Surgical Management of Foot/Ankle Entrapment Neuropathy
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Disclosures
Entrapment Neuropathies

• Outline:
  • Common Peroneal Nerve
  • Superficial Peroneal Nerve
  • Deep Peroneal Nerve (Anterior Tarsal Tunnel)
  • Sural Nerve
  • Saphenous Nerve
  • Tibial Nerve (Posterior Tarsal Tunnel)
    • Medial Plantar Nerve
    • Lateral Plantar Nerve
  • Morton’s Neuroma
Entrapment Neuropathies

• Anatomic Considerations
• Exam/Imaging/Work-up
• Non-operative Treatments
• Surgical Treatment
• Outcomes
Common Peroneal Nerve

• Terminal branch of the sciatic nerve from L4-S2.
• Sends a branch → short head of biceps femoris near gluteal fold
• Relatively tethered at sciatic notch, so sciatic nerve injury often affects CPN more than Tibial nerve.
• Follows medial border of biceps femoris muscle and tendon at popliteal fossa.
Common Peroneal Nerve

- Courses around fibular neck and travels under peroneus longus.
  - Sites of compression: gastroc and soleus fascial bands
  - Between peroneus longus and lateral aspect of fibular neck
  - Between peroneal tendons and tibialis anterior (anterior crural intermuscular septum)
- At risk of stretch injury/transection with knee dislocations/multi-ligamentous injuries
- Other Causes: lipomas, nerve sheath tumors, ganglion cysts
Weakness in ankle dorsiflexion/eversion, altered sensation in SPN/DPN distributions most common findings
  - SPN: dorsum of foot
  - DPN: 1st webspace

Pain is variable: only in ~15-20% of patients (Mahan et al 2015)

Tinel positive in only 12/30 (Souter et al 2018)

Total Knee Replacement: 0.3 – 4% → CPN neuropathy

Proximal tibial osteotomy: 3 – 13% (Calhoun J 2015)

Concern when alignment is corrected at knee, especially valgus deformity
Work-Up

• Imaging: XR for obvious knee deformity or mass lesion
• MRI: best for ganglion cysts or to evaluate for proximal tib-fib pathology
• EMG/NCS useful, especially if there is motor involvement
  • Tibial nerve muscles should be normal for CPN neuropathy but may be abnormal with L5 radiculopathy (or sciatic)
  • Significant drop in amplitude or slowing of conduction at fibular head
• Non-operative Treatments: if weakness, would avoid steroid injections → surgical treatment
Imaging: Common Peroneal Nerve
Case Example: 60 yo M with mass/numbness
• Patient underwent excision of lipoma, decompression of common peroneal nerve at knee.

• Immediate relief of numbness, 5/5 motor of TA/EHL/EDL.
Surgical Considerations

• Incision along medial border of biceps femoris → fibular neck

• Nerve is freed at popliteal fossa and distally where the CPN enters Peroneus Longus and peroneal tunnel

• Leave deep surface to preserve blood supply (vasa nervorum)

• Can consider Posterior Tibial Transfer to Lateral Cuneiform for Complete CPN Injury/Transection
• Retrospective review: 30 patients (2 from mass lesions, most were post-op or post-traumatic in nature)
• All with +EMG/NCS
• 12/30 Tinel’s sign
• Mean f/u: 52 weeks
• Results: 24/26 had improvement of motor deficit
• Paresthesias/Sensory deficit: 7/14 improved on sensory exam
• Zero cases of worsening of neurologic exam
Posterior Tibial Tendon Transfer for Foot Drop
Superficial Peroneal Nerve

- Travels through lateral compartment of the leg → peroneus longus/brevis
- However: 14-17%: SPN travels in the anterior compartment
- Exits deep fascia of leg and becomes subcutaneous 12.5 cm proximal to tip of lateral malleolus (Rosson et al CORR 2005)
Superficial Peroneal Nerve

- Can be tethered at deep fascia, muscle herniation, lipoma
- Athletes with ankle instability → traction injury
- Consider Chronic Exertional Compartment Syndrome
- Exam: percussion, Tinel’s, compression test
  - Provocative Maneuver: Inversion and plantarflexion of ankle and palpation at exit site of nerve.
• Think of SPN after
  • Ankle fracture ORIF
  • Ankle arthroscopy (intermediate branch)
  • Inversion injury
  • Hallux valgus correction! (medial branch dorsal cutaneous-NOT from SAPHENOUS)
SPN: Surgical Considerations

- EMG/NCS not as useful
- Release nerve at exit from deep fascia
- Anatomic variability exists!
- OUTCOMES: Rosson and Dellon CORR 2005: 31 patients: 17% SPN in anterior compartment, 26% SPN in both ant/lat, 57% only in lateral compartment
- Surgery reasonable if non-surgical measures have failed.
Deep Peroneal Nerve

• Compression at “Anterior Tarsal Tunnel” between Inferior extensor retinaculum (superficial) and Talonavicular capsule (deep)

• Nerve travels between Tibialis Anterior and Extensor Hallucis Longus 5 cm above the ankle mortise

• Branches:
  - Lateral Branch - courses deep to inferior extensor retinaculum ➔ motor to Extensor Digitorum Brevis, ➔ sensory to ankle joint, lateral tarsal joints
  - Medial Branch - travels with Dorsalis Pedis Artery ➔ sensation to 1st dorsal webspace
Deep Peroneal Nerve

- Compression: dorsal osteophytes at Talonavicular Joint, Tarsometatarsal Joints
- Non-Op: limit external compression from shoes/braces, reduce inflammation
- Surgical: Release portion of Inferior Extensor Retinaculum and remove ganglion cysts, osteophytes/fuse arthritic joints as necessary
DPN: Outcomes

• Dellon 1990: 80% good or excellent results with decompression in 18 patients after DPN decompression.

• Must address underlying cause: ex-Talonavicular Arthritis.

• Complete release of Retinaculum → bowstringing of tendons
• Compression can occur along the lateral ankle, calcaneus, fifth metatarsal.
  • Usually due to Trauma, Surgery, Osteophytes, Soft tissue scarring, instability

• Surgical Causes: peroneal tendon surgery, achilles repair, Strayer procedure (Gastroc Lengthening) fibular/posterior tibial ORIF, calcaneus fracture ORIF, 5th MT ORIF/screw placement, lateral ligament reconstruction.
Sural Nerve: Treatments

• Non-op Rx: NSAIDS, nerve medication, neural gliding, desensitization, hydrodissection, steroid injections

• Operative: Decompression or nerve excision/burial, nerve conduit
Sural Nerve- Outcomes

- Fabre et al AJSM 2000
- 12/13 athletes who underwent release were able to return to sport at same level.
- My experience: widely variable depending on cause of sural neuropathy/injury
- Conduit treatment has had good success
Sural Nerve Injury from Peroneal Tendon Repair - Neurolysis with Placement of Collagen Conduit
Saphenous Nerve

• Often compressed proximally (adductor canal, infrapatellar)
• NCS not reliable
• Often iatrogenic: medial malleolar ORIF, distal tibial ORIF, deltoid ligament repair, posterior tibial tendon surgery, Tight-rope
• Rx: decompression/neurolysis with collagen conduit
• No outcome Studies
Tarsal tunnel syndrome

- More diffuse heel pain than PFitis or Baxter’s nerve.
- (+) Tenderness, (+) Tinels over tarsal tunnel, worse with DF/eversion
- May have Valleix phenomenon (proximal radiation)
Tarsal Tunnel Syndrome

- EMG/NCV may aid in diagnosis (slowed conduction at tarsal tunnel)
- Injection may provide temporary relief/diagnosis
- Treatment: conservative (orthotics, physical therapy) tarsal tunnel release
- Consider Soleal Sling Syndrome: compression from fibrous sling at origin of soleus muscle: more proximal point of pain/paresthesias, can be a source of failed tarsal tunnel release.
Case: DS 42 yo M

• Avid runner: 3,000 mi/year including ultra-marathons (100 mi)
• + compression test, Tinel's, Valleix phenomenon
• EMG/NCS: Mild left tibial neuropathy primarily affecting the medial plantar nerve. No evidence of generalized lumbar radiculopathy.
• MRI:
Case: DS

- Underwent tarsal tunnel release with excision of accessory FDL muscle/tendon.
- Substantial relief, return to running by 6 weeks (not always...)

• 201 targeted steroid injections under ultrasound around tibial nerve within tarsal tunnel since 2013
• 78% of patients were female
• 149 of 201 (74%) did not require decompression of tibial nerve
• 51 of 201 (26%) did undergo tarsal tunnel release
  • Unpublished data (Small, Pierce, Park 2020)
Tarsal Tunnel Syndrome: Surgical Results

- Success Rate Varied: 44-78%
- Sammarco 2003 showed better outcomes if symptoms present for < 1 year.
- Complications: incomplete release, wound complications, iatrogenic neurovascular injury.
Baxter’s nerve (First Branch of Lateral Plantar Nerve)

• 20% of chronic heel pain
• Common in runners
• Females >> Males (More distal branching of Baxter’s Nerve, Nakano et al JFAR 2015)

• Supplies
  – Medial calcaneal tuberosity
  – Abd. Digiti quinti
  – Flexor digitorum brevis
  – Long plantar ligament

• Entrapment occurs between quadratus plantae and abductor hallucis
Baxter’s nerve

- Tender over abductor hallucis muscle along course of nerve
- May also have PF pain
- Surgical treatment
  - Divide superficial fascia of abductor hallucis
  - Divide deep fascia of abductor hallucis
  - +/- PF release
- 89% Good-Excellent at 4 year f/u
  - Baxter, CORR 1992
- 92% satisfactory at 3 years with partial PF release
  - Sammarco, FAI 1996
Medial Plantar Nerve “Jogger’s Foot”

• Sites of compression:
  • Between Abductor hallucis fascia and origin at navicular and calcaneus
  • Between abductor hallucis muscle belly and knot of henry
  • As it passes through medial intermuscular septum

• Symptoms: medial plantar pain, often exercise-induced
• Can radiate to the plantar aspect of first, second and third toes, proximally to medial heel and ankle
• Valgus alignment/pronation may predispose to Jogger’s Foot
MPN “Jogger’s Foot”

- Non-Op: orthotics, injections, NSAID’s.
- Surgical Rx: Release of the abductor hallucis fascia, from origin at calcaneus → knot of Henry
- Would also recommend proximal release of tarsal tunnel, as there may also be proximal compression.
Morton’s Neuroma

- Entrapment of interdigital nerve near distal edge of inter-metatarsal ligament/repetitive microtrauma
- Degenerative changes and peri-neural fibrosis.
- ~85-90% in 3-4 (“third”) webspace
- History: cannot tolerate shoes with narrow toe box, numbness, remove shoes immediately at work.
- EXAM: Mulder’s click, numbness at toes, plantar pain proximal to metatarsal heads.
  - Look for other causes of pain: MTP instability, fat pad atrophy, subluxation, hammer toes.
Morton’s Neuroma

• If considered as a diagnosis in 2-3 webspace, MTP joint pathology should be ruled out.
  • Metatarsalgia or MTP synovitis
  • Patients with narrow 2-3 inter-metatarsal space → nerve compression
Morton’s Neuroma

• Can try orthotics, metatarsal pads, wide toe-box shoes, injections
  • Limit steroid injections as it may damage MTP joint capsule/plantar plate. Diagnostic Role
  • AVOID ALCOHOL SCLEROSING AGENTS!!

• Surgery: dorsal approach with excision of nerve to level of normal appearing nerve (4-5 cm whenever possible)

• Complications: inadequate nerve resection, excision of incorrect tissue (lumbrical tendon/digital artery)
• 235 targeted steroid injections under ultrasound guidance to suspected Morton’s neuroma since 2013
• 78% of patients were female (184/235)
• 175 of 235 (74%) did not require neuroma excision
• 60 of 235 (26%) did require Morton’s neuroma excision
• Less likely to require surgery if nerve < 4 mm in diameter
  • Unpublished data (Small, Pierce, Park 2020)
Morton’s Neuroma Excision: Outcomes

- Good outcomes range from 51% to 93%
- Likely better outcomes with extended open approach
- Villas et al FAI 2008: release transverse metatarsal ligament: neuroma excision only if nerve is thickened
  - Ligament Release → 96% Total Relief of Symptoms
  - Neuroma Excision → 98% Total Relief of Symptoms
- Consider Gastroc Contracture/forefoot overload if patient has more diffuse symptoms!
Thank You! jsp3x@virginia.edu