Pathology of Foot and Ankle Nerves

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Outline
• Nerve entrapment
  – Superficial fibular nerve
  – Tarsal tunnel syndrome
• Morton neuroma
• Nerve transection

Superficial Fibular Nerve
• Branch of common fibular (peroneal) nerve
• Sensory: dorsolateral foot and ankle
• Motor: collateral branches to fibularis (peroneus) muscles

Delfaut, RadioGraphics 2003; 23:613

Superficial Fibular 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
**Outline**

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  - **Tarsal tunnel syndrome**
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**Tibial Nerve (TN)**

- Bifurcates in tarsal tunnel (distal tibia)
  - Medial plantar nerve (MPN)
  - Lateral plantar nerve (LPN)
- Plantar nerves divide into interdigital nerves
  - Motor branches: muscles of sole of foot
  - Sensory: digits (via common and proper plantar digital nerves)

  Martinoli, RadioGraphics 2000; 20:S199

**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
Tibial Nerve: Medial, lateral plantar nerve and medial calcaneal nerve branches

Transverse

Tibial Nerve (TN)
- Medial calcaneal nerve (MCN)
  - From TN 62%, trifurcation 18%, LPN 18%
  - Sensory: medial heel
- Inferior calcaneal branch
  - From LPN 81%, TN 12%, 6% TN + MCN
  - Motor: FDB, quadratus plantae, abductor digiti quinti
  - Sensory: long plantar ligament, ant calcaneal tubercle

Delfaut, Radiographics 2003; 23:613

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

Ganglion Cyst: tarsal tunnel syndrome

Axial

Sagittal

Ganglion Cyst
**Ganglion Cyst: tarsal tunnel syndrome**

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

**Tarsal Tunnel Syndrome: Varices**

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

**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"

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

*From: Martinoli, RadioGraphics 2000; 20:S199*

*Quinn T et al. AJR 2000; 174:1723*

*Bignotti B et al. Eur Radiol 2015; 25:2254*

Interdigital Space

Morton Neuroma

Axial

Transverse

Coronal T1w

Interdigital Space

Morton Neuroma

3rd MT

2nd MT

MT

MT

Morton Neuroma: nerve continuity

Proximal

Distal

Longitudinal

Morton Neuroma

Plantar

Dorsal

Plantar

Dorsal

Dynamic Evaluation

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

Dynamic imaging: Mulder’s Maneuver

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

Courtesy of Mark Murphy, MD
Morton Neuroma + Bursa

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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

Sural Nerve: transection neuromas

Take Home Points
- Superficial fibular nerve: entrapment
- Tarsal tunnel syndrome: ganglion
- Morton neuroma: dynamic evaluation
  - Neuroma displaces
  - Bursa compresses
  - Reproduce symptoms