Tarsal Tunnel Syndrome

Description

Did not come until the 1960's

- Kopell and Thompson 1960
- Named by Keck, JBJS-A, 1962

Etiologies:

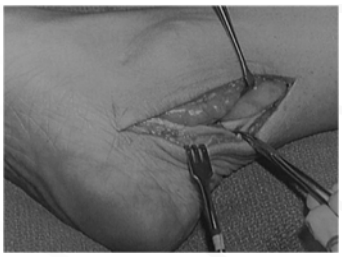
- Recent emphasis on venous varicosities
  - Keck's original description
  - Gould and Alvarez, F&A 1983
  - The "tourniquet test" has been proposed by some symptoms exacerbated by a venous calf tourniquet

Other proposed etiologies:

- Tension on the nerve from varus or valgus deformities
- Bony spikes (e.g. sustentacular fragments from calcaneus fracture)
- Accessory muscles (Abductor hallucis) or persistent muscle belly of the FDL

Mass Lesions:

- Ganglions
- Schwanoma
- Lipoma



Often have the best clinical result.

Work Associations?

Some reports in runners, dancers, jockeys

Industrial Associations?

- One anecdotal case
  - Forst L, Hryhorczuk D, Br J Indust Med, 1988
    - Sewing machine operator, not confirmed electrodiagnostically, ultimately failed two releases
- Differing opinions
  - Lam SJS, JBJS-B, 1967
    - One of the original descriptions, "no significant common factor concerning occupation".

Electrodiagnosis

- Still the most controversial area in Tarsal Tunnel Syndrome
- No clear progression as in Carpal Tunnel Syndrome:
  - increased sensory latencies, then . . .
  - increased motor latencies, then . . .
  - needle EMG abnormalities, then . . .
  - clinically detectable atrophy

Electrodiagnosis

- Another challenge: the tibial nerve gets very deep immediately proximal to the tarsal tunnel. Difficult to stimulate (unlike the median nerve in CTS)
- Hindfoot position and temperature all need to be carefully controlled

Electrodiagnosis

- Motor Latencies
- Sensory Conduction
- Mixed Nerve Conduction Studies
- EMG

Motor Latencies

- Goodgold, 1965, first proposed, their numbers are now considered small
  - 5.2 msec for MPN
  - 5.7 msec for LPN

Electromyography

- Background of needle EMG abnormalities in normal intrinsic foot musculature, particularly in older patients.
- Consistent recording points for the Abductor Hallucis and Abductor Digiti Quinti.
- Temperature Control

Utility of Electrodiagnosis

- Emphasized in neurology papers
- Deemphasized in orthopaedic papers
  - Pfeiffer and Cracchiolo - no correlation between electrical studies and results of surgery
  - Mann - 7 of 11 patients with increased motor latencies
  - Edwards - 3 of 19 with abnormal NCV's

The Bottom Line on Electrodiagnosis

- Motor Latencies have been the traditional standard
- Sensory or Mixed Latencies may be better
- EMG results difficult to evaluate against background abnormalities in the adult population
- Side-to-side comparisons may be useful

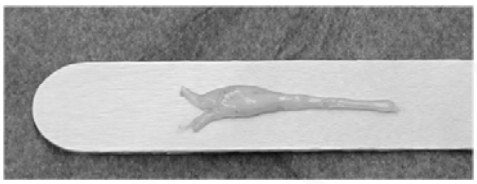
MRI

- Useful to exclude presence of mass lesion

Results

- 44% - 78% success reported with release
- Far lower success rate than carpal tunnel surgery
- *Best results occur in patients with mass lesions or bony prominences in the tunnel*

Morton's Neuroma (Interdigital Neuroma)



Original Description

- Thomas Morton, Philadelphia, 1876
- 12 cases of pain under the 4th metatarsal head
- Excised the 4th metatarsal head, base of phalanx, both arteries, both nerves
- Because his pathologic examination found no problems, he ascribed the pain to neuralgia.

Modern Era

- Betts, 1940 - excised the 4th digital nerve only.
  - Raised the concept of traction neuritis as the nerve passes under the intermetatarsal ligament.

Pathology

- Graham and Graham - 24 specimens, found histologic changes consistent with nerve entrapment just distal to the intermetatarsal ligament.
  - Increased fascicle size, increased vascularity in the area of compression. Similar changes to that seen in CTS.

Ischemia?

- Nissen, 1948 - claimed the vasculature had thickened intimal walls with degeneration. Claimed neural ischemia played a role.

The Bursa?

- Mulder, 1956 - the intermetatarsal bursa lies between the metatarsal heads just dorsal and distal to the intermetatarsal ligament. It becomes inflamed and painful in the condition.

Mulder's click

Etiology

- Is the nerve bigger? - Historical argument
  - The common digital nerve in the 3rd web space sometimes receives contributions from both MPN and LPN
  - Levitsky et al., 1993 - nerve diameters are no different regardless of where their communicating branches come from.
  - Intermetatarsal head distances likely explain why neuromas occur in the 2nd and 3rd web spaces.

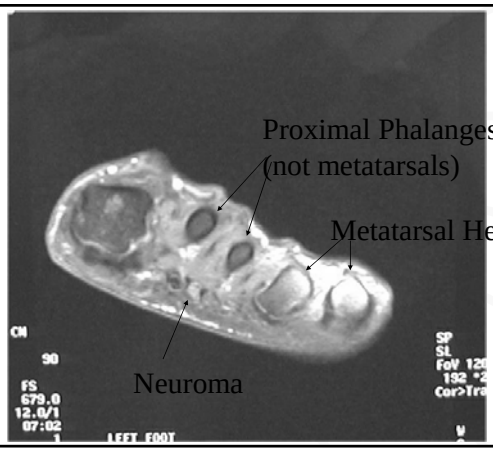
Diagnosis

- The primary difficulty lies in distinguishing it from other causes of 2nd, 3rd, or 4th MTP pain.

It is primarily a clinical diagnosis!

Differential Injection - useful for solving the intraarticular versus extraarticular pathology

MRI - can occasionally be used in special circumstances



Conservative Management

- Metatarsal pad
- Shoe stiffener

Injections

- Best thought of as a diagnostic technique
- Greenfield et al.- 65 patients for injection
  - 14% relieved with one injection
  - total of 30% of patients could achieve relief with injections, average of 3.8 injections per patient.

Most authors recommend no more than 1 or 2 fat pad atrophy!

Surgery

- Primary neuroma surgery
  - approximately 80% successful outcomes
  - Most surgeons use the dorsal approach

Outcomes

- Mann and Reynolds - 65% have some persistent plantar tenderness that usually resolves over the first 3 months. 80% subjective satisfaction
- Plantar sensory branches - Amis et al. described
  - can prevent proximal migration of the nerve stump and persistent painful neuromata

Neurolysis and ligament release alone?

- Recently advocated by a few
- Gauthier - neurolysis alone on 206 patients
  - 83% success rate.
  - No recurrent neuromas

Recurrent Neuromas

- Most advocate a plantar approach *unless* the previous dorsal approach was inadequate
- Plantar approach allows the nerve to be resected much more proximally
- Even so, results are not very predictable

Revision Neuroma Excision

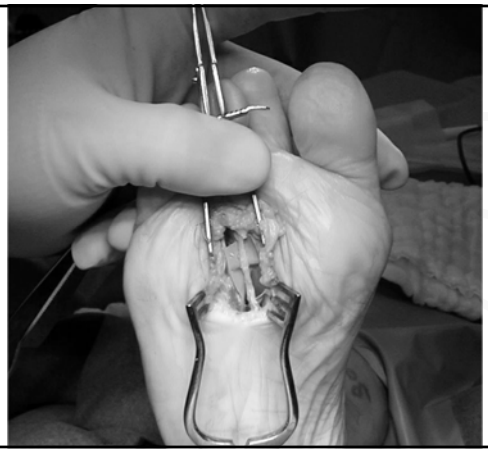
- Johnson et al. - plantar longitudinal approach 67% good results
- Baxter et al. - transverse plantar approach 50% good results

The Rules of Thumb

- 80% success rate for primary resection
  - about 5% can be made worse
- 50% success rate for revision resection

Original Incision

Plantar Incision



Baxter's Nerve

- First Branch of the Lateral Plantar Nerve
- Diagnosis Popularized by Baxter, 1984

Baxter's Nerve

- Runs deep to abductor hallucis fascia
- Innervates abductor digiti minimi
- Provides sensory fibers to plantar fascia
- Release often performed in conjuction with plantar fascia release
- Entrapment suspected by pain more distal and superior to plantar fasciitis symptoms

Baxter's nerve

- Clinical results variable
  - 92% success reported by Baxter, 1992
  - Not reproduced elsewhere

Charcot-Marie-Tooth Disease

- 1886 - Marie and Charcot
- 1886 - Tooth (England)
- Considered a Primary Disease of Muscle

Charcot-Marie-Tooth Disease

- 1886 - Marie and Charcot
- 1886 - Tooth (England)
- Called Progressive Muscular Atrophy for years
- Also Peroneal Muscular Atrophy

Dyck and Lambert, 1960's

- Defined EMG/NCV criteria to categorize the disease
- Called Hereditary Motor-Sensory Neuropathy (HMSN)

Motor Weakness Patterns

- Intrinsics
- Anterior Compartment - occasional sparing of EHL
- Lateral Compartment - Often Peroneus Brevis but spares Peroneus Longus
  - known from manual testing and from MRI data of muscle cross-section

CMT is actually many molecular diseases all with a similar phenotype

Peripheral Myelin Protein - 22

- A myelin sheath constituent
- Function remains unclear

CMT – 1A

- 60% of cases
- Caused by a focal trisomy on the chromosome containing the PMP-22 gene

CMT – 1A

- Autosomal dominant inheritance
- 50% of cases represent new recombination errors
- The Phenotype can be caused by point mutations in the PMP-22 gene as well

Other CMT Forms

- Caused by other mutations in other genes for myelin sheath constituents

The Problem: CMT is an asymmetric neuropathy

The lesson of the potato?

- Family of Maine potato diggers
- Profound sensitivity to pressure palsy

Hereditary Neuropathy with Liability to Pressure Palsy (HNPP)

- Defect in one of the two copies of the PMP-22 gene

Could an element of pressure palsy be active in CMT foot deformities?

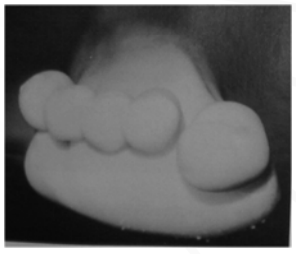
- Guyton, CORR 2005
- The branching patterns of the peroneal nerve are highly variable

Example

- Nerve to the peroneus longus comes off up to 1.5 cm before crossing the fibular neck
- Nerve to the anterior tibialis comes off at the fibular neck and wraps directly around it

Forefoot Valgus

- Weak Agonist - Tibialis Anterior

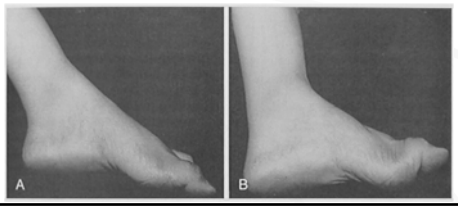


Forefoot Valgus

- Weak Agonist - Tibialis Anterior
- Intact Antagonist - Peroneus Longus

Overpull of the Toes

- Absent Anterior Tib, EHL still functional
- Toe extensors used as accessory dorsiflexors



Equinus

- Weak Agonist - Anterior Tibial Tendon
- Intact Antagonist - Triceps

Hindfoot Varus

- Weak Agonist - Peroneus Brevis

Hindfoot Varus

- Weak Agonist - Peroneus Brevis
- Strong Antagonist - Tibialis Posterior

Toe Deformities

- Weak Agonist - Intrinsics
- Intact Antagonist - Extrinsics

Correction Algorithm

- Every CMT Patient has a little bit of a unique pattern

TAL

Plantar Fascia Release

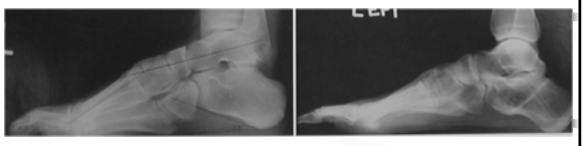
Dwyer Calcaneal Osteotomy

Dorsiflexion Osteotomy of the First Ray

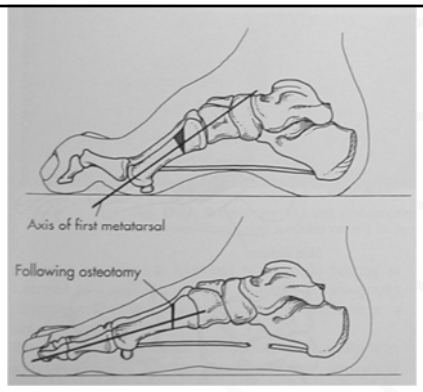
Hammertoe Repairs

Jones Transfer with IP Fusion

Peroneus Longus to Brevis Transfer



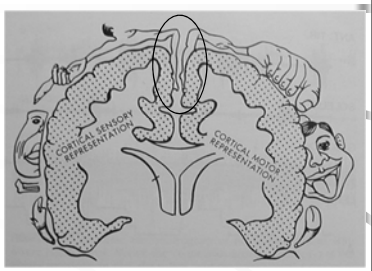
Repositioning the Hindfoot Only



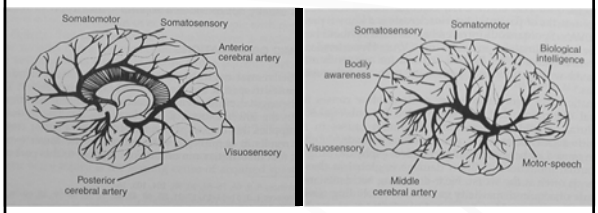
Dorsiflexion Osteotomy of 1st Ray

CVA

- The midcortex in the Sagittal Sulcus provides lower extremity sensory and motor function



Anterior Cerebral Artery Supplies the Lower Extremity Areas



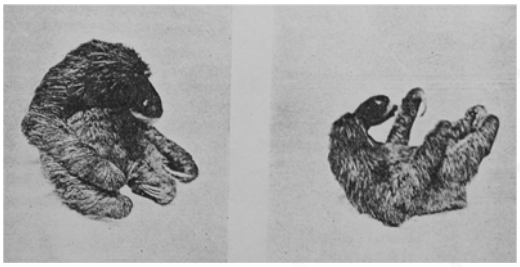
But MCA strokes are most common (aphasia,

The Equinovarus Deformity

The Lesson of the Decerebrate Sloth

Richter and Bartemeier, Hopkins 1926

A Decerebrate Sloth Postures in *Flexion*



You can even still hang one from a stick.

Upright quadrupeds posture into extension in all four limbs.

The antigravity muscles used to maintain a mammals resting posture are the ones that predominate in a decerebrate condition.

Dynamics of Acquired Spasticity

- Initial Flaccid Paralysis and Hypotonia
  - hours to days (weeks at most)
- Increased tone and hyperreflexia
  - peaks within days to weeks
- Slow return *toward* normal
  - Depends upon the condition

Length of Time for Recovery

- CVA - 6 months
- TBI - 18 months or longer
- SCI - 18 months or longer
- Anoxic - Poor Prognosis for Recovery

Indications for Sugery

- Ambulation
- Positioning and Transfers

Ambulation Potential after CVA

- 25% - normal ambulation
- 75% - some level of ambulation

Prerequesites for GAIT

- *Voluntary Hip Flexion*
- Adequate Standing Balance
- Limb Stability

Prerequesites for Standing/Transfers

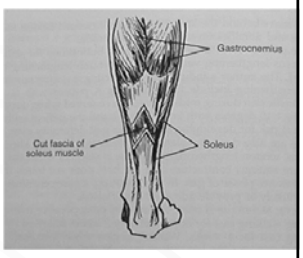
- Plantigrade Feet and Ankles
- Ability to Extend the Hip and Knee
- Adequate Balance of the Trunk

Tight Heel Cord

- Gastroc Only or Soleus Involved Too?
  - Flex the knee to relax the gastroc.

Gastrocnemius Recession

- Vulpius Procedure - inverted v-shaped cut about 1-3 cm distal to the MT junction
- Strayer Procedure - a cut straight across in the same location



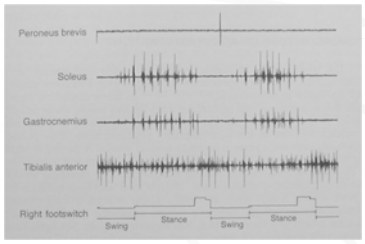
Vulpius Procedure

Triple-Hemisection TAL

- Hoke Procedure
  - Can be done open or percutaneously

Equinovarus Deformity

- Spasticity of the Anterior Tibial Tendon, although still overwhelmed by the Triceps Surae

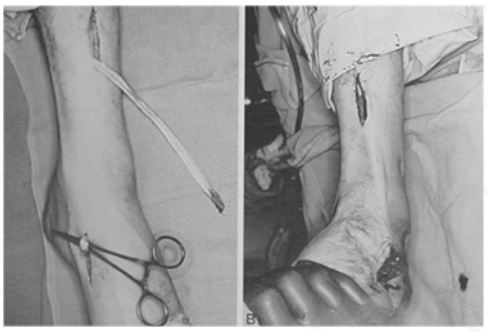


Address Fixed Deformities if Present

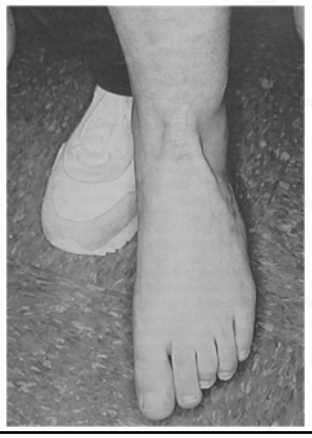
- Subtalar Fusion with a Lateral Closing Wedge
- Calcaneal Osteotomy
- Plantar Fascia Release

SPLATT

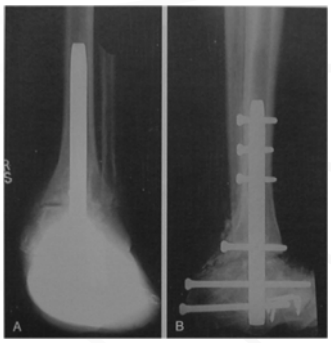
- Split Anterior Tibial Tendon Transfer



SPLATT



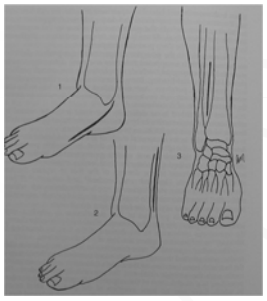
If transfers only are the goal, fusions can be relatively predictable

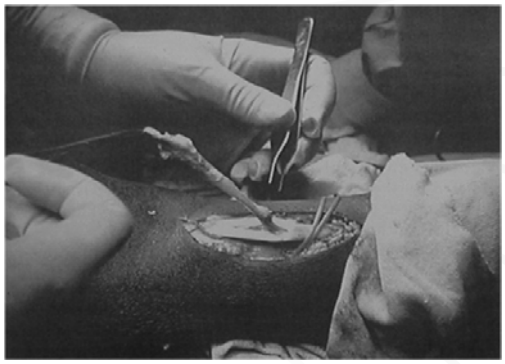


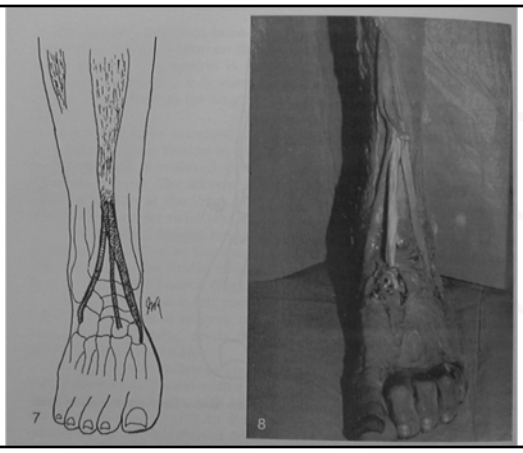
Traumatic Nerve Palsy

Complete Peroneal Palsy - Anterior and Lateral Compartments Gone

Bridle Transfer or Isolated Posterior Tibialis Transfer







25. The abductor digiti quinti muscle of the foot is most frequently innervated by what peripheral nerve?

1- Medial plantar
2- Deep peroneal
3- Saphenous
4- Sural
5- Lateral plantar

49. The dorsal-medial aspect of the great toe receives sensory innervation from which nerve?

1- Deep peroneal
2- Saphenous
3- Posterior tibial
4- Superficial peroneal
5- Medial plantar

•A 67 year old woman has a left sided residual spastic equinovarus deformity following a stroke. Examination shows passive 10-degree plantar flexion deformity and the inability to manually correct the heal to neutral. Muscle strength about the ankle is grade 4 or better, and she has normal sensation. An AFO was not tolerated. What is the next most appropriate step in management?

1. Common extensor tendon transfer to the midfoot
2. Peroneus longus tendon lengthening
3. Split anterior tibialis tendon transfer and gastrocnemius recession
4. FDL tendon transfer to the navicular
5. Ankle arthrodesis

Thank You