

Morton's Neuroma

OVERVIEW

Forefoot pain is a common complaint that is treated by the foot and ankle orthopaedic surgeon. Morton's neuroma is frequent cause of forefoot pain and disability. Morton's neuroma is a paroxysmal neuralgia that presents as a sharp, burning pain in the 3rd webspace, most commonly between the 3rd and 4th toes. It is not a neuroma in the formal definition of the word, but rather a perineural fibrosis.

Historically, Morton's neuroma was first described by Queen Victoria's surgeon chiropodist, Lewis Durlacher as a "form of neuralgic affection" involving the distal plantar nerves in 1845.¹ Thirty years later, Thomas G. Morton of Philadelphia incorrectly described this disorder as a capsulitis of the 4th metatarsophalangeal joint, though he accurately described the disorder's symptomatology.² In 1883, Hoadley was the first surgeon to actually excise the interdigital neuroma as a treatment for these symptoms.³ In 1940, L.O. Betts confirmed that Morton's neuroma pain was attributed to a swelling of the interdigital nerve.⁴

The epidemiology of the disease is not clearly defined as the incidence and prevalence are not known.⁵ Typically, women ages 45-50 are affected. Though men are affected, women account for the overwhelming majority.^{5,6} Both feet are equally affected, though bilateral complaints are rare. It is also uncommon to find two neuromas in the same foot, though recent literature suggest otherwise with 65.2% of their patient population being treated for multiple neuromas in the same foot.⁷ In a study of prevalence of interdigital nerve enlargements in an asymptomatic population,⁸ 54% of volunteers had a nerve thickening as seen on ultrasound. 35.4% had bilateral enlargements. Older patients were more likely to have nerve thickening.

The differential diagnosis must be carefully crafted to exclude more serious disorders of the forefoot. The differential diagnosis for Morton's neuroma includes:

- intermetatarsal bursitis

- plantar plate rupture
- metatarsophalangeal joint capsulitis
- metatarsal stress fractures
- metatarsalgia
- lumbar radiculopathy
- tarsal tunnel syndrome
- Freiberg's infraction
- infection
- tumors (such as synovial sarcoma)
- painful callosities
- rheumatoid nodule
- peripheral neuropathy^{9,10}

ANATOMY

Morton's neuroma most commonly affects the third interdigital nerve in the third webspace between the third and fourth toes (80-85%) and next commonly, the 2nd common digital nerve in the second webspace (10-15%)⁹. There may be anatomic and biomechanical reasons for the frequency of the third common digital nerve in Morton's neuroma. Firstly, the common digital nerve of the third webspace is the largest digital nerve and is usually a confluence of the terminal branches of the medial and lateral plantar nerves (the two terminal divisions of the tibial nerve) (Figure 1). Secondly, the space that the nerve occupies is subject to shearing forces as the relatively mobile 4th metatarsal can stress the nerve against the relatively fixed 3rd metatarsal. Thirdly, the nerve may experience compression during high-heeled wear. These shoes increase the stresses of weightbearing to the forefoot which causes hyperextension of the metatarsophalangeal joints, compressing the common digital nerve and metatarsal heads against the tough and unwielding intermetatarsal ligament.

BIOMECHANICS

The neuroma itself is usually densely adherent to the intermetatarsal ligament. It is part of the neurovascular bundle which is fusiform in shape⁴. The tissue itself is usually a soft-yellow or whitish, glistening soft mass. (Figure 2) Histologically, there is evidence of fibroblast and

Schwann cell proliferation which is represented by extensive juxta- and intraneural fibrosis as well as perivascular and subintimal fibrosis¹⁰. There is demyelination, axonal damage, and Renaut bodies (subperineural hyalinized nodules).

The exact etiology and pathogenesis of Morton's neuroma is still a point of contention. Morton suggested that enlargement or a neuroma of the digital branches of the lateral plantar nerve was the source of pain². Neuritis as a source of pain has also been suggested¹¹. Betts speculated that contraction of the flexor digitorum brevis caused the nerve to shear against the intermetatarsal ligament, which in turn, causes inflammation. Another theory popularized by Nissen states that the intermetatarsophalangeal bursa balloons out, causing traction on the digital nerve. This leads to an ischemic effect on the nerve¹². Current theories believe that Morton's neuroma is a consequence of the combination of repetitive mechanical and ischemic trauma, entrapment, and tethering¹⁰.

CLINICAL PRESENTATION

A careful history and physical examination must be made in order to exclude other pathologies in the differential diagnosis. A patient with a Morton's neuroma often complains of a burning, sharp pain that is located in between the third and fourth toes. They may describe a feeling of a pebble or stone in their shoes while walking. This pain is often plantar at the metatarsal heads and radiates distally on either side of the toe. It can often radiate from the forefoot up the leg proximally. It is exacerbated with wearing tight or constricted shoes and alleviated while walking barefoot. A patient may describe characteristically and temporally-different pain. The first, intense pain lasts for about 5-10 minutes and is precipitated by direct compression of the neuroma. This pain then becomes a dull ache for the next 2-3 hours^{4,10}. One feature of a Morton's neuroma is that patient may need to rest after walking, remove the shoe and massage the area of discomfort for moderate relief¹³. This may occur several times throughout the day.

EXAM

On visualization, the patient's foot is often unremarkable without any signs of intermetatarsal bursitis or dorsal bulging. On palpation, the usual location of pain is located at the interspace

between the metatarsal heads. Therefore, one must examine the metatarsophalangeal joints for synovitis or instability (metatarsophalangeal drawer test). Interdigital skin sensation is often decreased. A useful test for Morton's neuroma is the "lateral squeeze test". This test is performed with the index and thumb on the dorsal and plantar aspect of the painful intermetatarsal space. The forefoot is then compressed with the opposite hand by squeezing together the metatarsal heads. The test is positive if a painful or palpable click is felt. This "Mulder's click" is likely due to subluxation of the neuroma between the metatarsal heads.¹⁴

STAGES

There are no stages of Morton's neuroma, though pain may wax and wane over time.

IMAGING

Morton's neuroma is usually a clinical diagnosis made on a thorough history and physical examination. Imaging is necessary to rule out the differential diagnosis listed above. Often, an x-ray may show a faint radiopaque mass and lateral toe deviation¹⁰. MRI (Figure 3) and ultrasonography (Figure 4) may also confirm a Morton's neuroma. An MRI will show inflammation surrounding the neuroma as seen in T2 weighted images. An ultrasound will show a non-compressible hypoechoic interdigital mass with or without a bursal effusion.

While early studies of imaging showed that the clinical utility of these modalities is questionable¹⁵ most studies did not evaluate a Morton's neuroma with today's more sensitive magnets and ultrasound machines. Owens and colleagues showed that an MRI may have a sensitivity of 97% in patients with symptomatic neuromas, but showed neuromas in 25% of patients without symptoms. Sharp et al evaluated 29 confirmed cases of Morton's neuroma that were evaluated with an MRI, ultrasound and physical examination. MRI and ultrasound's accuracy was dependent on the size of the lesions. Physical exam proved to be the most sensitive and specific modality¹⁶. A recent study¹⁷ showed that with a sensitivity of 0.84 and specificity of 0.33, an MRI's accuracy is not as high as a thorough clinical assessment (sensitivity: 0.94; specificity: 0.33). The negative predictive value for the MRI was 0.08 and the positive predictive value was 0.97.

CONSERVATIVE TREATMENT

When a diagnosis of Morton's neuroma is made, some surgeons believe that conservative management is not warranted since the pain will persist and worsen as the neuroma enlarges⁴. However, several conservative treatment modalities exist. There is no agreed-upon treatment algorithm, but most believe that these treatments should be tried from 3 months to a year^{9,10}.

Firstly, a patient should wear wide, comfortable shoes with large toe boxes⁹. The shoes should be low-heeled and may be supplemented with either a metatarsal pad or a custom orthotic. The pads help to relieve metatarsal head pressure. Custom orthotics seek to limit foot subtalar pronation which should theoretically limit the mobility of the first ray and reduce forefoot abduction¹⁸. Unfortunately, a randomized trial¹⁸ failed to show any subjective pain differences between the pronated orthotic group and the control group. Some surgeons may also treat the neuroma by trying to unload the metatarsal heads with either a metatarsal pad or dancer's pad. A person may try to decrease the neuroma pain and inflammation with non-steroidal anti-inflammatory medications. Physical therapy has also been used¹⁹. Ultrasound, whirlpool, massage and electrical stimulation are often used though their efficacy has not been studied.

Another treatment modality is an intermetatarsal corticosteroid and local anesthetic injection. It is imperative that the needle traverses the intermetatarsal ligament in order to enter the bursa and infiltrate the neurovascular bundle. While some studies show that 47% of people may experience relief with injections²⁰, others fail to show any long-term relief²¹. Another study which looked at neuromas <5mm and >5mm in 43 patients demonstrated good relief of pain at 6 weeks in both groups, but no difference between pre-injection for either group at 1 year.²²

Recently, studies have looked at injection of either phenol or alcohol. An electrode-guided injection of phenol proved to be effective in 80.3% of cases in the short term²³. Ultrasound-guided injection of alcohol gave 84% of patients total relief with partial relief to 94%.²⁴ However, long-term data is not so promising. In a study of 45 patients at five years

after injection²⁵, 36% underwent surgery and 29% had a recurrence of symptoms. Only 29% remained symptom free.

The evidence for conservative therapies is relatively weak⁵. If a patient fails these measures, surgery is warranted. Relative contraindications include uncontrolled diabetes, complex regional pain syndrome, and vascular dysfunction.

OPERATIVE TREATMENT

Many surgical methods have been described including: interdigital nerve excision with intermetatarsal ligament division with or without submuscular transposition, isolated intermetatarsal ligament division, metatarsal shortening osteotomy and intermetatarsal ligament release²⁶, and isolated interdigital nerve excision^{5,9}. An interactive multimedia educational tool may be useful before surgery to help answer patient questions and concerns.²⁷

The patient is usually given regional anesthesia with sedation. A thigh or ankle tourniquet is used to prevent bleeding.

One group reported on a prospective, randomized controlled trial of plantar versus dorsal incisions for operative treatment of a Morton' neuroma.²⁸ In the plantar group, 87% had clinically good outcomes, while the dorsal group had 83%. There were no significant differences between the procedures in regard to pain, restrictions in activities, and scar tenderness. Differences were seen in the type (not number) of complications seen.

Dorsal Approach

A dorsal incision is made in the interspace between the affected metatarsals. The 3 to 4cm longitudinal incision is taken down through the skin and subcutaneous tissues. One must take care to identify and retract away the dorsal sensory branch of the intermediate dorsal cutaneous branch of the superficial peroneal nerve.⁹

Dissection is then bluntly continued down to the level of the intermetatarsal ligament. A small lamina spreader is inserted between the metatarsal heads to facilitate exposure and to

place the ligament under tension. A Freer elevator is placed beneath the intermetatarsal ligament and transected with a scalpel or scissors, protecting the underlying neurovascular structures.

The neuroma is then identified between the metatarsal heads adherent to the **intermetatarsal** bursa. The neuroma is pulled distally such that the nerve trunk can be divided as proximally as possible with long scissors. The distal branches of the nerve are then dissected. The remaining nerve trunk is often treated with phenol, followed by isopropyl alcohol to prevent the recurrence of a neuroma. The neuroma is then identified between the metatarsal heads adherent to the intermetatarsal bursa. The neuroma is pulled distally such that the nerve trunk can be divided as proximally as possible with long scissors. The distal branches of the nerve are then dissected. The remaining nerve trunk is often treated with phenol, followed by isopropyl alcohol to prevent the recurrence of a neuroma.

If there is an adjacent interdigital neuroma, DeOrio²⁹ describes resecting the neuroma in one webspace and releasing the intermetatarsal ligament in the other. This prevents complete sensory loss in the affected toe.

Plantar Approach

The plantar approach is often used in cases of neuroma recurrence as it provides better visualization of the proximal nerve trunk. A plantar excision is made just proximal to the web space and extends at least 4 cm proximally making sure to extend the incision between the metatarsal heads to avoid scarring the bony prominences. Strands of the fibrous plantar tissue must be divided. The neuroma is usually located subcutaneously. The neuroma is resected as described above.

One main problem with the plantar approach is the formation of a painful plantar scar as these are notoriously difficult problems to treat.

Post-operative care

A compression dressing is applied and a post-operative shoe is placed on the foot. A dorsal approach allows for immediate weight bearing and suture removal after 2 weeks. A plantar incision delays weight bearing and suture removal for 2 more weeks⁹. A patient usually transitions to a normal shoe by 3-4 weeks, with return to sports in 4-6 weeks.

Complications

The most common complication results from wound healing, keloid formation or superficial infection¹⁰. In one series, 1.1% of patients had a wound infection while 2.2% had keloid formation over the scar¹⁰. Recurrent neuroma formation is another complication. This results from inadequate proximal resection of the common digital nerve. This neuroma is then trapped by the metatarsal heads, compressed, and causes pain. In re-operation for recurrent neuroma, one may bury the stump in the intrinsic musculature of the foot.

Despite the above complications, patients describe high satisfaction rates from 80- 96%^{20,30}.

CONCLUSION

While Morton's neuroma plagues many patients, with a careful physical examination, diagnosis can be readily achieved. Conservative treatment types are diverse and met with varying degrees of success. However, surgery can provide long-lasting and satisfying relief in the majority of patients.

Fig. 1. Plantar anatomy of the foot

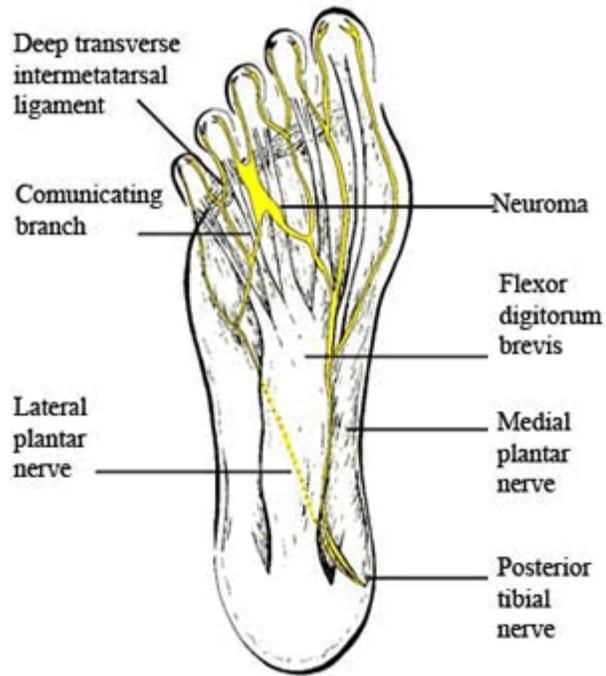


Fig. 2. Intra-operative image of Morton's neuroma as a fusiform swelling of the nerve

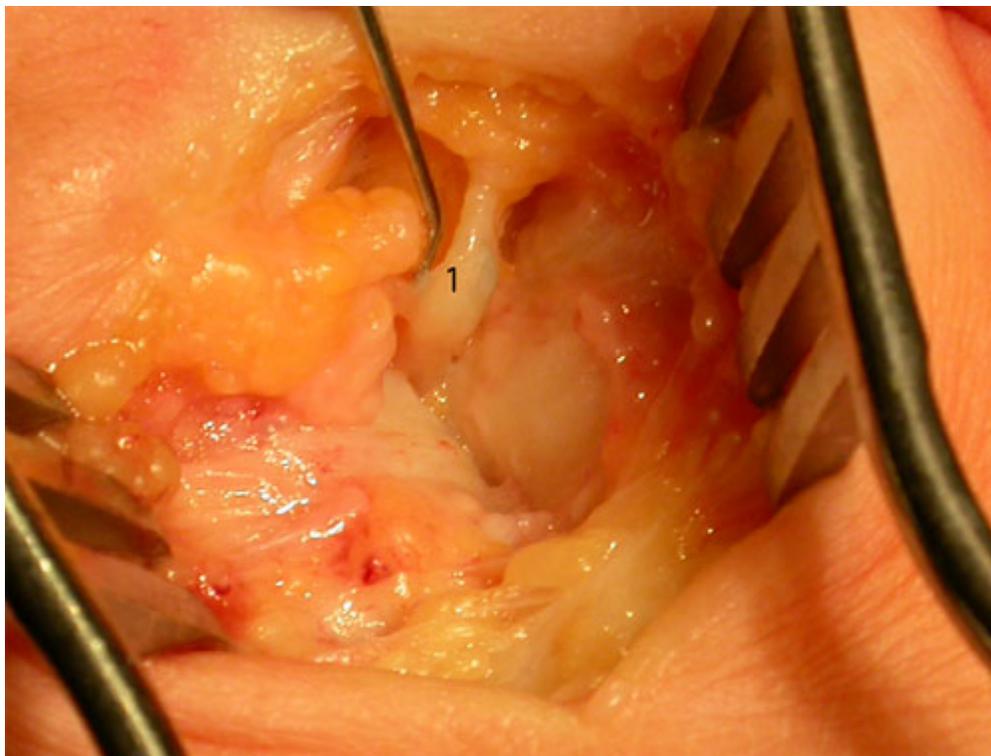


Fig. 3. MRI of Morton's neuroma

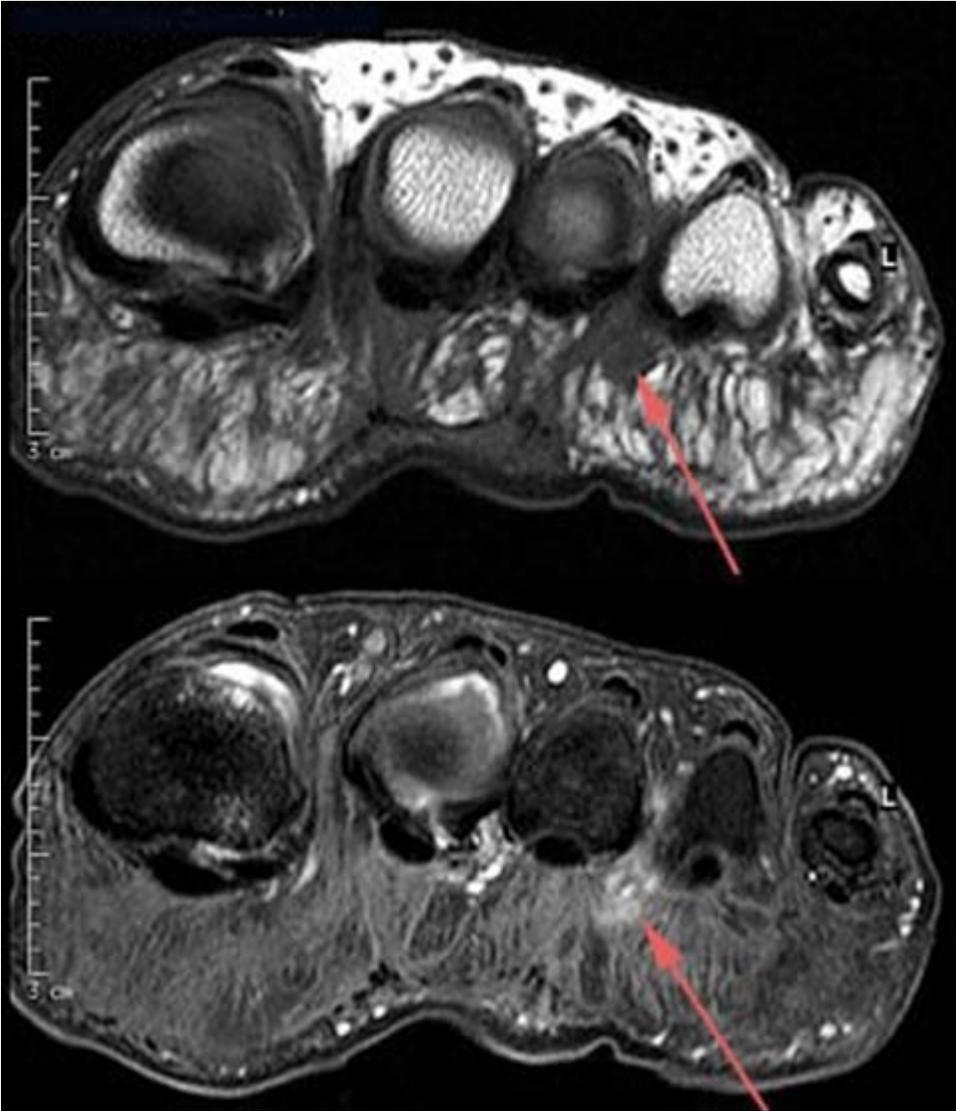
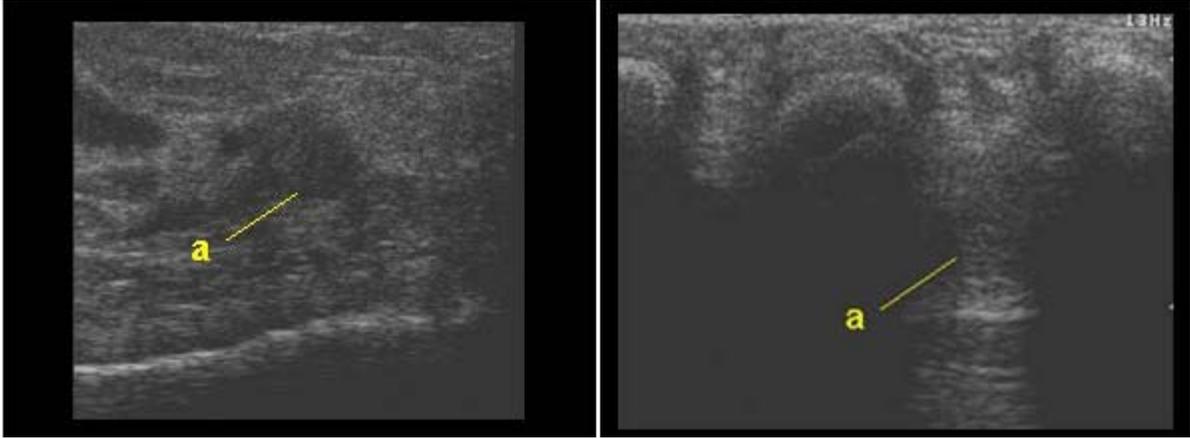


Fig. 4. Ultrasound: Longitudinal and transverse views of Morton's neuroma



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