DECOMPRESSION AND RELOCATION OF MORTON'S NEUROMA: A Preliminary Study

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Intermetatarsal neuroma, or Morton's neuroma, occurs in all adult age groups and is most common among females. It is very uncommon to find this condition in individuals younger than 18 years of age. Keh et al. reported an 88% female incidence, with an age range from 30-86 years.[1] Mann reported a higher incidence in females (95%) in a similar age group.[2]

Morton's neuroma is actually a peripheral nerve compression syndrome, similar to that of carpal tunnel syndrome. A peripheral nerve is classified by fiber size and whether it is myelinated or unmyelinated. Group A fibers are myelinated, and are further subdivided by fiber size and function.[3] (Table 1) Group C fibers are unmyelinated, which measure 1-2 micrometers in size, and function to transmit burning pain.

Table 1

CLASSIFICATION OF GROUP A PERIPHERAL NERVES

GROUP A

A-Delta
Size: 2-5 micrometers
Function: Sticking pain and Temperature

A-Beta
Size: 10-15 micrometers
Function: Touch

A-Alpha
Size: 15-20 micrometers
Function: Motor Fiber

When a peripheral nerve is compressed, perineural fibrosis is the presumed underlying pathologic process that causes dysfunction and irritation of the involved nerve. This can lead to an enlargement of the nerve by fibrotic changes. An anatomic study of the site of Morton's neuroma implicates the distal aspect of the deep transverse intermetatarsal ligament as the main constrictive factor.[4] At the entrapment site, vascular congestion, edema, progression of nerve fiber degeneration, fibrosis, and increased nerve and fascicular width have been identified.[5,6,7]

Therefore, when direct pressure is applied to a nerve, the force applied to the epineurium is distributed throughout the fascicles to the axons. The largest axons will be compressed against adjacent axons. (Figure 1) Therefore, the first perceptions to be lost are those of the larger nerves: ie. touch. Pain perception, which is transmitted by smaller fibers, is the last to be compromised. Therefore, clinical diagnostic testing of a mixed nerve should not be done with a pin or a needle, but with a tuning fork to evaluate the perception of touch. (Figure 2)

When a peripheral nerve is compressed, as in a Morton's neuroma, vibratory perception of the involved digit is abnormal. Commonly, the first alteration of nerve compression is one of hypersensitivity. For example, a patient with a nerve compression of the third intermetatarsal space of short duration may relate that the felling caused by the tuning fork touching the digit is

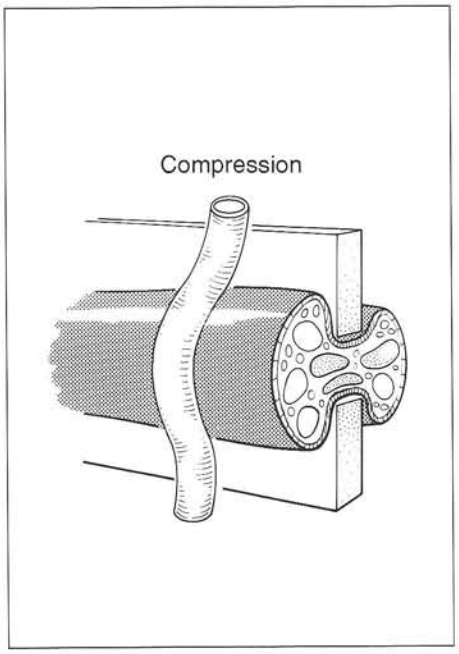

Figure 1. Compression of large sensory fascicles leads to loss of touch sensation.

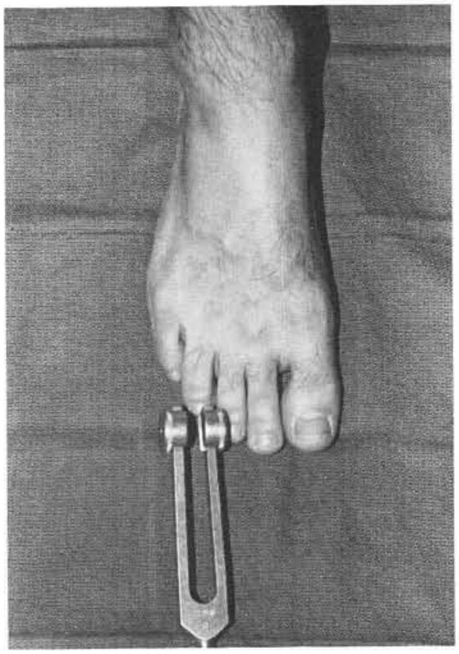

Figure 2. A tuning fork is used to test sensory aberration of the third interspace.

Figure 3A. The Gauthier Test is performed with the digits in a neutral position, while mild pressure is applied to the 1st and 5th metatarsal heads.

Figure 3B. The digits are then dorsiflexed to compress the neuroma against the intermetatarsal ligament.

"more sensitive" or "more electric". It is therefore possible that, early in the course of neural ischemia (compression), a state of hyperesthesia is present. The examiner must be aware of this possibility.

Long duration compression of the intermetatarsal nerve will result in the classical description of decreased sensory input.[3] The neuroma is usually tender to palpation, and pain or sensory aberration occurs with compression of the forefoot while dorsiflexing the digit (The Gauthier Test). (Figure 3A, 3B) This clinical test is highly sensitive in evaluating a Morton's neuroma. A positive sign is sensory deficit or aberration when compared to the opposite extremity. Pain may present later in the progression of the disease.

The author does not emphasize the use of Maulders test to confirm the clinical impression of the intermetatarsal neuroma. In this test, pain is elicited by compressing the 1st and 5th metatarsal heads with direct dorsal-plantar compression of the interspace. A "pop" can be felt by the examiner upon manual compression. This "pop" can be attributed to tendon movement, a bursae sac, or actual compression of the metatarsal heads. (Figure 4)

Figure 4. The Maulders test is performed by applying compression to the first and fifth metatarsal heads, while palpating the interspace.

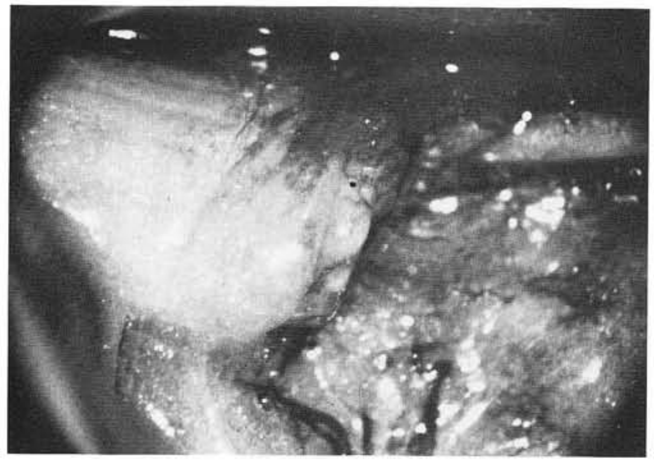

Figure 5. A cut nerve in the intermetatarsal space.

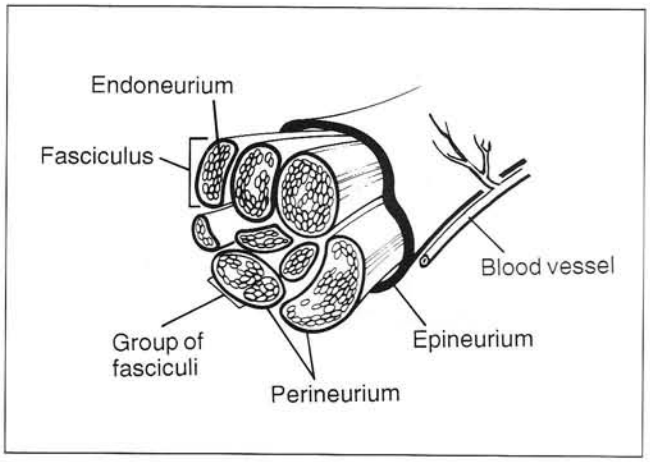

Figure 6A. Cross section anatomy of a peripheral nerve.

Figure 6B. Magnification of a peripheral nerve (30x) with the use of an operative microscope.

When a patient presents with a nerve compression syndrome (specifically Morton's neuroma), it must be decided whether the surgical procedure should be removal of the neuroma or a nerve decompression technique. The effect of resecting an interdigital nerve is neural regeneration and stump neuroma formation. Whether this neuroma will be symptomatic or asymptomatic is unpredictable. The cutting of a nerve can result in a recurrent intermetatarsal neuroma, in which the pain can be severe and extremely disabling. (Figure 5) In light of the potentially significant complications, primary resection of Morton's neuroma should be re-examined. Decompression techniques with or without the combination of nerve relocation can be performed with excellent results, without the use of the operating microscope.

Peripheral nerve anatomy can be easily identified with the aid of an operative microscope. A nerve contains three separate and distinct supportive tissue sheaths - the endoneurium, perineurium and epineurium. The perineurium and the epineurium are the only structures that can be manipulated to perform an external or internal neurolysis. (Figure 6A, 6B) The endoneurium consists of collagen, a reticular ground substance that surrounds the axon-Schwann cell complex.

The perineurium is a connective tissue condensation around individual nerve fascicles. This layer is more organized than the endoneurium, and consists of an inner layer of lamellated squamous-like cells, and an outer layer of collagen fibers condensed into a lattice of longitudinal, circumferential, and oblique bundles. The perineurium is the strongest skeletal support of

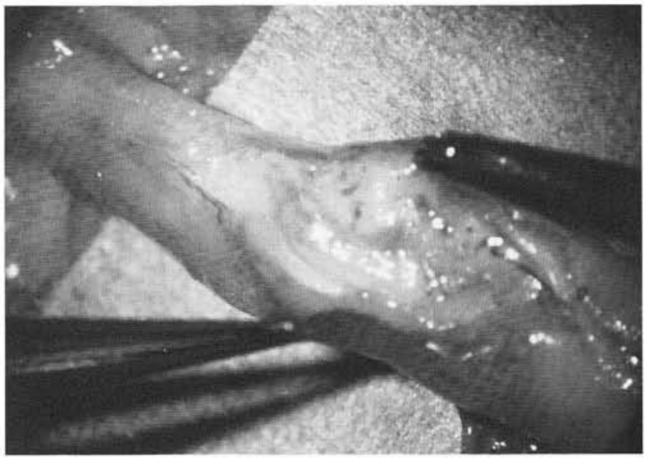

Figure 7. An epineural release is performed longitudinal to the nerve fibers.

Figure 8. Fascicular dissection is demonstrated in conjunction with an epineural release.

neural tissue, and is the primary contributor to the tensile strength of a peripheral nerve.

The epineurium is a loose outer sheath which comprises the perifascicular and interfascicular connective tissue around and between nerve fascicles. Its outer layer is continuous with the mesoneurium, which is the suspensory mesentery of the peripheral nerve. The epineurium is a vascular structure which carries the nutrient blood vessels that supply the capillary plexus of the nerve. Lymphatics are also found in this layer. A greater amount of epineurial connective tissue exists where the number of fascicles is the greatest, and it is also thicker in areas where a nerve crosses a joint.

Mann reported that 65% of his patients with intermetatarsal resection presented with persistent pain, and 14% with no improvement.[8] There is no other upper or lower extremity chronic nerve compression syndrome that is treated by excision of the nerve at the entrapment site. Dellon described epineurial release with loupe magnification in five patients.[9] Four of the five patients had complete relief of their preoperative symptoms.

SURGICAL TECHNIQUE

Epineural and Fascicular Release

A standard dorsal interspace incision, approximately 3 cm in length, is performed. The digital nerves are identified with the aid of vessel loops. The metatarsal heads are spread to reveal the intermetatarsal ligament, which is cut. The common plantar digital nerve (Morton's neuroma) is identified, and the epineurium is cut in the region of nerve compression (external neurolysis). (Figure 7) A section of the epineurium may be removed, in an attempt to prevent additional scarring of the nerve.

Price and Miller suggest the use of an epineurial release with fascicular dissection (internal neurolysis) in conjunction with release of the deep transverse intermetatarsal ligament.[10] The procedure was introduced by Babcock and perfected by Curtis and Eversmann in 1972.[11,12]

Performing an internal neurolysis requires intensive training in microsurgical techniques using the operative microscope. The author believes that this technique cannot be performed with surgical magnification loupes, and that a microscope should be used when performing this procedure. The goal of internal neurolysis is to release the individual fascicles from interfascicular scar tissue in a peripheral nerve, and preserve the fascicles and interfascicular plexus. (Figure 8) The fascicles are separated with the use of microinstrumentation and the operative microscope.

It is the opinion of the author that an epineurial or interfascicular release is not necessary to adequately release an entrapped nerve, following transection of the deep transverse intermetatarsal ligament.

Nerve Decompression with Relocation

The author's surgical procedure of choice for an intermetatarsal neuroma consists of cutting the deep transverse intermetatarsal ligament, freeing the nerve and relocating the nerve above the adjacent metatarsal heads, using either 6-0 or 7-0 Prolene suture. The digital branches of the neuroma are not dissected, reducing potential nerve injury to these branches. This procedure is typically performed with the use of 3.5 power loupes, however the procedure can be performed without any magnification.

This technique is performed though a 2 to 4 cm dorsal linear incision. The superficial fascia is bluntly dissected until the nerve is located. (Figure 9) The digital branches of the nerve are not identified or manipulated in any way. A vessel loop is then passed beneath the nerve, suspending it without causing any significant traction on the nerve. (Figure 10) While the nerve is suspended, the soft tissue attachments to the nerve are released, along with the deep transverse intermetatarsal ligament, by suspending the nerve medially and laterally and using small dissecting scissors. (Figure 11) After complete release of the nerve, a 6-0 Prolene suture is placed longitudinally through the epineurium longitudinally so as to not impinge any fascicles. (Figure 12) This suture is then tied to the adjacent metatarsal's deep fascia/periosteum. (Figure 13) The vessel loop is then removed, with the nerve decompressed and relocated above the epicondyles of the adjacent metatarsals. The deep transverse ligament, which is now below the nerve, is not repaired. The superficial fascia and skin are then closed.

The patient is to remain non-weight bearing for 36 hours, and is then permitted partial weight bearing with a surgical shoe for one week. Afterward, the patient is allowed to wear shoes as tolerated. The wound should remain dry for the first two postoperative weeks. After two weeks, the patient is allowed to perform any tolerable activity.

Figure 9. Surgical exposure of a Morton's neuroma under the operative microscope.

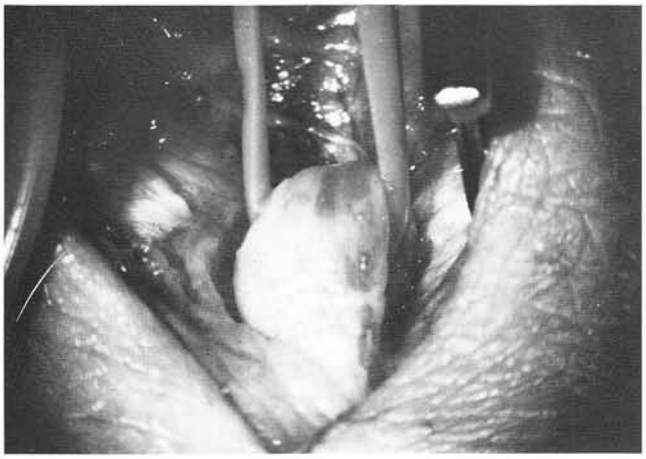

Figure 10. A vessel loupe is used to suspend the neuroma.

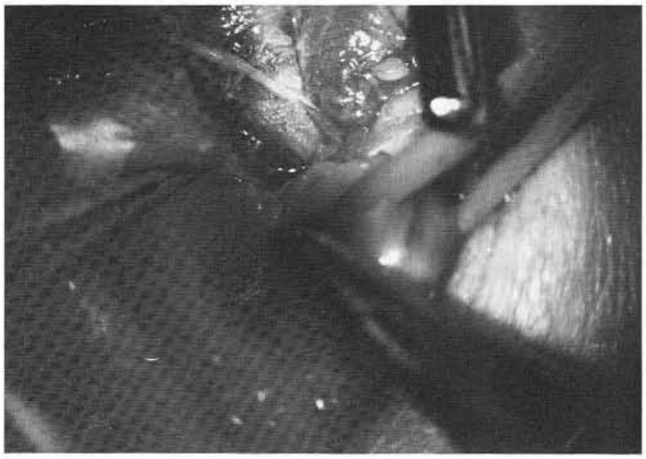

Figure 11. The nerve is retracted to one side of the interspace, the soft tissue attachments are released, and the deep transverse intermetatarsal ligament is transected.

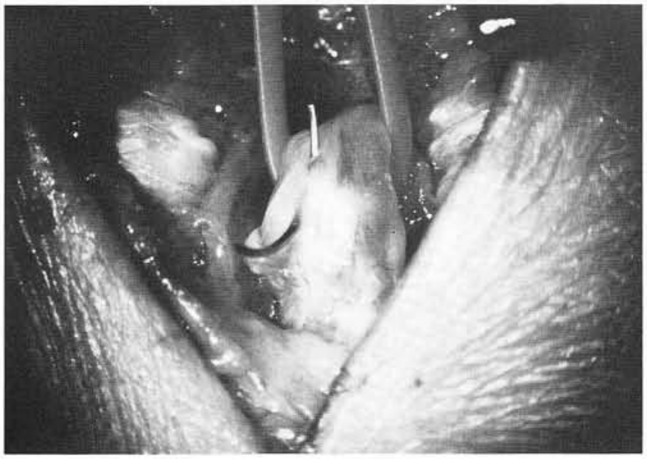

Figure 12. The needle is passed though the epineurium without entrapping the nerve fascicles.

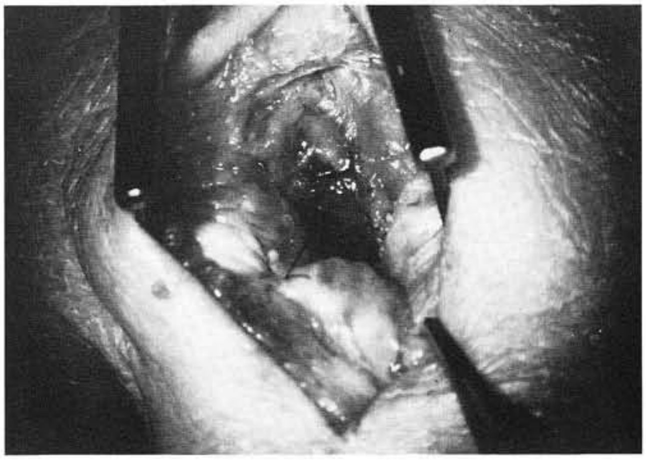

Figure 13. Final result of the suspended nerve using 6-0 Prolene.

To date, 14 nerve decompressions/relocations have been performed on 13 patients. The mean age of the patients was 43 years (29-56). Eleven of the patients were female. All procedures have been performed on third interspace neuromas. The longest follow-up to date is 22 months. Prior to surgery, all patients demonstrated significantly abnormal sensation to the 3rd and 4th digits, as tested with a tuning fork. All 13 patients also had a positive Gauthier test, while only 4 had a positive Maulder's sign.

Prior to surgery, all were treated with 2 injections of decadron, marcaine, and xylocaine, without significant relief. Physical therapy and shoe modifications were also attempted. The average time upon initial presentation of symptoms to surgery was 4 months.

All 14 procedures have proven to be successful at the present time. No additional therapy was performed on any of the patients. Full sensation returned to the digits within two months of surgery (range 22-56 days). The average amount of time for relief of pain following surgery was four days (range 1-7 days). Further evaluation will be necessary to assess the long-term effectiveness of this procedure. It is the author's opinion that this procedure can be performed prior to removal of any nerve compression syndrome. Nerve removal should be performed only after decompression and relocation procedures have been attempted.

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