

Musculoskeletal Ultrasound

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Disclosures

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

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Fundamentals of Musculoskeletal Ultrasound
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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:

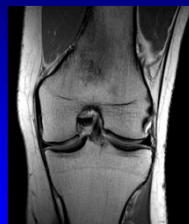
- Inexpensive
- Examine multiple joints
- Better tolerated by patient
- Higher resolution
- Guide needle aspiration
- Improved evaluation of distal extremities



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MRI versus Ultrasound:

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



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MRI versus US: Installation



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MRI versus US: dangers



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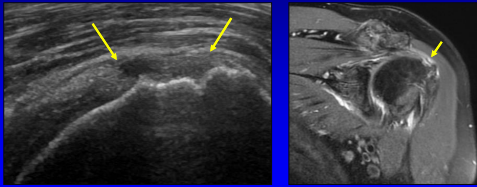
MRI versus US: dangers



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Resolution:

- Ultrasound:
 - High resolution: in-plane = 200 – 450 μ m

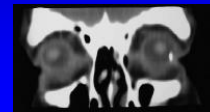


Erickson SJ. Radiology 1997; 205:593
Qian Y. Journal of MRI 2011

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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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Economics: *National (USA)*

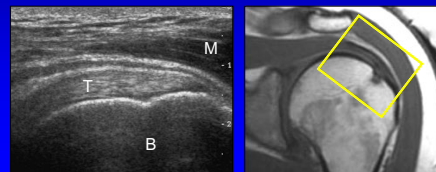
- 31% of diagnoses with MSK MRI could have been made with US
- With appropriate substitution of US for MRI: estimated **\$6.9 billion** dollar savings from 2006 - 2020

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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Rotator Cuff Tear:

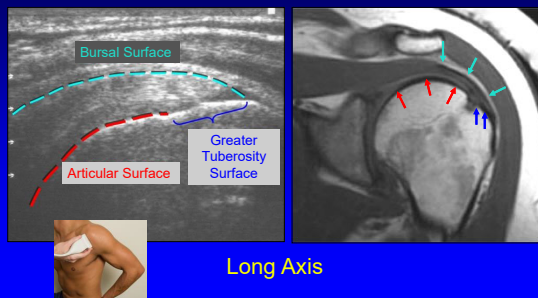
- Meta-analysis: 65 articles
- Full-thickness tears:
 - MRA, MRI, US = in sensitivity (92 – 95%)
 - MRA more specific
- Partial-thickness tears:
 - MRA most sensitive (86%) and specific
 - MRI (64%), US (67%)



de Jesus, 2009; 192:1701

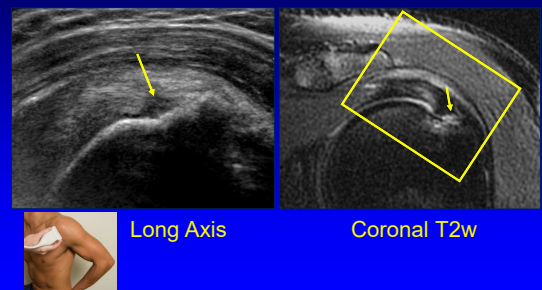
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Supraspinatus: normal



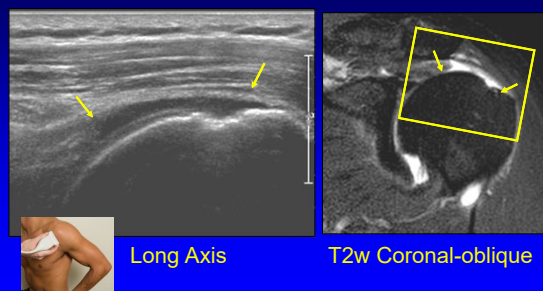
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Articular Partial-thickness Tear: supraspinatus



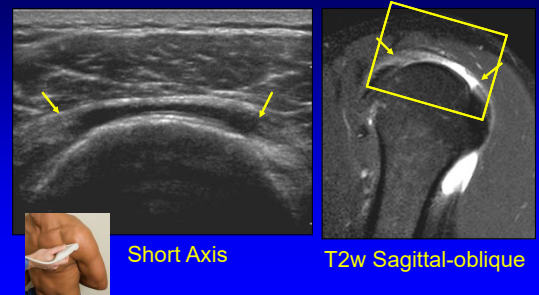
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Full-thickness Tear: supraspinatus



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Full-thickness Tear: supraspinatus



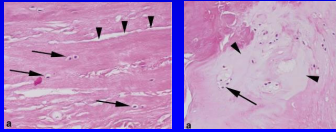
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Tendinosis

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

From: Wilson JJ, et al. *Am Fam Physician*, 2005; 32:165

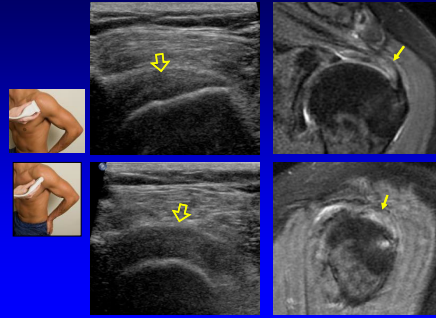
From: Hodler J, et al. *J MRI*; 2010; 72:811



*Radiology 2004; 230:234

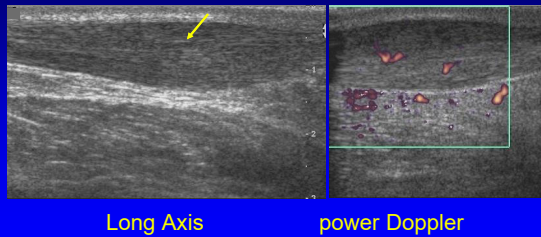
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Tendinosis: supraspinatus tendon



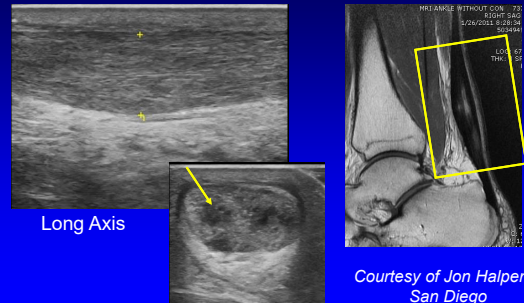
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Tendinosis: Achilles



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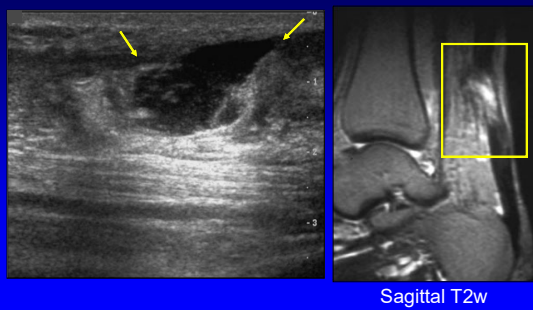
Achilles Tendon: partial-thickness tear



Courtesy of Jon Halperin, San Diego

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Achilles Tendon: full-thickness tear



Sagittal T2w

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Tendons: dynamic imaging

- Peroneal tendon subluxation
- Snapping hip syndrome
- Tendon tear: partial vs. full tear
 - Achilles

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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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Intrasheath Peroneal Subluxation

- Abnormal snapping: peroneal tendons
- No lateral displacement, intact retinaculum
- Type A: no tear; B: tendon tear
- Associations:
 - Convex posterior fibula in 92%
 - Tendon tear in 86%
 - Low lying peroneus brevis muscle in 71%

J Bone Joint Surg Am 2008; 90:992
J Foot Ankle Surg 2009; 48:323

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Snapping Hip Syndrome: iliopsoas

- Image long axis to inguinal ligament superior to femoral head
- Extension of flexed abducted and externally rotated hip
- Abrupt movement of iliopsoas as iliacus muscle interposed between tendon and bone moves

Deslandes et al. AJR 2008; 190:576

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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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Snapping Hip Syndrome: iliopsoas

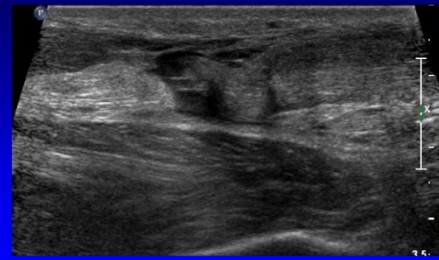
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Tendon Evaluation:

- Partial vs. complete vs. healing tear
- Dynamic imaging: look for
 - Widening of gap: passive or active motion
 - Lack of tendon movement across tear

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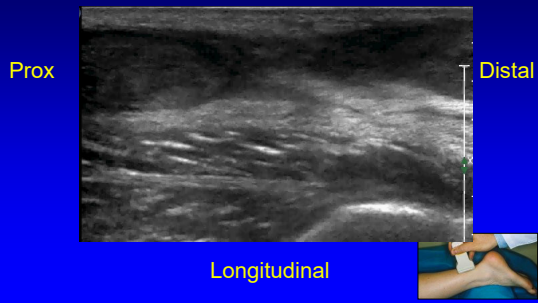
Achilles Tendon: *dynamic imaging*



Long Axis

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Achilles Tendon: *healing tear*



Longitudinal

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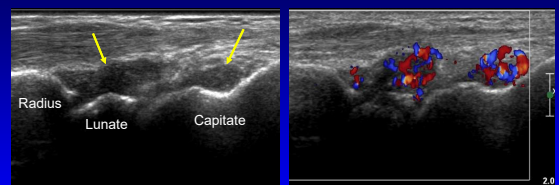
Arthritis: *synovitis*

- 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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Rheumatoid Arthritis: *synovitis*

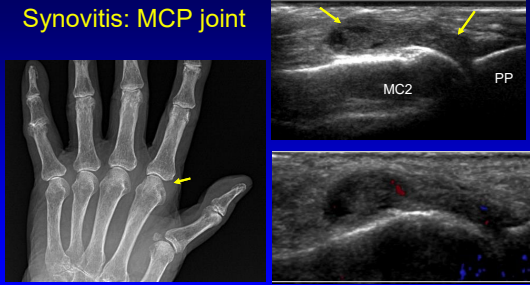


Sagittal Plane: Radiocarpal and Mid-carpal Joints



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Synovitis: MCP joint



The figure shows three images related to MCP joint synovitis. On the left is a radiograph of a hand with a yellow arrow pointing to the 2nd MCP joint. On the right are two ultrasound images in a sagittal plane of the 2nd MCP joint. The top image shows the MC2 (metacarpal 2) and PP (proximal phalanx) with yellow arrows indicating synovial thickening. The bottom image shows the same joint with a red arrow pointing to a hypoechoic area, likely representing a synovial cyst or effusion.

Sagittal Plane: 2nd MCP Joint

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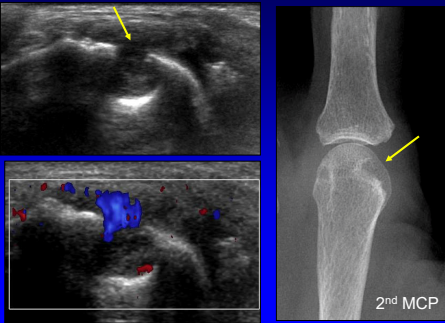
Erosions

- US criteria:
 - Disrupted cortex, two planes
 - Adjacent synovitis increases specificity
- US better than radiographs¹
- 29% false-positive rate compared to CT²
- 40% sensitivity³

¹Lopez-Ben, et al. Skeletal Radiol 2004; 33: 80
²Finzel S, et al. Arth Rheumatism 2011; 63:1231
³Dohn UF M, Arthritis Res Ther 2006; 8:1

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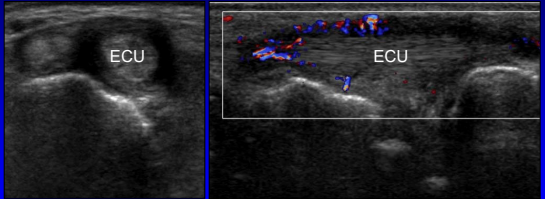
Rheumatoid Arthritis



The figure shows two images related to Rheumatoid Arthritis. On the left are two ultrasound images of a joint. The top image shows a yellow arrow pointing to a hypoechoic area, likely representing a synovial cyst or effusion. The bottom image shows a color Doppler image with red and blue areas indicating increased vascularity. On the right is a radiograph of a joint with a yellow arrow pointing to a joint space narrowing and erosion, labeled as 2nd MCP.

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Tenosynovitis: rheumatoid arthritis

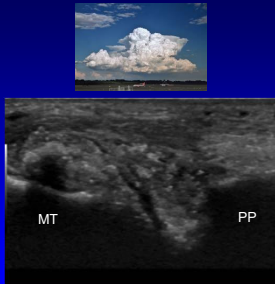


The figure shows two ultrasound images of the ECU (extensor carpi ulnaris) tendon. The left image is labeled 'Short Axis' and shows the ECU tendon. The right image is labeled 'Long Axis: color Doppler' and shows the ECU tendon with a color Doppler overlay indicating increased vascularity, consistent with tenosynovitis.

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Tophi

- Hyperechoic heterogeneous with hypoechoic rim
- Tiny internal speckles*
- "wet clump of sugar" appearance
- Variable shadowing: even without calcification

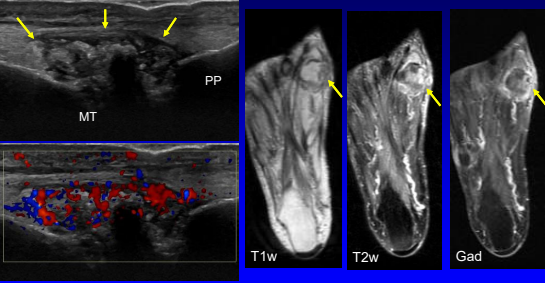


The figure shows two ultrasound images of tophi. The top image is a radiograph of a cloudy sky, used as a metaphor for the appearance of tophi. The bottom image shows two ultrasound images of a joint with MT (metatarsophalangeal) and PP (proximal phalanx) labels, showing hyperechoic heterogeneous areas with hypoechoic rims, characteristic of tophi.

Fernandes et al. Skeletal Radiol 2011; 40:309

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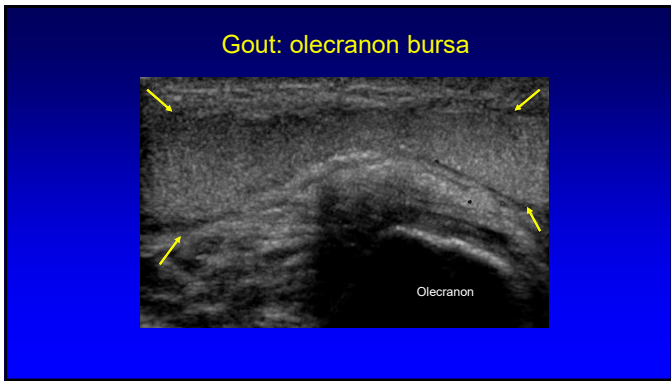
Gout: tophus



The figure shows four images related to a gout tophus. On the left are two ultrasound images of a joint with MT (metatarsophalangeal) and PP (proximal phalanx) labels, showing a large, hyperechoic heterogeneous mass. On the right are three MRI images of the 1st Metatarsophalangeal Joint: T1w, T2w, and Gad. The T1w image shows a bright signal, the T2w image shows a dark signal, and the Gad image shows a bright signal, all characteristic of a tophus.

1st Metatarsophalangeal Joint

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- ### Accepted Indications:
- Tendon abnormalities
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 - **Ligament tear**
 - Peripheral nerves
 - Foreign bodies
 - Soft tissue mass

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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

Note: sliding of adductor aponeurosis with isolated interphalangeal joint flexion

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Ulnar Collateral Ligament: thumb

1 Normal

2 Sprain

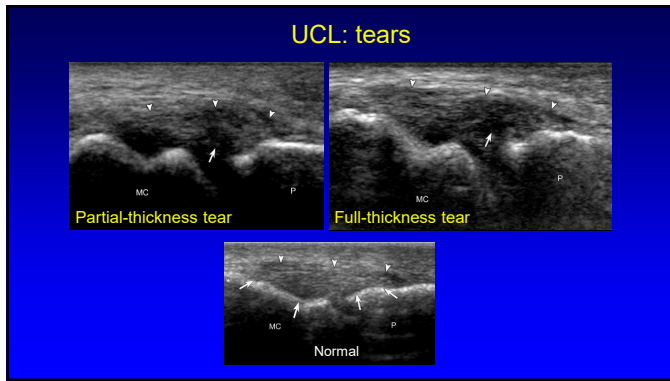
3 Partial Tear

4 Nondisplaced Complete Tear (+ fracture)

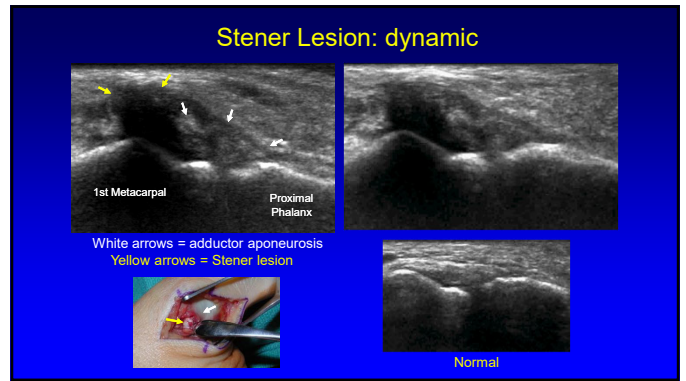
5 Displaced Complete Tear (Stener Lesion)

RadioGraphics 2006;26:1007

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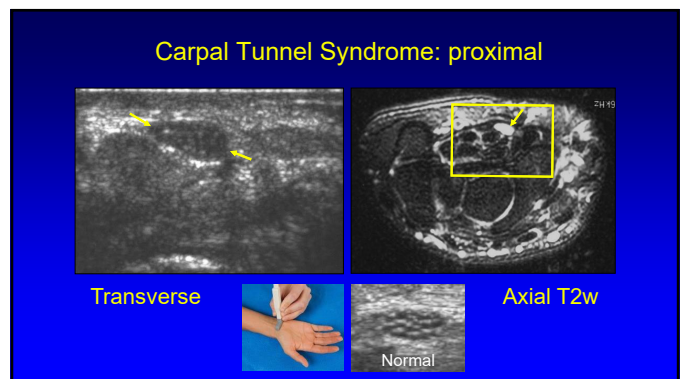
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- ### Normal Peripheral Nerve
- Ultrasound appearance:
 - Hypochoic nerve fascicles
 - Hyperechoic connective tissue
 - Transverse:
 - Honeycomb appearance
-
- Median Nerve
- Silvestri et al. Radiology 1995; 197:291

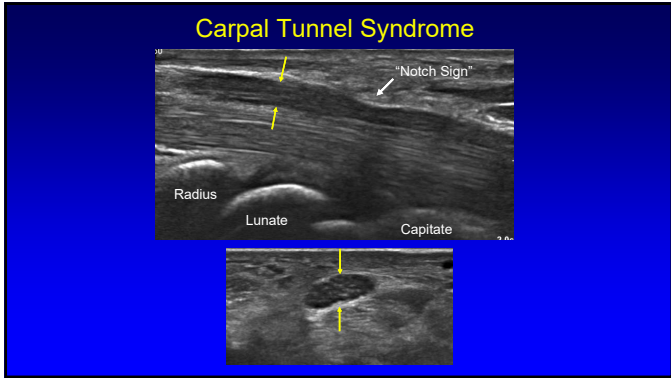
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- ### Nerve Entrapment
- US findings:
 - Nerve enlargement proximal to entrapment
 - Best appreciated transverse to nerve
 - Abnormally hypoechoic
 - Especially the connective tissue layers
 - Variable enlargement or flattening at entrapment site

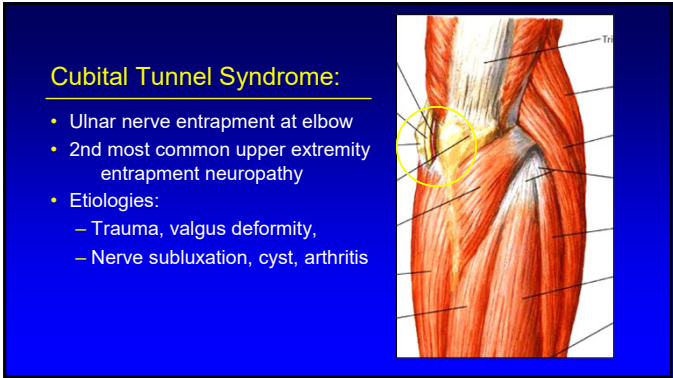
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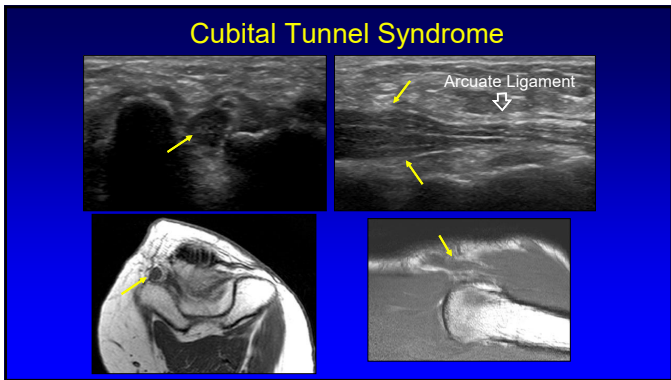
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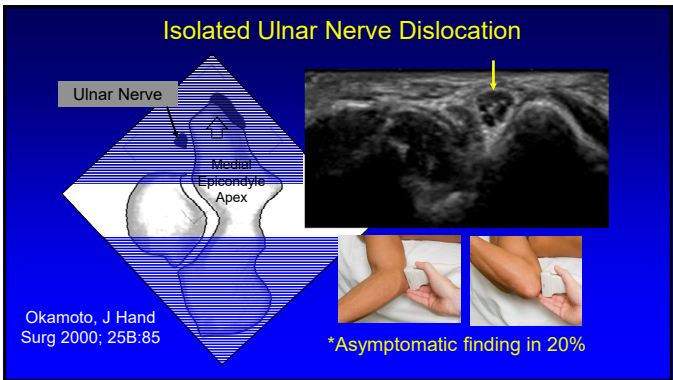
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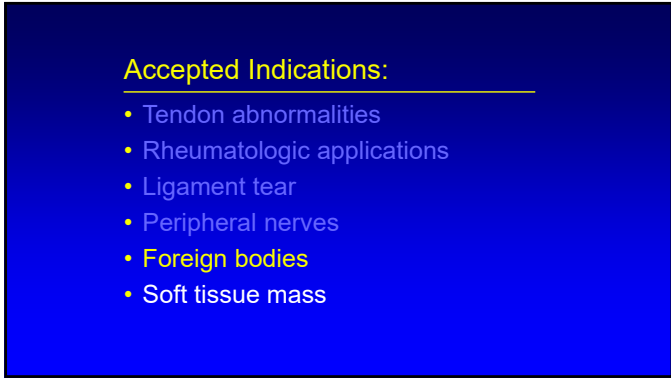
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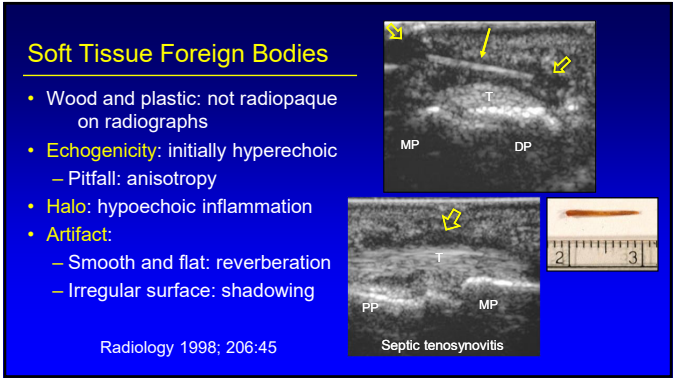
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Glass Foreign Body

- Glass:
 - Opaque
 - Regardless of tint or color

Radiology 1998; 206:45

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Rose Thorn: foot

Transverse Sagittal T2w

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Baker Cyst

- Semimembranosus-medial gastrocnemius bursa
- 50% over age of 50 have communication with knee joint
- Cyst communication to posterior knee between SM-MG tendons required (yellow arrow)

Ward EE et al. AJR 2001; 176:373

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Baker Cyst

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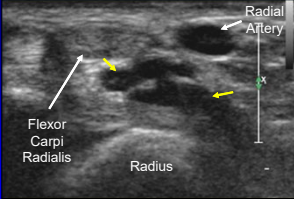
Baker Cyst: rupture

Longitudinal Coronal T2w

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Soft Tissue Mass: ganglion

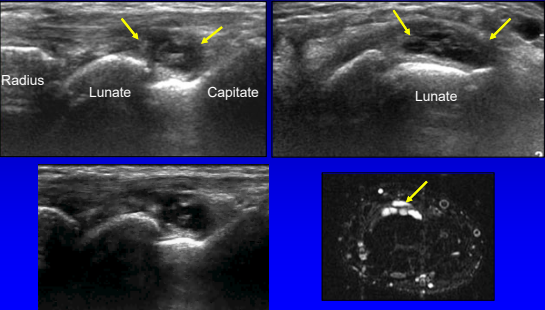
- Anechoic or hypoechoic
- Multilocular (except digits)
- Non-compressible
- Joint or tendon sheath communication
- Wrist: volar between radial artery and FCR (69%) and dorsal over scapholunate ligament



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

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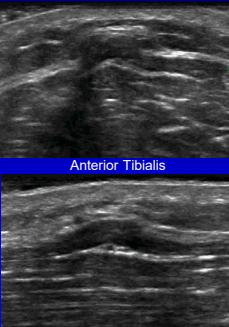
Ganglion Cyst: dorsal



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Muscle Hernia

- Cause: trauma, activities, weak fascia
- Lower leg: anterior tibialis
- Swelling with muscle contraction
- Ultrasound:
 - Muscle bulge
 - Possible fascial defect
 - Site of perforating vessel

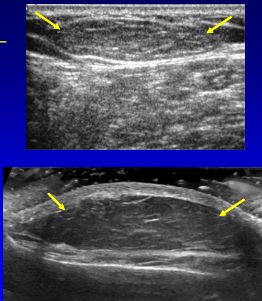


Beggs, AJR 2003; 180:395

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Lipoma

- Oval, homogeneous
- Isoechoic to adjacent fat
- Hyperechoic:
 - With increased fibrous tissue components
- No internal vascularity
- Compressible
- No pain or growth
- **Subcutaneous**



Inampudi et al. Radiology 2004; 233:763

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US: advantages

- 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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www.jacobsonmskus.com
 Twitter handle: @jjacobsn

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