

Morton's Neuroma

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Key Messages

- Morton's neuroma is a compression neuropathy of the common digital nerve, typically seen in the webspace between the third and fourth metatarsal heads.
- Utilizing the four clinical tests yields a high degree of accurate diagnosis.
- Insight into the differential diagnoses is important.
- Foot pathomechanics, footwear, and lifestyle are important considerations.
- Using diagnostic ultrasound and magnetic resonance imaging and complementary treatment modalities enhances pedorthic treatment outcomes.

Keywords

fibrous nerve tissue, interdigital neuropathy, Mulder's click, pinching, plantar nerves, squeeze test, thickening, webspace

Introduction

Thomas Morton was an orthopaedic surgeon practising in Philadelphia, Pennsylvania, in the 1870s. He described "a number of cases of a peculiar and a painful affection of the foot, which, so far as I am aware, has not been described" (Morton, 1876). The painful condition related to a lesion to the common plantar digital nerve of the third interspace bearing his name. In reality, he described the pain as being localized to the fourth metatarsophalangeal articulation, with possible neuralgia due to the bruising or pinching of the digital branches of the plantar nerve. In his examination of 15 cases, he described a greater frequency occurring in women. Morton attributed the pain to either injury to the fourth toe, or gradual onset from shoe pressure, or to no recognized cause. He believed that a greater prevalence in females was attributed to both the greater delicacy and pliability of the female foot and to wearing tighter fitting narrow shoes. Dr. Morton treated this painful condition by blood-letting and extended rest until sensitivity had subsided, or by complete excision of the metatarsophalangeal joint, the nerves (likely on either side of that joint), and amputation of the fourth toe (Morton, 1876).

A review of the historical literature demonstrates that Morton was not the first to describe a neuralgia-like condition of the third webspace. In 1835, a paper written by Dr. Civinini entitled "On a ganglionic

swelling of the sole of the foot" describes and illustrates the third common digital nerve neuroma as a fusiform swelling that was also associated with a valgus deformity of the big toe (Pisani, 2010). In 1845, Durlacher described a neuralgia involving the plantar nerve in the space between the third and fourth metatarsal joints, and specified the clinical signs known today (Adams, 2010; Pisani, 2010). The first description of the presence of a mass in the third interspace was by Tubby in 1912 (Pisani, 2010).

Although originally referred to III-IV interdigital neuropathy, today the term "Morton's neuroma" is used for all interdigital neuropathy (Oh, 2007). Morton's intermetatarsal neuroma is a mechanically induced compression neuropathy of the common digital nerve (Owens, Gougoulis, Guthrie, & Sakellariou, 2010), most commonly seen in the third intermetatarsal space. The second most common site for an interdigital neuroma is the second webspace, described by Dr. EDW Hauser in 1950 (Larson, Barrett, Battiston, & Maloney, 2005). A neuroma may occur in more than one intermetatarsal space and may be bilateral. Studies have suggested the occurrence at approximately 30% (Rout, Tedd, Lloyd, Ostlere, Lavis, Cooke, & Sharp, 2009). The occurrence of an interdigital neuroma is rare in the first or fourth intermetatarsal spaces.

Pathology

Anatomically, the tibial nerve enters the foot by passing through the tarsal tunnel, the space between the medial malleolus and the flexor retinaculum. It then bifurcates into the medial and lateral plantar nerves (Netter, 2014). The medial plantar nerve supplies sensory innervation to the skin along the plantar side of the first three toes and the medial half of the fourth toe as well as to the medial anterior two-thirds of the sole. The distal branches of the medial and lateral plantar nerves ultimately form the interdigital nerves.

These pass between the distal heads of the metatarsal bones, cross the plantar surface of the transverse metatarsal ligaments, and supply sensation to the webspace between the toes. The III–IV interdigital nerve is formed by a branch from the medial and lateral plantar nerves.

The term “neuroma” is actually a misnomer for this condition. Neuroma implies that the swelling of the nerve distal to the transverse metatarsal ligament consists of an abnormal overgrowth of nerve tissue. In fact, the symptoms are brought about by degenerative nerve fibres with extensive perineural fibrosis which is the development of fibrous tissue surrounding the nerve (Adams, 2010). The lesion is likely due to repeated trauma or compression of the nerve before it divides to innervate the adjacent toes, typically within the third and fourth intermetatarsal webspace (Adams, 2010; Ahearne & Rosenfeld, 2010; Kincaid & Barrett, 2005; Oh, 2007; Wu, 1996).

The high frequency of occurrence of Morton’s neuroma in the third intermetatarsal space is explained by both anatomical and biomechanical contributing factors (Wu, 1996). As noted above, the third common digital nerve is potentially thicker because of its formation by branches of both the medial and lateral plantar nerves. Although the correlation between a thicker nerve and the development of Morton’s neuroma is not supported by all literature (Frank, Bakkum, & Darry, 1996), this potentially thicker nerve, which is tethered in the third webspace, is more vulnerable to repetitive trauma of activities of daily living.

Secondly, the fourth metatarsal is more mobile than the third, thus subjecting the third common digital nerve to more stretching and shearing forces.

Thirdly, high heeled shoes create a rise in the body’s centre of gravity. This results in a significant reduction of the base of support of the weight-bearing

foot and hyperextension of the metatarsophalangeal joints which bring the common digital nerve against the unyielding transverse intermetatarsal ligament. Couple this with compression of all the metatarsal heads from a narrow toe-box and the combined contribute to harmful trauma to the well-being of the third common digital nerve (Wu, 1996; De Maeseneer, 2015).

Pain is typically worse with weight-bearing and ambulation, but it can also occur while at rest (Adams, 2010; Woods, Cervone, & Fernandez, 2004). There may be a sensory deficit in the involved toes (Ata, Onat, & Özçakar, 2016; Thomas, Blich, Chaney, Dinucci, Eickmeier, Rubin, & Vanore, 2009). The affected digits may be splayed (Thomas *et al.*, 2009).

Differential Diagnoses

The differential diagnosis of Morton’s neuroma includes inflammatory, neurological, and biomechanical causes:

- Metatarsal stress fractures (Thomas *et al.*, 2009; Wu, 1996)
- Neoplasm (e.g., Rheumatoid nodule, soft tissue tumours) (Sharp, Wade, Hennessy, & Saxby, 2003; Thomas *et al.*, 2009; Wu, 1996)
- Bursitis (Adams, 2010; Thomas *et al.*, 2009; Wu, 1996)
- MTP joint pathologies (e.g., Freiberg’s disease) (Sharp *et al.*, 2003; Thomas *et al.*, 2009)
- Infection (Sharp *et al.*, 2003)
- Metabolic neuropathy (Thomas *et al.*, 2009)
- Fibromyalgia and other chronic pain syndromes (Thomas *et al.*, 2009)
- Tarsal tunnel syndrome (Adams, 2010; Wu 1996)
- Lumbar radiculopathy (Adams, 2010; Wu, 1996)
- Peripheral neuropathy (Adams, 2010; Wu, 1996)
- Capsulitis (Adams, 2010)
- Metatarsalgia (Adams, 2010)
- Painful plantar callosity associated with hammer toes and claw toes (Wu, 1996)

Common Testing

i) Webspace tenderness test

Webspace compression will produce severe pain as the affected nerve is squeezed between thumb and finger from a dorsal and plantar position. A palpable mass

may be felt between the fingers when massaging the webspace. Occasionally, this causes paresthesia into the toes (Adams, 2010; Rout *et al.*, 2009; Wu, 1996). Simultaneously squeezing the metatarsal heads together with the other hand or translating the two adjacent metatarsal heads relative to each other may produce a painful and palpable click called a “Mulder’s sign”. This causes a sudden displacement of the neuroma from between the two adjacent metatarsal heads (Mulder, 1951; Thomas *et al.*, 2009; Wu, 1996).



Web space tenderness test. Photo by Deborah Wolf.

ii) Foot squeeze test

Squeezing the metatarsal heads together (medial to lateral pressure) with one hand (Gauthier’s test) while actively dorsiflexing and plantarflexing the digits for 30 seconds will replicate symptoms as the nerve is pinched between the adjacent metatarsal heads. A positive test results in pain to the patient or a sensory abnormality (DeHeer & Werber, 2006; Thomas *et al.*, 2009).



Foot squeeze test. Photo by Deborah Wolf.

iii) Plantar percussion test

Percussion over the site of the neuroma while passively extending the toes may cause paresthesia (a

positive Tinel’s sign) in the associated toes, or pain (Owens *et al.*, 2010; Thomas *et al.*, 2009). A modified version involves passively hyperextending the toes and rolling the thumb of the examiner in the area of symptoms. This maneuver may reveal a tender, thickened, longitudinal mass.



Plantar percussion test. Photo by Deborah Wolf.

iv) Toe tip sensation deficit test

Applying a pin prick or the extended end of a paper clip to the adjacent aspects of the toes or the plantar aspect of the adjacent toes may reveal reduced sensation (numbness, paresthesia) (Adams, 2010; Di Caprio, 2017; Owens *et al.*, 2010).



Toe tip sensation deficit test. Photo by Deborah Wolf.

v) Digital nerve stretch test

The digital nerve stretch test is performed with the patient seated with the feet upon the examiner’s knees. Both ankles are held in full dorsiflexion, whilst the lesser toes on either side of the suspected webspace are passively and fully extended on both feet. The test is positive if the patient complains of discomfort in the webspace of the affected foot (Clove & Greiss, 2006).



Digital nerve stretch test. Photo by Deborah Wolf.

The literature confirms diagnostic ultrasound as a valuable and highly accurate diagnostic tool (Kincaid & Barrett, 2005). The neuroma appears as an ovoid mass parallel to the long axis of the metatarsals (Adams, 2010; Rout *et al.*, 2009). Interpretation of an ultrasound scan is straightforward and uncomplicated (Gomez, Jha, & Jepson, 2005).

Radiographs are useful to rule out metatarsal stress fractures and other metatarsal pathologies but neuromas will not be visible on X-ray (Adams, 2010). MRI may reveal the neuroma as a low density mass (Adams, 2010).

Contraindications

Additional forefoot padding or a neuroma pad that is too thick may make the shoe too tight.

The Patient Perspective

The literature emphasizes diagnosing Morton's neuroma based on the patient's history and physical findings. These details are often enough to establish the correct condition.

The diagnosis might be validated when a patient describes any or all of the following:

- A perceived "lump" or feeling of walking on a rolled-up or wrinkled sock or the seam of the sock
- A feeling of relief walking barefoot or with massage on removing footwear
- Sharp, dull, or throbbing pain
- Radiating, aching, burning pain localized to the plantar aspect of the intermetatarsal space
- Numbness and tingling (paresthesia)
- Symptoms may radiate into the adjacent toes, described as shooting sensation (Ata *et al.*, 2016;

Di Caprio, 2017; Gabriel, 2004; Rout *et al.*, 2009; Thomas *et al.*, 2009; Woods *et al.*, 2004; Wu, 1996).

Common Treatment

Pedorthic treatment protocol may initially consist of the use of a neuroma (or metatarsal) pad placed in existing footwear that has sufficient toe-box width and depth. This pad is placed proximal to the metatarsal heads (ideally peaked at the third webspace) to provide space between the metatarsals to relieve pressure on the pinched nerve. This can provide a more cost effective method of controlling the symptoms.

If the severity of the pathology warrants further intervention, pedorthic treatment would consist of custom foot orthoses that are designed to control excessive rearfoot motion, typically eversion. The orthoses will address forefoot equinus (if present) and will feature a metatarsal pad or neuroma pad (either elongated or narrow) placed between and just proximal to the affected metatarsal heads (within 10mm). This positioning likely separates the metatarsal heads to decrease pressure and trauma on the involved digital nerve. Appropriate footwear consists of a wide, deep toe-box with lower heels to minimize metatarsal head pressure. The addition of a metatarsal bar or shoes with rockered soles or stiff soles may enhance the orthosis efficacy by reducing MTP extension during the push-off phase of gait (Decker & Albert, 2002; Rout *et al.*, 2009; Valmassy, 1996; Wheelless, 2011; Woods *et al.*, 2004).

If pedorthic treatment fails to improve symptoms, consider referral to an allied health care professional for appropriate modalities like ultrasound or laser treatment.

Three cycles of radiofrequency ablation provide a high rate of patient satisfaction (Brooks, Parr, & Bryceson, 2017).

The literature also recommends invasive treatment of ultrasound guided injection using a combination of steroids and local anaesthetic to relieve symptoms. Other surgical options include neurolysis, percutaneous electrocoagulation, cryogenic denervation of the intermetatarsal neuroma, and surgical decompression (Kasperek & Schneider, 2013; Kincaid & Barrett, 2005; Rout *et al.*, 2009).

Key Considerations

Neuromas are more prevalent in adults beginning in the third decade of life, and are more common

in females than males (Owens *et al.*, 2010; Thomas *et al.*, 2009). Typically, neuromas most often afflict fashion-minded women between the ages of 40 to 60 who wear high-heeled narrow-fitting footwear (Wu, 1996). Ultrasound is as accurate as MRI in diagnosing Morton's neuroma (Bignotti, Signori, Sormani, Molfetta, Martinoli, & Tagliafico, 2015).

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Sample Chapter