

## Ultrasound of Nerve Entrapment: Upper Extremity

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### Disclosures

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

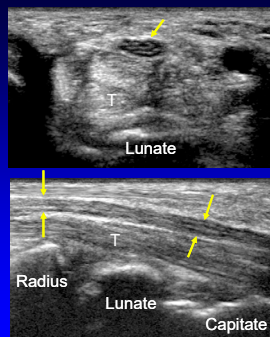
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### Peripheral Nerves

- More coarse compared to tendon
  - Fascicular not fibrillar
  - Less anisotropy unlike tendons
- Transverse
  - Speckled, honeycomb
- Longitudinal: hypoechoic nerve fascicles and hyperechoic fascia

Silvestri et al. Radiology 1995; 197:291



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### Nerve Entrapment

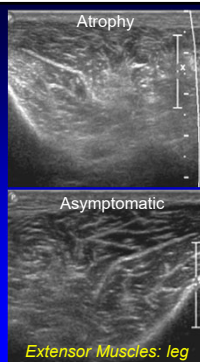
- US findings:
  - Nerve enlargement proximal to entrapment
    - Best appreciated transverse to nerve
  - Abnormally hypoechoic
    - Especially the connective tissue layers
  - Variable enlargement or flattening at entrapment site

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### Denervation

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

J Ultrasound Med 1993; 2:73



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### Entrapment Neuropathies

- Median nerve:
  - Carpal tunnel syndrome
  - Pronator teres syndrome
- Ulnar nerve:
  - Cubital tunnel syndrome
  - Ulnar tunnel syndrome
- Radial nerve:
  - Posterior interosseous nerve syndrome
- Suprascapular nerve

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## Median Nerve

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


Silvestri et al. Radiology 1995; 197:291

Median Nerve

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## Carpal Tunnel Syndrome:

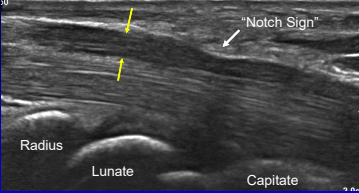
- Proximal median nerve swelling
  - Area: circumferential trace
  - Normal:  $< 9 \text{ mm}^2$
  - Borderline:  $9 - 12 \text{ mm}^2$
  - Abnormal:  $> 12 \text{ mm}^2$ 
    - $12.8 \text{ mm}^2$  = moderate (83% sens, 95% spec)
    - $14.0 \text{ mm}^2$  = severe (77% sens, 100% spec)



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

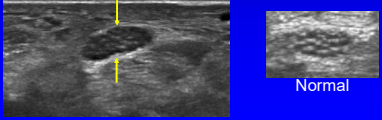
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## Carpal Tunnel Syndrome



Notch Sign

Radius Lunate Capitate

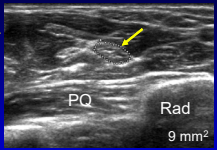


Normal

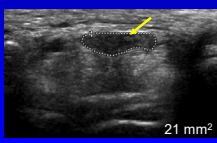
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## Carpal Tunnel Syndrome

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



PQ Rad 9 mm<sup>2</sup>

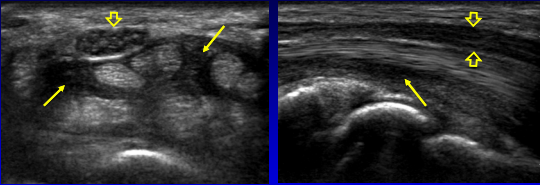
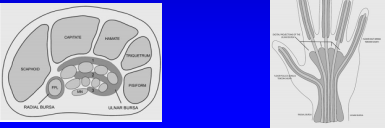


21 mm<sup>2</sup>

Klauser AS. Radiology 2009; 250:171

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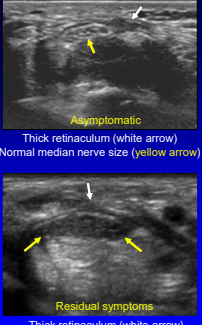
## Carpal Tunnel Syndrome: ulnar bursa distention

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## Postoperative Carpal Tunnel

- Discontinuous or thickened transverse carpal ligament
- Anterior displacement of transverse carpal ligament<sup>1</sup>
- Median nerve size:
  - May decrease<sup>2</sup>
  - Does not correlate with success<sup>3</sup>



Asymptomatic

Thick retinaculum (white arrow)  
Normal median nerve size (yellow arrow)

Residual symptoms

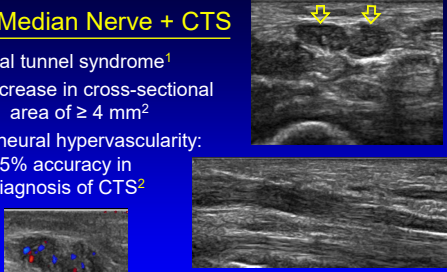
Thick retinaculum (white arrow)  
Enlarged median nerve (yellow arrow)

<sup>1</sup>Lee CH et al. Ann Plast Surg 2005; 54:143  
<sup>2</sup>Abicalaf CA et al. Clin Radiol 2007; 62:891  
<sup>3</sup>Naranjo A et al. Scand J Rheum 2010; 39:49

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### Bifid Median Nerve + CTS

- Carpal tunnel syndrome<sup>1</sup>
  - Increase in cross-sectional area of  $\geq 4 \text{ mm}^2$
- Intraneural hypervascularity: 95% accuracy in diagnosis of CTS<sup>2</sup>

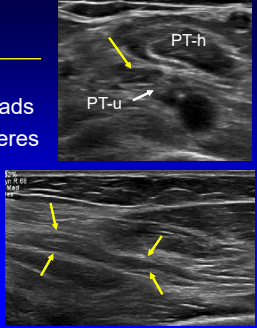


<sup>1</sup>Klauser et al. Radiology 2011; 259: 808  
<sup>2</sup>Mallouhi et al. AJR 2006; 186:1240

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### Pronator Teres Syndrome

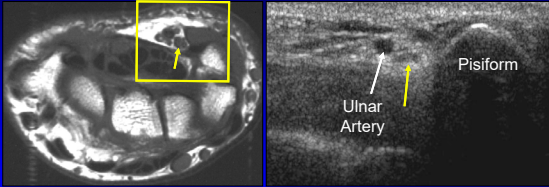
- Median nerve compression between humeral and ulnar heads
- Trauma, congenital, pronator teres hypertrophy
- Rare
- Forearm pain, numbness, weakness



Jacobson JA, et al. Semin Musculoskeletal Rad 2010; 14:473

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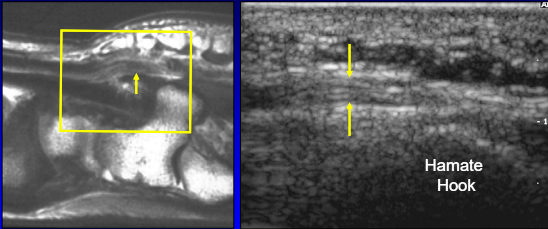
### Volar Wrist: Guyon's canal



Axial T1w      Short Axis

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### Volar Wrist: ulnar nerve

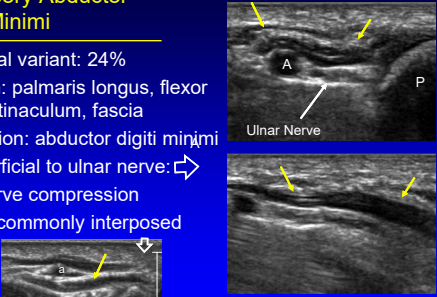


Sagittal T1w      Long Axis

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### Accessory Abductor Digiti Minimi

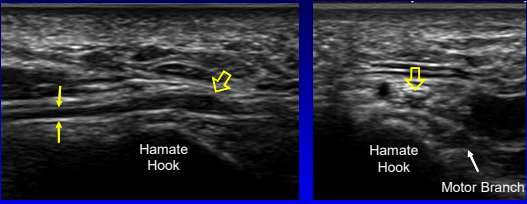
- Normal variant: 24%
- Origin: palmaris longus, flexor retinaculum, fascia
- Insertion: abductor digiti minimi
- Superficial to ulnar nerve:
  - Nerve compression
  - Uncommonly interposed



Timins et al. AJR 1999; 172:1397

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### Ulnar Nerve: cyclist wrist



Longitudinal      Transverse

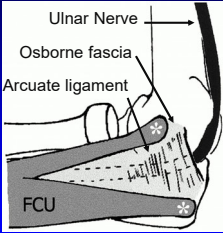
Sensory branch impingement between hook of hamate and bicycle handlebar

Courtesy of EFW Radiology, Calgary, Alberta, Canada

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### Ulnar Nerve: anatomy


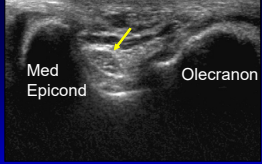
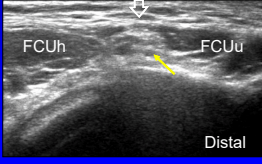
- Behind medial epicondyle of humerus:
  - Cubital tunnel retinaculum or Osborne fascia
- Distal to epicondyle:
  - True cubital tunnel
  - Between ulnar and humeral heads: flexor carpi ulnaris
  - Under arcuate ligament



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

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### Technique: cubital tunnel

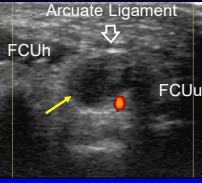
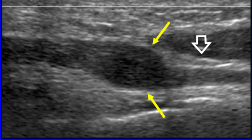




Med Epicond    Olecranon  
Arcuate Ligament  
FCUh    FCUu  
Distal

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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

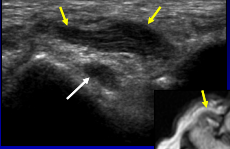
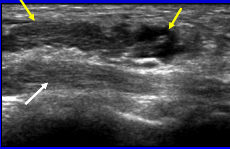



<sup>1</sup>Thoirs K et al. J Ultrasound Med 2008; 27:737  
<sup>2</sup>Yoon JS et al. Muscle Nerve 2008; 38:1231

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### Anconeus Epitrochlearis

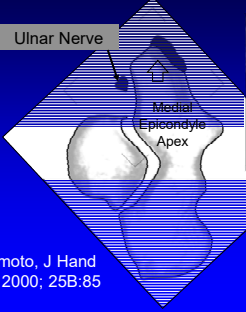
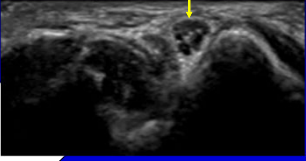


- Normal variant: 34% of population
- Roof of cubital tunnel:
  - Residual muscle
  - In absence of normal attrition forming Osborn fascia
- Secondary ulnar nerve entrapment
- **Diagnose in elbow extension!**

Sem Musculoskel Radiol 2000; 14:814:473

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### Isolated Ulnar Nerve Dislocation

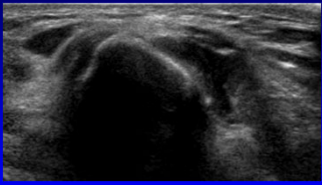





Okamoto, J Hand Surg 2000; 25B:85  
**\*Asymptomatic finding in 20%**

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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

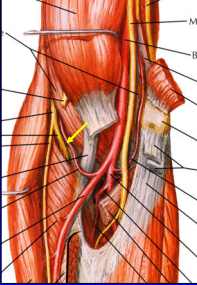


Jacobson JA et al. Radiology 2001; 220:601

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### Radial tunnel

- Radial nerve: deep branch
  - Originates from radial nerve between brachioradialis and brachialis
  - Passes between deep and superficial layers of supinator muscle
  - Exits as posterior interosseous nerve

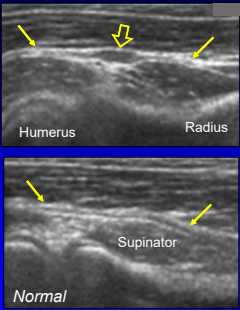


Jacobson JA, et al. Sem Musculoskel Rad 2010; 14:473

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### Radial Nerve: deep branch

- Supinator syndrome:
  - Motor deficits (wrist, finger extension)
  - Abnormal electrodiagnostic studies
  - Nerve enlargement: entrapment
- Radial tunnel syndrome:
  - Pain, no motor deficits, normal EMG
  - Muscle denervation on MRI
  - No nerve enlargement

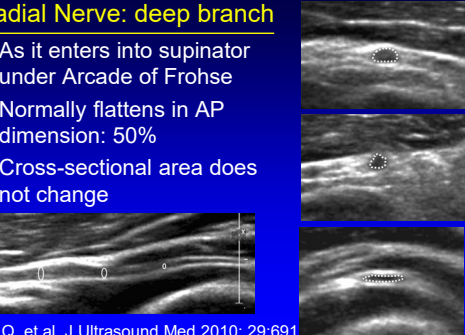


Ferdinand BD et al. Radiology 2006; 240:161

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### Radial Nerve: deep branch

- As it enters into supinator under Arcade of Frohse
- Normally flattens in AP dimension: 50%
- Cross-sectional area does not change



Dong Q, et al. J Ultrasound Med 2010; 29:691

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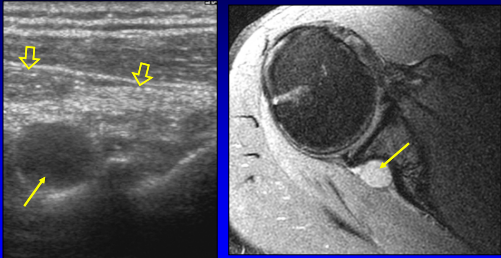
### Paralabral Cyst:

- Most associated with labral tear
- Suprascapular notch:
  - Supraspinatus and infraspinatus atrophy
- Spinglenoid notch:
  - Infraspinatus atrophy
- US guided aspiration



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### Paralabral Cyst: infraspinatus atrophy



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### Pitfall: suprascapular vein dilation



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### Take-home Points

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- Nerve evaluation: short axis
- Entrapment:
  - Characteristic locations
  - Hypoechoic, enlarged proximal
- Muscle denervation: hyperechoic
- Dynamic evaluation:
  - Ulnar nerve dislocation
  - Snapping triceps syndrome

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