

Ultrasound Evaluation of Peripheral Nerves

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Disclosures

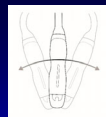
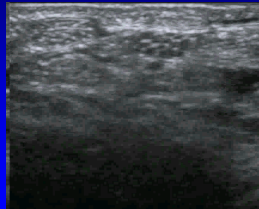
- Book Royalties: Elsevier
- Consultant: Bioclinica
- Medical Director: POCUSPRO
- Not relevant to this talk

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

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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 Compression

- Experimental model (rat, sciatic nv):
 - Compression causes ischemia
 - First pathologic change: edema
 - Correlated with severity of axonal injury
 - Mild compression: demyelination
 - Severe compression: axonal damage

Powell, Laboratory Investigation 1986; 55:91

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Nerve Entrapment

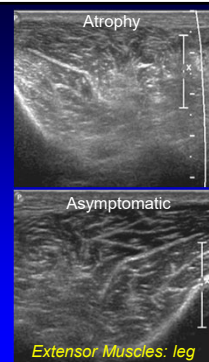
- US findings:
 - Nerve enlargement proximal to entrapment
 - Best appreciated transverse to nerve
 - Abnormally hypoechoic
 - Especially the connective tissue layers
 - Variable enlargement or flattening at entrapment site

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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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Nerve Entrapment Syndromes

- Median:
 - Carpal tunnel syndrome
 - Pronator teres syndrome
- Ulnar:
 - Ulnar tunnel syndrome
 - Cubital tunnel syndrome

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Carpal Tunnel Syndrome:

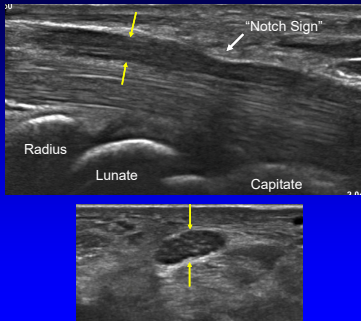
- Proximal median nerve swelling
 - Area: circumferential trace
 - Normal: $< 9 \text{ mm}^2$
 - Borderline: $9 - 12 \text{ mm}^2$
 - Abnormal: $> 12 \text{ mm}^2$
 - 12.8 mm^2 = moderate (83% sens, 95% spec)
 - 14.0 mm^2 = severe (77% sens, 100% spec)



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

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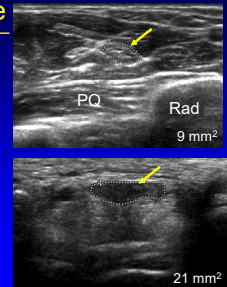
Carpal Tunnel Syndrome



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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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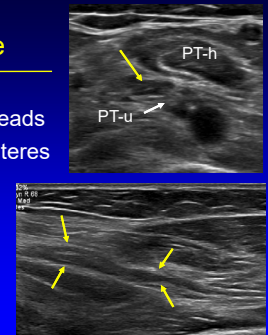
Nerve Entrapment Syndromes

- Median:
 - Carpal tunnel syndrome
 - Pronator teres syndrome
- Ulnar:
 - Ulnar tunnel syndrome
 - Cubital tunnel syndrome

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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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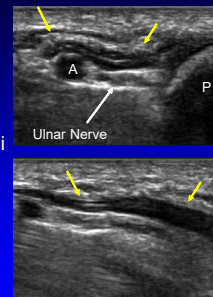
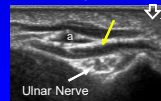
Nerve Entrapment Syndromes

- Median:
 - Carpal tunnel syndrome
 - Pronator teres syndrome
- Ulnar:
 - Ulnar tunnel syndrome
 - Cubital tunnel syndrome

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Accessory Abductor Digiti Minimi

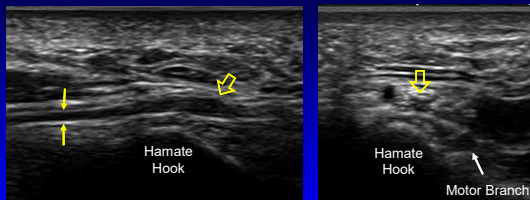
- Normal variant: 24%
- Origin: palmaris longus, flexor retinaculum, fascia
- Insertion: abductor digiti minimi
- Superficial to ulnar nerve:
 - Nerve compression
 - Uncommonly interposed



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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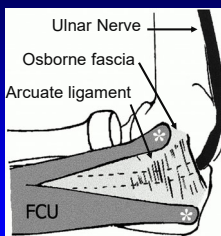
Nerve Entrapment Syndromes

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 - Ulnar tunnel syndrome
 - Cubital tunnel syndrome

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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

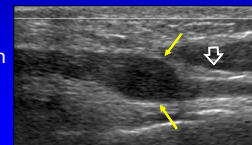
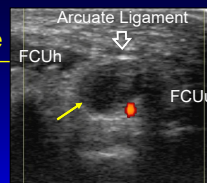


Martinoli, C. et al. Radiographics 2000;20:S199-S217 **RadioGraphics**

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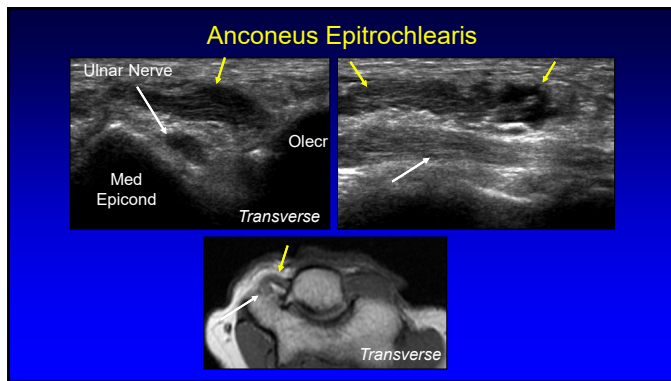
Ulnar Nerve: cubital tunnel syndrome

- Hypoechoic and enlarged
 - $> 9 \text{ mm}^2$ area¹
 - 2.8x area compared to proximal²
- Mild hypoechoogenicity alone: may be normal
- Causes:
 - Idiopathic, overuse, joint process
 - Anconeus epitrochlearis: compression
 - Normal variant accessory muscle

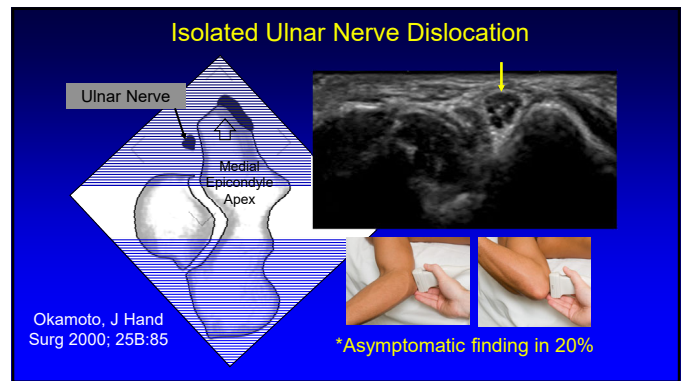


¹Thoirs K et al. J Ultrasound Med 2008; 27:737
²Yoon JS et al. Muscle Nerve 2008; 38:1231

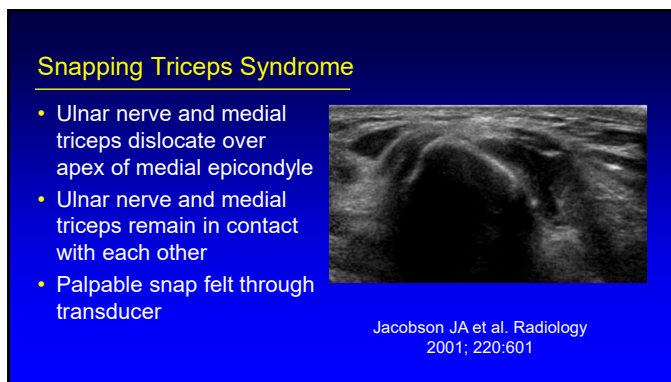
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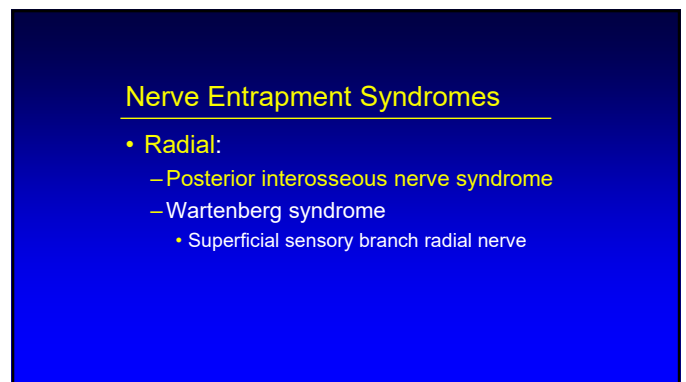
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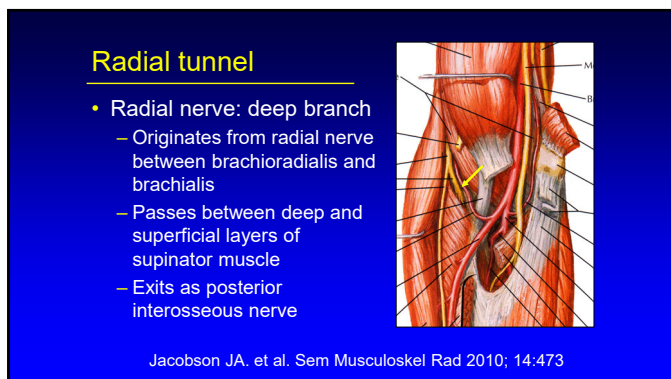
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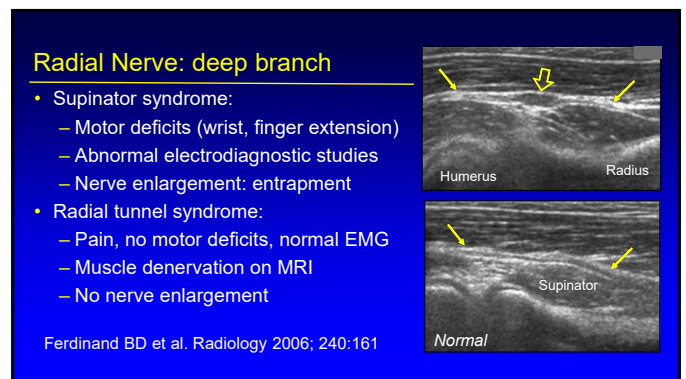
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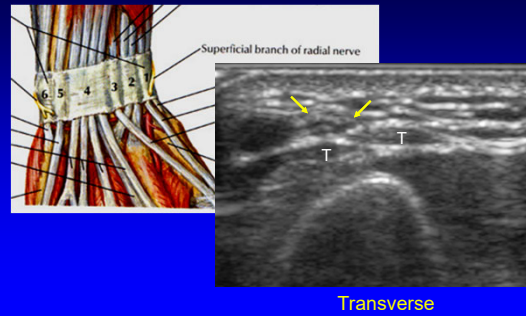
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Nerve Entrapment Syndromes

- Radial:
 - Posterior interosseous nerve syndrome
 - Wartenberg syndrome
 - Superficial sensory branch radial nerve

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Wartenberg Syndrome



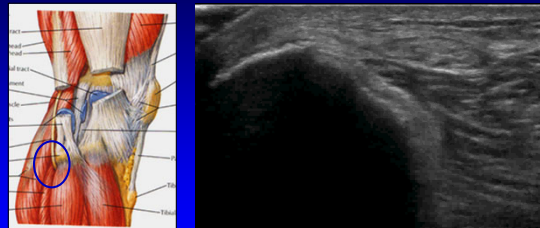
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Nerve Entrapment Syndromes

- Peroneal (fibular):
 - Common peroneal
 - Superficial peroneal
- Tibial
- Interdigital (Morton neuroma)

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Common Peroneal Nerve: entrapment



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Peroneal Intraneural Ganglion

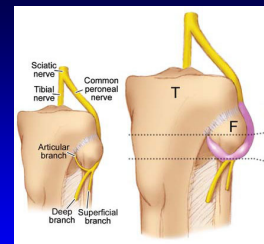
- Pain: knee or peroneal nerve distribution
 - Possible palpable mass, fluctuating course
- 18% of those with foot drop¹
- No identifiable etiology
 - Weight loss, trauma, leg crossing
- High body mass index²
 - Unlike other causes for peroneal neuropathy

¹Visser et al. Neurology 2006; 67:1473
²Young et al. Neurology 2009; 72:447

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Peroneal Intraneural Ganglion

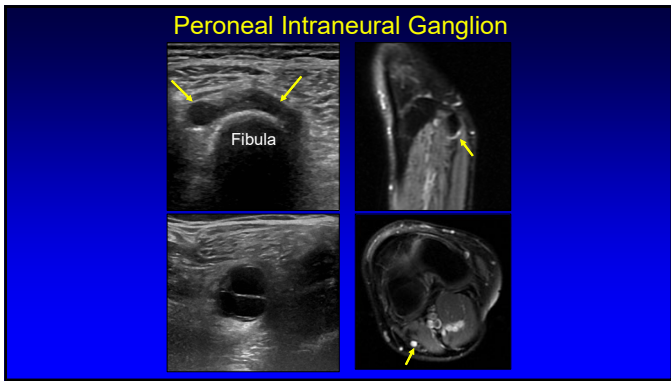
- Joint fluid from proximal tibiofibular joint
 - Enters peroneal nerve via articular nerve branches
 - Shown at MR arthrography after exercise
 - Extends proximal via epineurial sheath¹



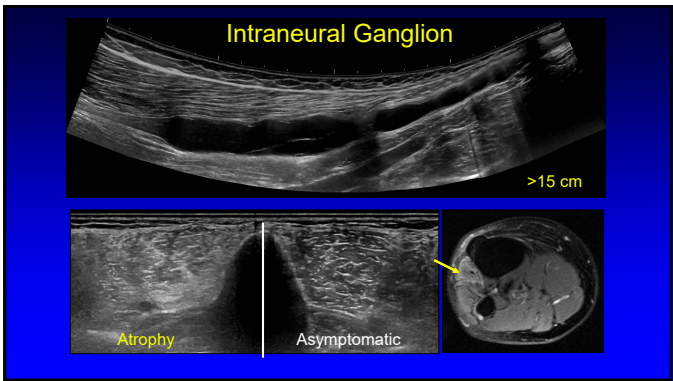
From: Spinner et al. Skeletal Radiol 2008;37:1091

Spinner et al. Clin Anatomy 2007; 20:826

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Nerve Entrapment Syndromes

- Peroneal:
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 - Superficial peroneal
- Tibial
- Interdigital (Morton neuroma)

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Superficial Peroneal Nerve

- Pierces crural fascia of leg:
 - 9.2 cm proximal to fibular tip
 - Range: 6 to 16 cm proximal
 - Potential **entrapment site**
- Terminal branches: 6 cm proximal to fibular tip
 - Superficial to inferior extensor retinaculum

Canella, AJR 2009; 193:174

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Superficial Peroneal Nerve

From Canella, AJR 2009; 193:174

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Muscle Hernia (extensor digitorum): superficial peroneal nerve entrapment

Longitudinal

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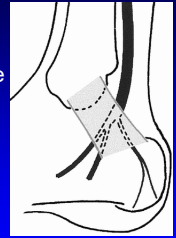
Nerve Entrapment Syndromes

- Peroneal:
 - Common peroneal
 - Superficial peroneal
- **Tibial**
- Interdigital (Morton neuroma)

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Tarsal Tunnel:

- Osteofibrous tunnel: medial ankle
- Tibial nerve
- Tendons: tibialis posterior, flexor digitorum longus, flexor hallucis longus
- Entrapment: mass, ganglion

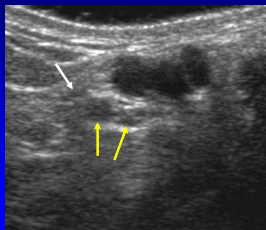


From: Martinoli, RadioGraphics 2000; 20:S199

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Tibial Nerve:

Medial, lateral plantar nerve and medial calcaneal nerve branches



Transverse

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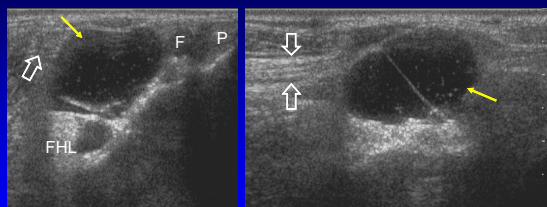
Tarsal Tunnel Syndrome

- 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

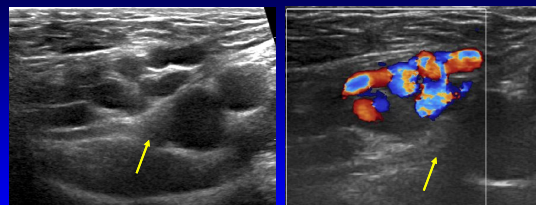


Axial

Sagittal

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Tarsal Tunnel Syndrome: Varices



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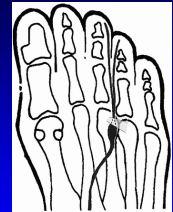
Nerve Entrapment Syndromes

- Peroneal:
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- Tibial
- Interdigital (Morton neuroma)

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Morton Neuroma:

- Digital nerve entrapment
 - Common plantar digital nerve
- Edema, fibrosis, necrosis
- 3rd intermetatarsal space > 2nd
- 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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Technique:

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



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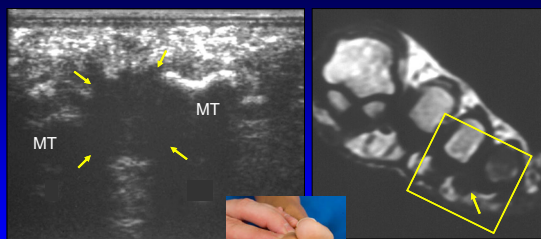
Morton Neuroma:

- Hypoechoic 5 mm mass
 - Sensitivity: 100% ; Specificity: 83%
- Digital nerve continuity*
 - Excludes other causes for mass
- Compression:
 - Produces symptoms
 - Bursa (compressible) vs. neuroma (not compressible)

Redd et al. Radiology 1989; 171:415
Quinn et al. AJR 2000; 174:1723

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Morton Neuroma



Transverse

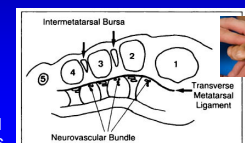
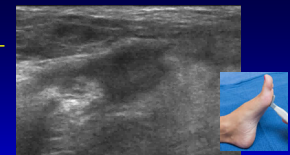
Coronal T1w



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Dynamic Evaluation

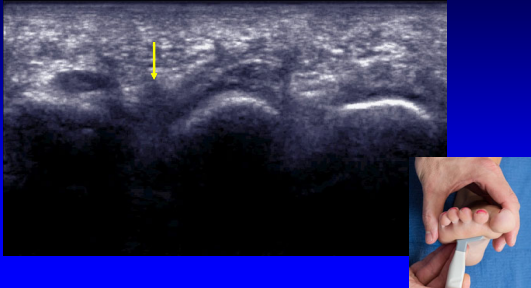
- Compression
 - Between transducer and palpation
 - Bursae (dorsal) compress, neuromas (plantar) do not
- Sonographic Mulder Sign
 - Scan plantar: coronal plane
 - Neuroma displaces: plantar
 - Palpable click



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

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Dynamic imaging: Mulder's Maneuver



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Summary: peripheral nerve US

- Evaluate entire limb efficiently
- Easy comparison to contralateral side
- Direct correlation: signs and symptoms
- Complements electrodiagnostic testing
- Dynamic imaging

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Thank you!

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

Twitter handle: @jjacobsn

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