

# Peripheral Nerve Ultrasound

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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  
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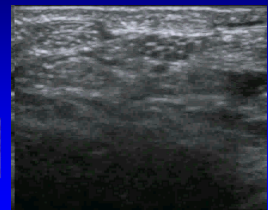
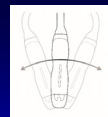
## Outline

- Normal ultrasound appearance
- Entrapment syndromes
- Nerve trauma and transection neuroma
- Peripheral nerve sheath tumors

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## Normal Peripheral Nerve

- Ultrasound appearance:
  - Hypoechoic nerve fascicles
  - Hyperechoic connective tissue
- Transverse:
  - Honeycomb appearance



Silvestri et al. Radiology 1995; 197:291

Median Nerve

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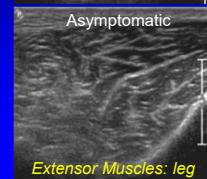
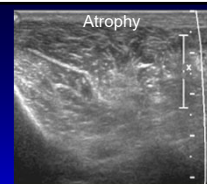
## Nerve Entrapment

- 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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## Denervation

- Edema: hyperechoic
- Fatty degeneration:
  - Hyperechoic
  - Echogenic interfaces
- Atrophy:
  - Hyperechoic with decreased muscle size
- Compare to other side!



J Ultrasound Med 1993; 2:73


Extensor Muscles: leg

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### Carpal Tunnel Syndrome:

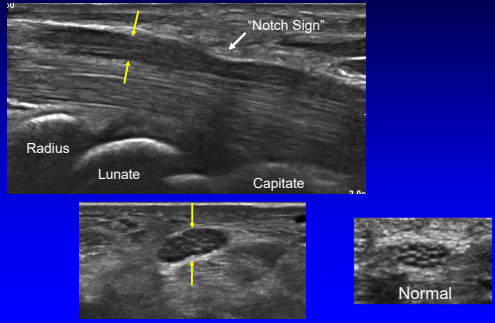
- Proximal median nerve swelling
  - Area: circumferential trace
  - Normal: < 9 mm<sup>2</sup>
  - Borderline: 9 – 12 mm<sup>2</sup>
  - Abnormal: > 12 mm<sup>2</sup>
    - 12.8 mm<sup>2</sup> = moderate (83% sens, 95% spec)
    - 14.0 mm<sup>2</sup> = severe (77% sens, 100% spec)

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

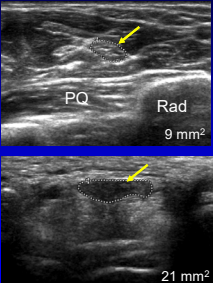


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### Carpal Tunnel Syndrome

- Compare areas:
  - Proximal: pronator quadratus
  - Distal: carpal tunnel
- $\geq 2 \text{ mm}^2$  = carpal tunnel syndrome
- 99% sensitivity
- 100% specificity

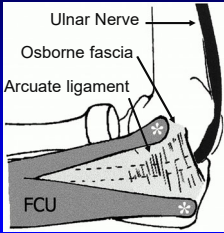
Klauser AS. Radiology 2009; 250:171



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### Ulnar Nerve: anatomy


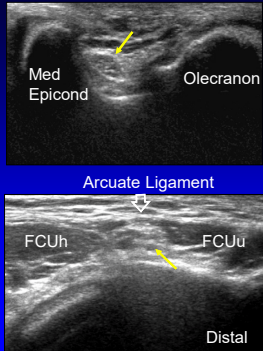
- Behind medial epicondyle of humerus:
  - Cubital tunnel retinaculum or Osborne fascia
- Distal to epicondyle:
  - True cubital tunnel
  - Between ulnar and humeral heads: flexor carpi ulnaris
  - Under arcuate ligament



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

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### Technique: cubital tunnel

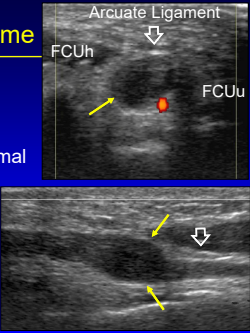



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### Ulnar Nerve: cubital tunnel syndrome

- Hypoechoic and enlarged
  - > 9 mm<sup>2</sup> area<sup>1</sup>
  - 2.8x area compared to proximal<sup>2</sup>
- Mild hypoechoogenicity alone: may be normal
- Causes:
  - Idiopathic, overuse, joint process
  - Anconeus epitrochlearis: compression
    - Normal variant accessory muscle

<sup>1</sup>Thoirs K et al. J Ultrasound Med 2008; 27:737  
<sup>2</sup>Yoon JS et al. Muscle Nerve 2008; 38:1231



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### 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

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### Isolated Ulnar Nerve Dislocation

Okamoto, J Hand Surg 2000; 25B:85

\*Asymptomatic finding in 20%

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### 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

Jacobson JA et al. Radiology 2001; 220:601

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### Tarsal Tunnel Syndrome

- Entrapment of tibial nerve
  - Ganglion cyst: most common
  - Varicose veins, tenosynovitis
  - Trauma, deformity, coalition, idiopathic
- Tibial nerve:
  - May appear normal
  - May be hypoechoic and swollen

Nagaoka, J Ultrasound Med 2005;24:1035

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### Ganglion Cyst: tarsal tunnel syndrome

Medial plantar nerve impingement from ganglion cyst originating from middle facet of anterior subtalar joint

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### Morton Neuroma:

- Interdigital nerve entrapment
- Edema, fibrosis, necrosis
- 3<sup>rd</sup> intermetatarsal space > 2<sup>nd</sup>
- Sharp, burning pain from metatarsal head to toes
- Females: pliable foot, high-heeled narrow-toed shoes

From: Martinoli, RadioGraphics 2000; 20:S199

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### Morton Neuroma

- Hypoechoic 5 mm mass
  - Sensitivity: 100% ; Specificity: 83%
  - Accuracy equal to MRI
  - Nerve continuity: sagittal plane
- Intermetatarsal bursa
  - Associated with neuroma
  - “Neuroma-bursal complex”

Quinn T et al. AJR 2000; 174:1723  
 Bignotti B et al. Eur Radiol 2015; 25:2254  
 Cohen SL et al. J Ultrasound Med 2016; 25:3191

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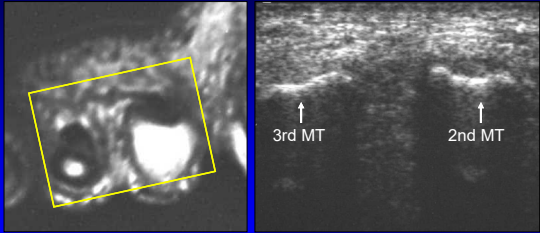
### Technique:

- Interdigital space
  - Transducer:
    - Plantar
    - Dorsal
  - Normal digital nerve difficult to visualize
  - Correlate with symptoms



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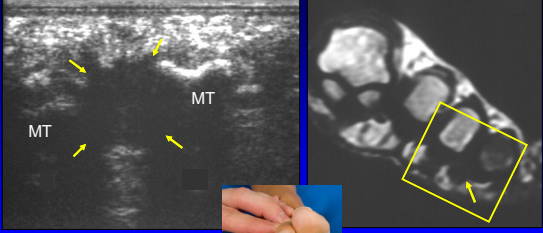
### Interdigital Space



Axial

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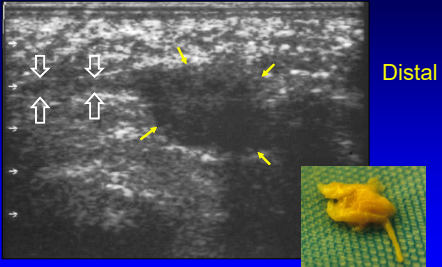
### Morton Neuroma



Transverse      Coronal T1w

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### Morton Neuroma: nerve continuity



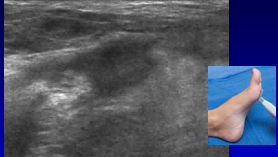
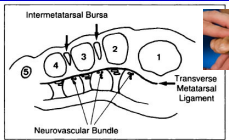
Longitudinal

Courtesy of Mark Murphey, MD

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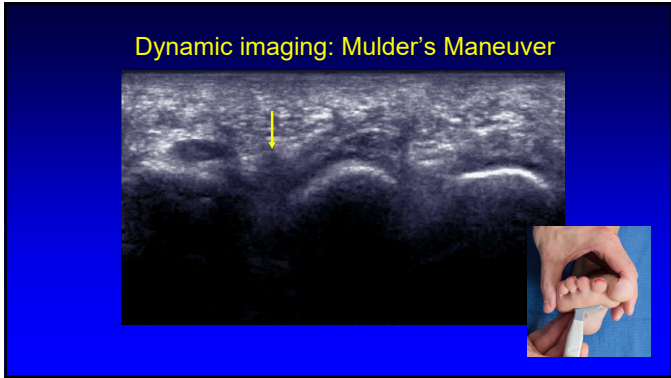
### Dynamic Evaluation

- Compression
  - Between transducer and palpation
  - Bursae (dorsal) compress, neuromas (plantar) do not
- Sonographic Mulder Sign
  - Scan plantar: coronal plane
  - Neuroma displaces: plantar
  - Palpable click

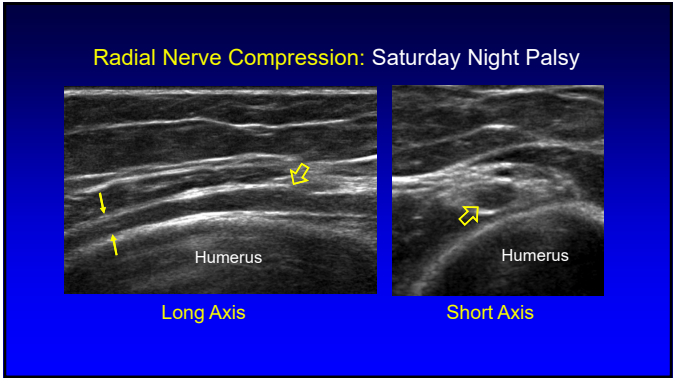



Torriani M et al. AJR 2003; 180:1121  
 Zanetti M et al. Radiology 1997; 203:516

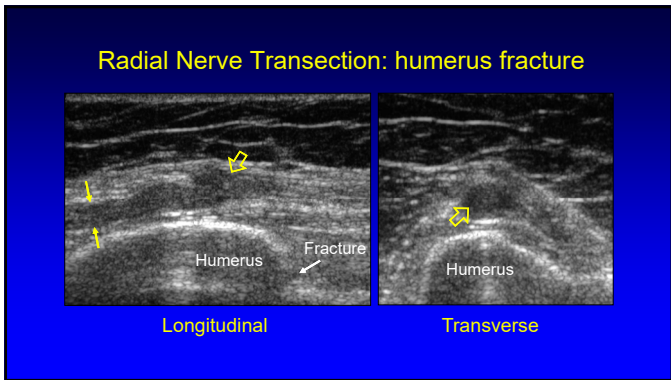
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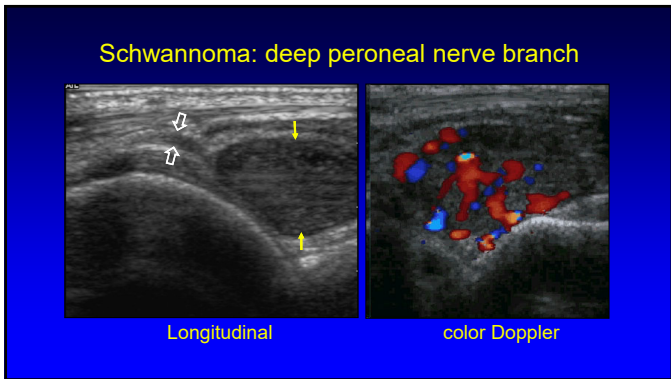
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### Peripheral Nerve Sheath Tumor

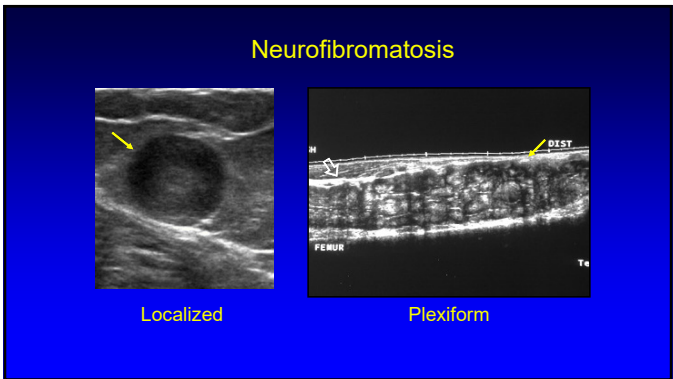
- Hypoechoic mass
- Nerve continuity (most important)
- Posterior acoustic enhancement
  - Possible pseudocyst appearance
- Neurofibroma
  - Central, fusiform, lobular, and avascular
- Schwannoma
  - Eccentric, possible calcifications, cystic

Ryu JA et al. J Ultrasound Med 2015; 34:2253  
Reynolds D et al. AJR 2004; 182:741

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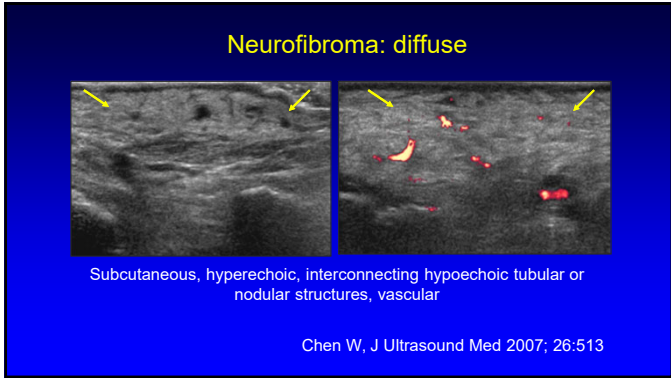


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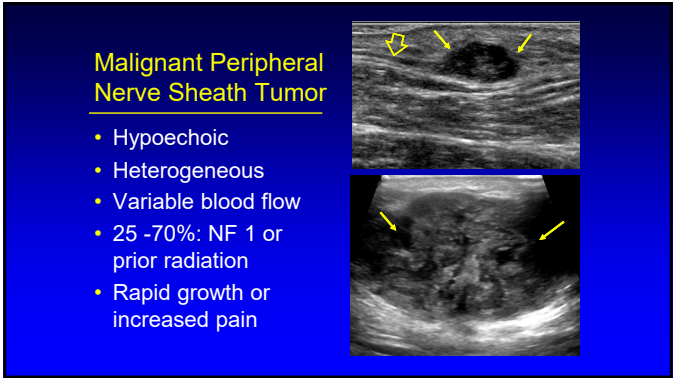


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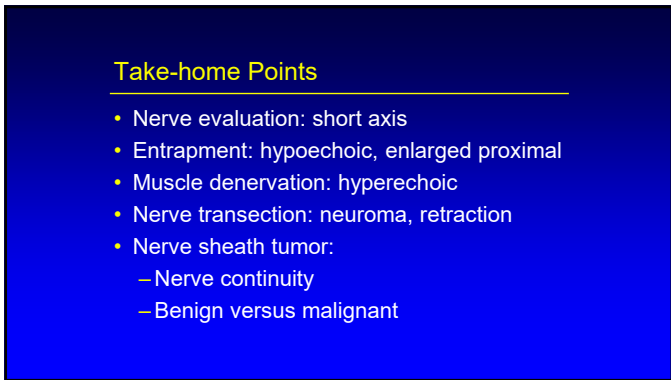




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