Utility of Ultrasound in Musculoskeletal Medicine

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## Disclosures

- Consultant: Bioclinica
- Contractor: POCUS PRO
- Advisory Board: Philips
- Book Royalties: Elsevier
- Not relevant to this lecture

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Fundamentals of Musculoskeletal Ultrasound are  
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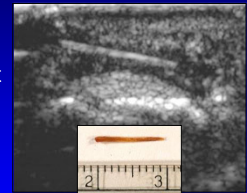
## Accepted Indications:

- Tendon abnormalities
- Rheumatologic applications
- Ligament tear
- Peripheral nerves
- Foreign bodies
- Soft tissue mass

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## Ultrasound versus MRI:

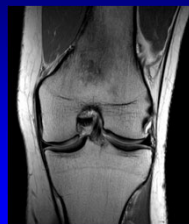
- Inexpensive
- Examine multiple joints
- Better tolerated by patient
- Higher resolution
- Guide needle aspiration
- Improved evaluation of distal extremities



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## MRI versus Ultrasound:

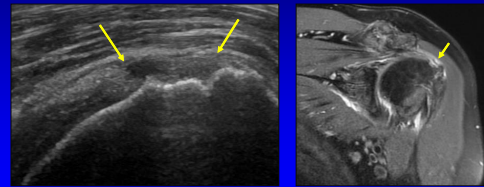
- Examine entire joint
- Intraarticular assessment
  - Cartilage
- Intraosseous abnormalities
- Deep structures
- Less operator dependent



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## Resolution:

- Ultrasound:
  - High resolution: in-plane = 200 – 450  $\mu$ m

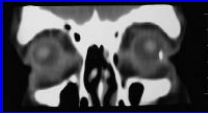


Erickson SJ. Radiology 1997; 205:593  
Qian Y. Journal of MRI 2011

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### MRI: Contraindications

- Ferromagnetic devices or foreign bodies
  - Near critical organs or newly implanted
  - Adjacent to region of interest



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### Equipment: *cart-based*

- Advantages:
  - Powerful: fast, software
  - High resolution: > 20 MHz
- Disadvantages:
  - Not portable
  - Relatively expensive



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### Equipment: *portable*

- Advantages:
  - Small size
  - Less expensive
- Disadvantages:
  - Possible decreased resolution of superficial structures



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### Economics: *National (USA)*

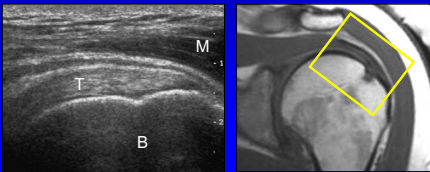
- 31% of diagnoses with MSK MRI could have been made with US
- With appropriate substitution of US for MRI: estimated **\$6.9 billion** dollar savings from 2006 - 2020

Parker, et al. J Am Coll Radiol 2008; 5:182

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### Ultrasound Appearance:

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



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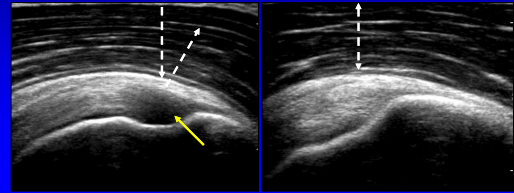
### Tendon Abnormalities:

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

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### Anisotropic Effect

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



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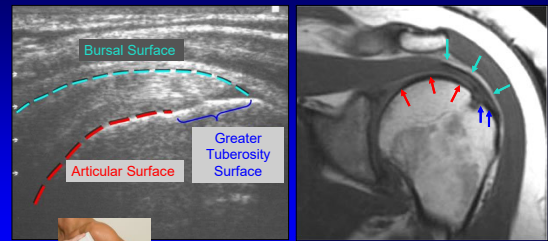
### Rotator Cuff Tear:

- 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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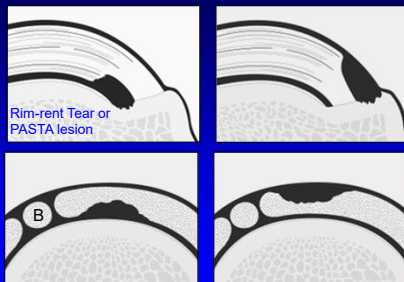
### Supraspinatus: normal



Long Axis

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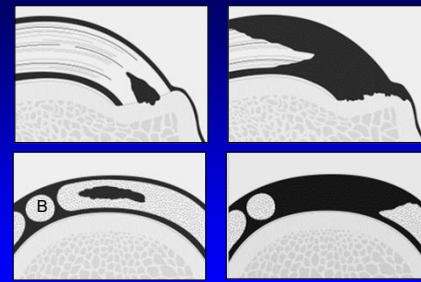
### Supraspinatus Tears: extent



From: Fundamentals of Musculoskeletal Ultrasound

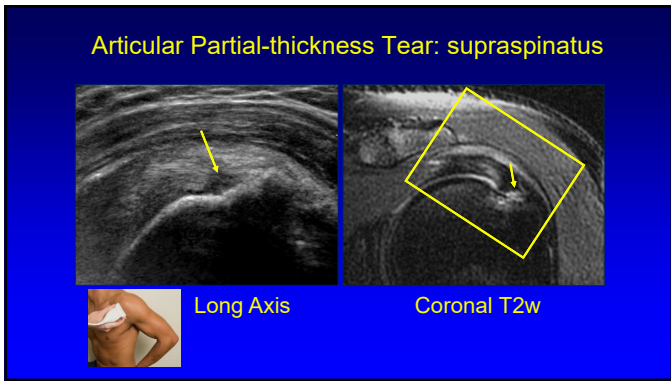
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### Supraspinatus Tears: extent



From: Fundamentals of Musculoskeletal Ultrasound

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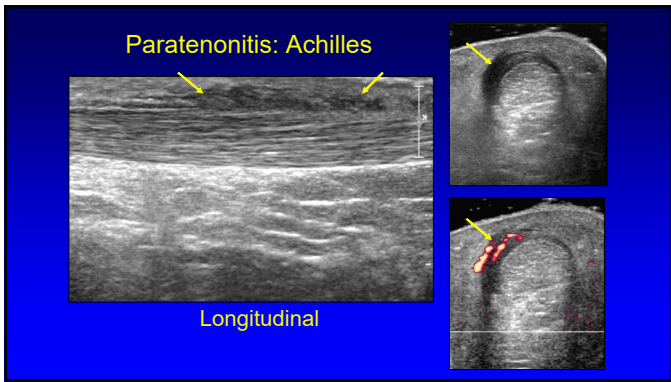


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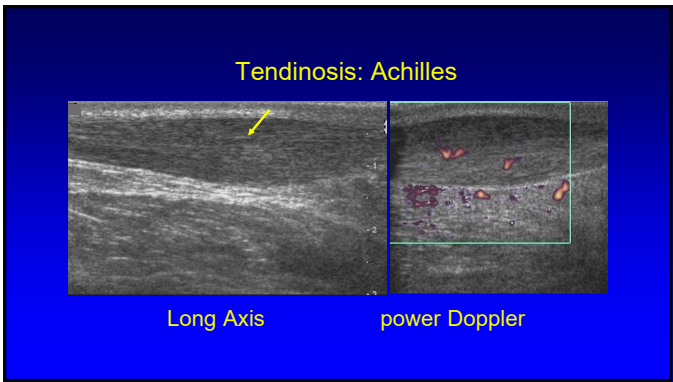
**Achilles Tendon**

- 2 – 6 cm proximal to insertion
  - Paratendinitis
  - Tendinosis
  - Tendon tear
- Calcaneal attachment
  - Tendinosis, tear
  - Haglund Syndrome

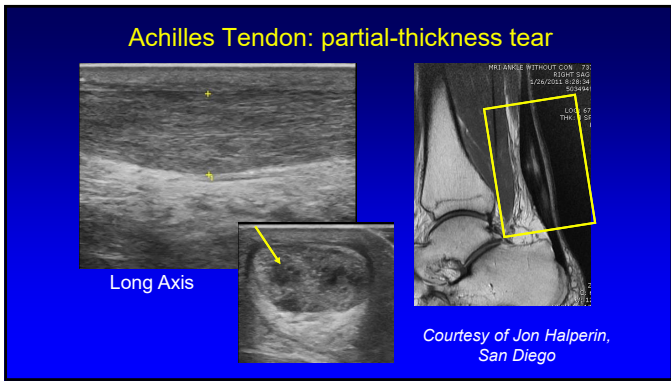
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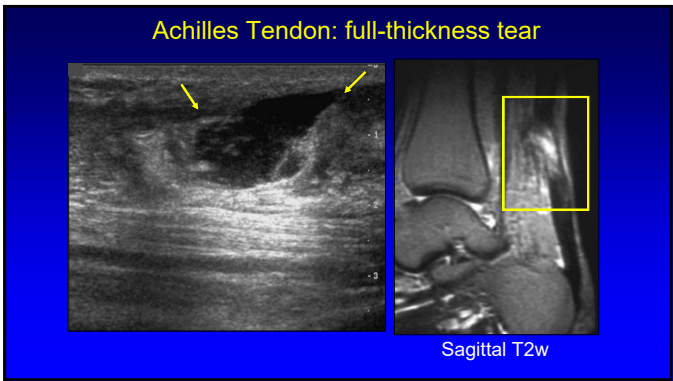
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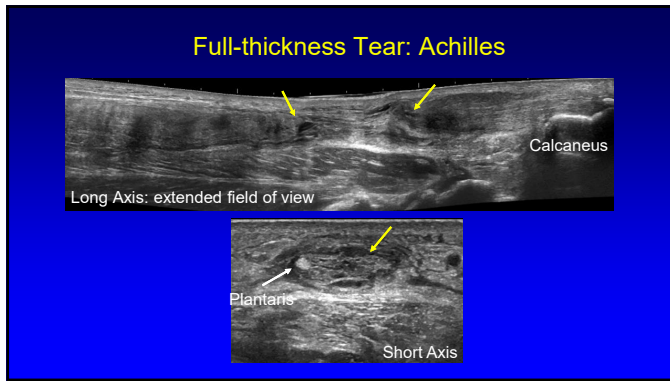
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### Achilles Tendon: complete tear

- Pitfall: misinterpretation of intact plantaris as Achilles fibers
- Dynamic imaging: look for
  - Widening of gap with passive dorsiflexion
  - Lack of tendon movement across tear
  - Determine if ends approximate

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### Tendons: dynamic imaging

- Evaluation of abnormal snapping
- Symptoms related to:
  - Joint movement
  - Positioning of extremity
  - Active muscle contraction

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### Peroneal Retinaculum

Rosenberg et al. AJR 2003; 181:1551

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### Peroneal Tendon Subluxation

- Abnormal movement may only occur dynamically
- Predisposes to peroneal tendon tears
  - Longitudinal split of peroneus brevis
- US: examine with dorsiflexion / eversion
  - 100% accurate US diagnosis

Neustadter et al. AJR 2004; 183:985

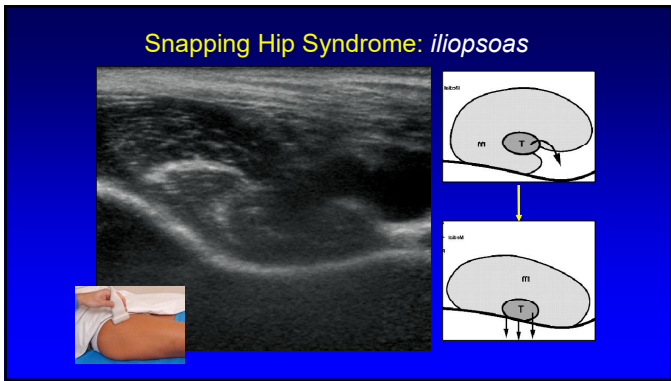
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### Iliopsoas Complex

Red: psoas major  
Orange: medial iliacus fibers  
Purple: lateral iliacus fibers

From: Guillin R. et al. Eur Rad 2009; 19:995

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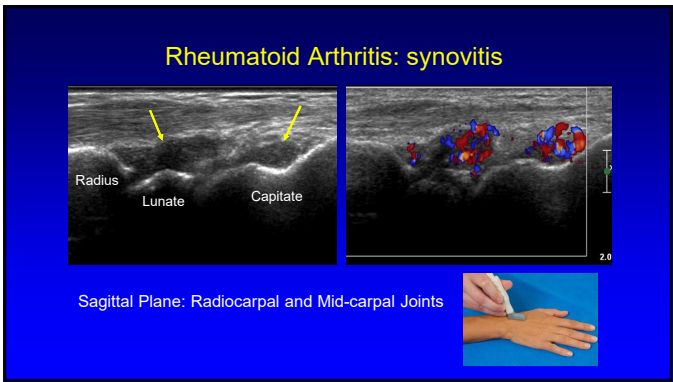
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  - Ligament tear
  - Peripheral nerves
  - Foreign bodies
  - Soft tissue mass

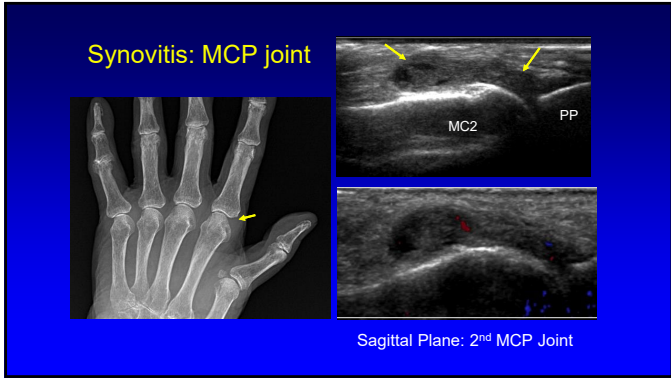
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- ### Arthritis: synovitis
- Synovial locations:
    - Joint recess, bursa, tendon sheath
  - Hypoechoic compared to adjacent subcutaneous fat
    - May be isoechoic or hyperechoic
  - Hyperemia: variable
    - Represents activity of inflammation
    - Decreased: treatment (even NSAIDS)
- Backhaus M, Arthritis and Rheum 1999; 42:1232

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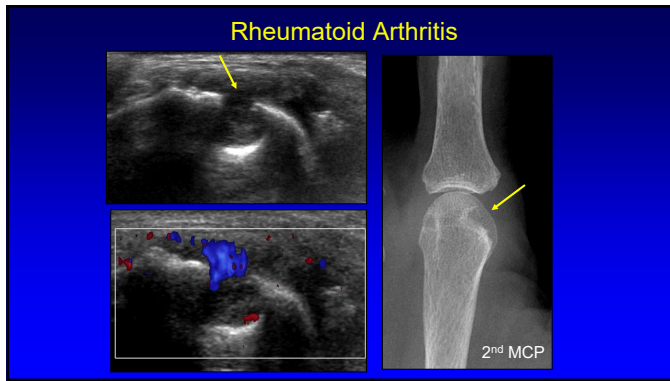
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- ### Erosions
- US criteria:
    - Disrupted cortex, two planes
    - Adjacent synovitis increases specificity
  - US better than radiographs<sup>1</sup>
  - 29% false-positive rate compared to CT<sup>2</sup>
  - 40% sensitivity<sup>3</sup>
- <sup>1</sup>Lopez-Ben, et al. Skeletal Radiol 2004; 33: 80  
<sup>2</sup>Finzel S. et al. Arth Rheumatism 2011; 63:1231  
<sup>3</sup>Dohn UF M, Arthritis Res Ther 2006; 8:1

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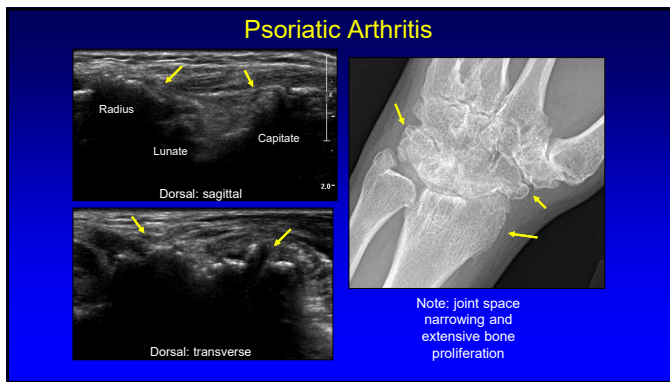
### Pitfall Alert! Pseudoerosions Are Everywhere!

- Pseudoerosions: 100%
- Metacarpal heads: all
  - 2<sup>nd</sup>: 92%
  - 3<sup>rd</sup>: 86%
- Carpal bones:
  - Lunate: 82%
  - Triquetrum: 84%
  - Distal ulna: 22%

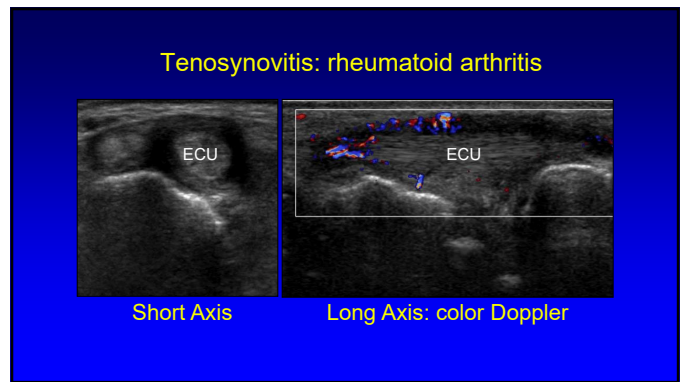
\*Falkowski A et al. Eur J Radiology 2020; 124

\*Note lack of adjacent synovitis

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- ### Synovitis: screening (<10 minutes)
- Hand and wrist: (6 joints – actually 10)
    - Radiocarpal, midcarpal, distal radioulnar (dorsal)
    - MCP2 and 3 (dorsal): transverse and sagittal
    - Any symptomatic site
    - Cine: flexor and extensor tendons (short axis)
  - Ankle and Foot:
    - Ankle joint
    - MTP5 (dorsal and plantar)
    - Any symptomatic site
- Rosa J et al. J Clin Rheumatol 2016; 22: 179


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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



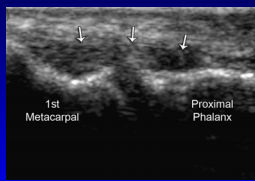
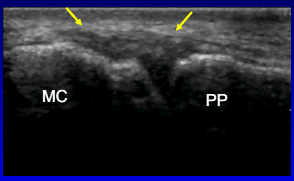
Acute Mechanism



Chronic Mechanism

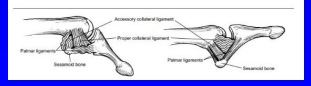
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### Ulnar Collateral Ligament: thumb






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      2      3      4      5

Normal      Sprain      Partial Tear      Nondisplaced Complete Tear      Displaced Complete Tear (Stener Lesion) (+ fracture)

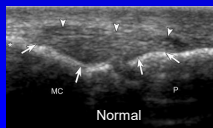
Radiographics 2006;26:1007      **RadioGraphics**

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### UCL: tears

Partial-thickness tear      Full-thickness tear

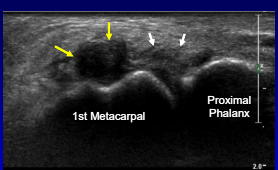



Normal

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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\*

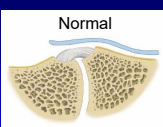



Yellow arrows: Stener  
White arrows: aponeurosis

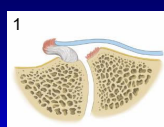
\*Melville D. et al. Skeletal Radiology 2013; 42:667

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### Stener Lesion: variations



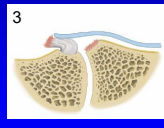
Normal



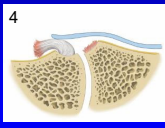
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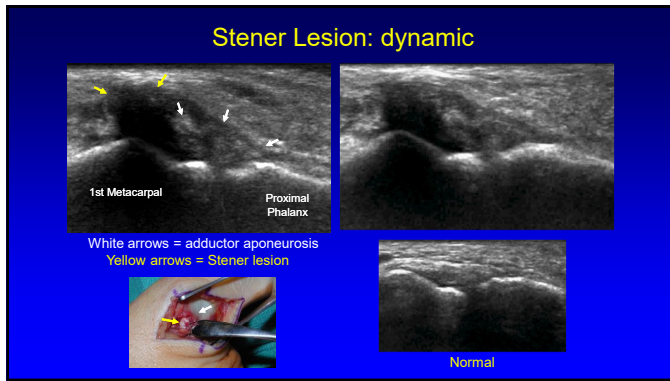


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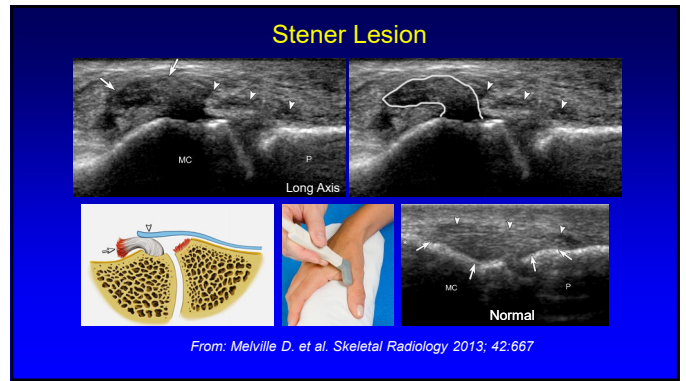
Displaced Full-thickness Tears

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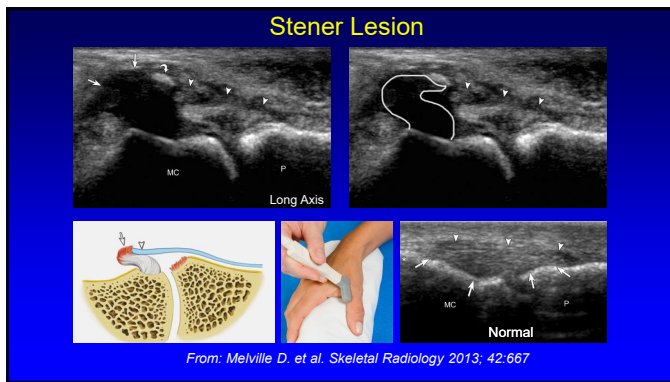




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  - **Peripheral nerves**
  - Foreign bodies
  - Soft tissue mass

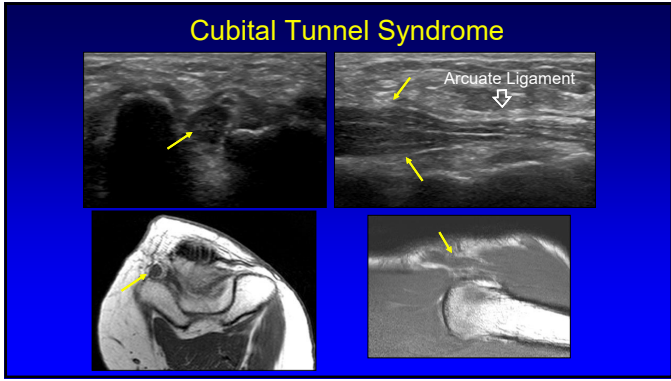
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- ### Normal Peripheral Nerve
- Ultrasound appearance:
    - Hypoechoic nerve fascicles
    - Hyperechoic connective tissue
  - Transverse:
    - Honeycomb appearance
- 
- Median Nerve
- Silvestri et al. Radiology 1995; 197:291

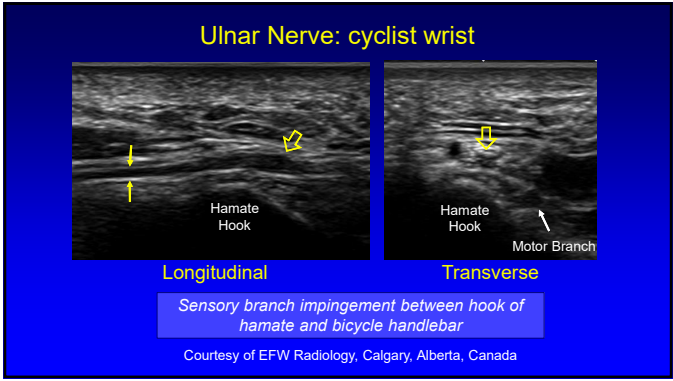
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- ### Nerve Entrapment
- US findings:
    - Nerve enlargement proximal to entrapment
      - Best appreciated transverse to nerve
    - Abnormally hypoechoic
      - Especially the connective tissue layers
    - Variable enlargement or flattening at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

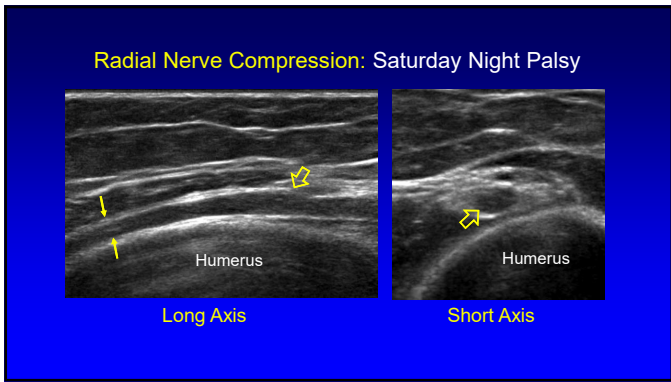
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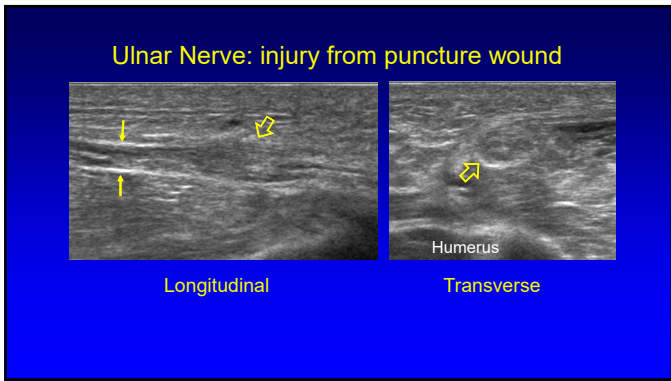
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### Nerve Transection

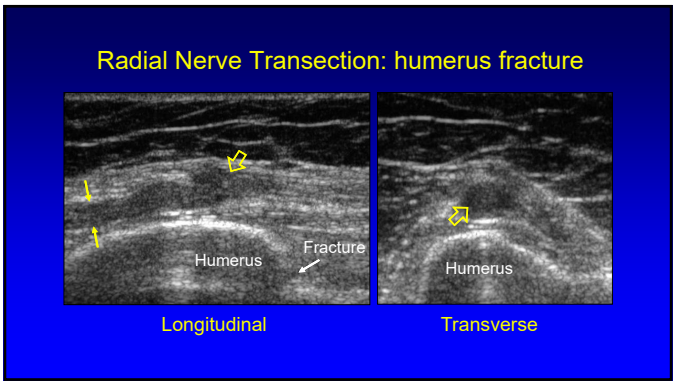
- Hypoechoic and retracted nerve ends if complete
- Neuroma formation:
  - Disorganized and tangled nerve end
  - Normal response to nerve transection
- After amputation:
  - US important to determine if symptomatic

J Clin Ultrasound 1997; 25:85

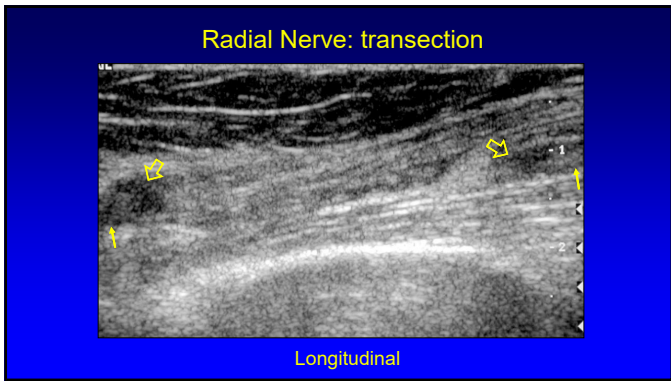
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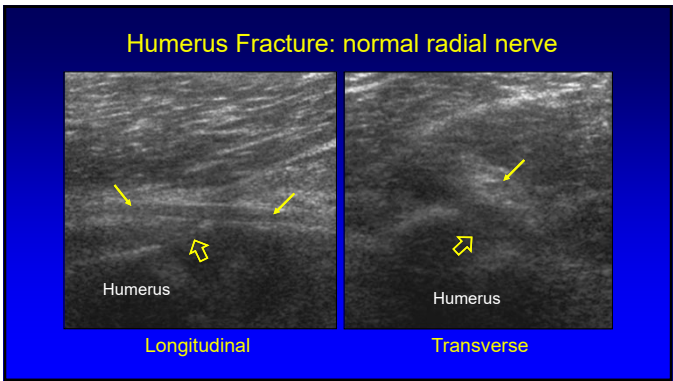
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### Soft Tissue Foreign Bodies

- 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

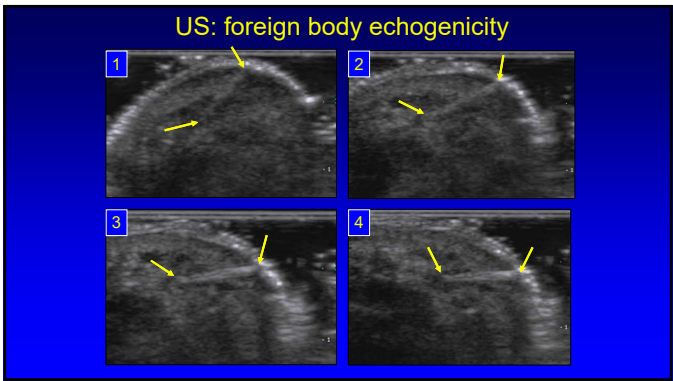
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### Glass Foreign Body

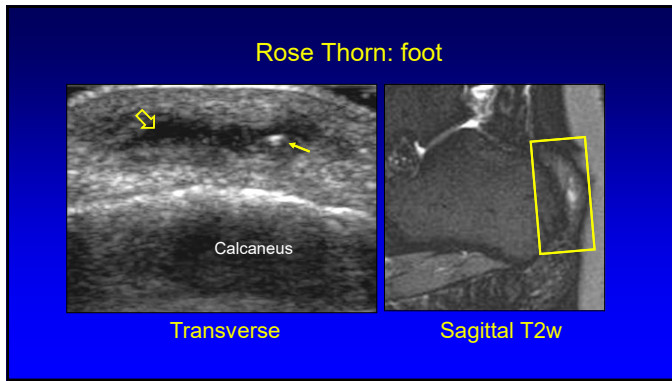
- Glass:
  - Opaque
  - Regardless of tint or color

Radiology 1998; 206:45

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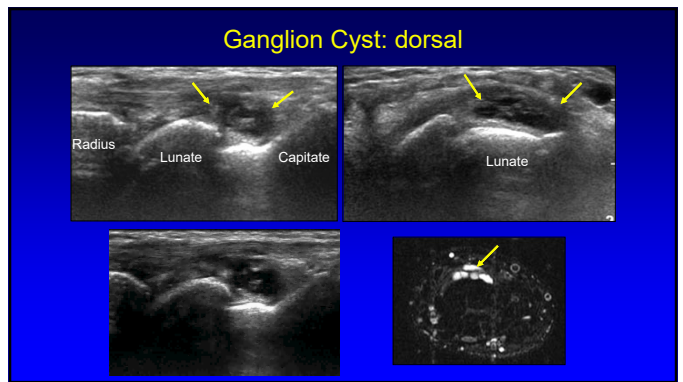
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### Soft Tissue Mass: ganglion

- Anechoic or hypoechoic
- Multilocular (except digits)
- Non-compressible
- Joint or tendon sheath communication
- Wrist: volar between radial artery and FCR (69%) and dorsal over scapholunate ligament

\*Wang et al. J Ultrasound Med 2007; 26:1323

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- ### Take Home Points
- Portable, accessible
  - No issue: claustrophobia, hardware, metal foreign bodies or implants
  - Less expensive compared to MRI
  - Compare to other side, intervention
  - **High resolution**
  - **Dynamic imaging**

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Thank you!

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[www.jacobsonmksus.com](http://www.jacobsonmksus.com)

Twitter handle: @jjacobsn

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