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Review

Morton's interdigital neuroma of the foot
A literature review

Francesco Di Caprio, MD*, Renato Meringolo, MD, Marwan Shehab Eddine, MD, Lorenzo Ponziani, MD

Operating Unit of Orthopedics and Traumatology, AUSL of Romagna, Ceccarini Hospital, Riccione 47838, Italy

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ABSTRACT

Morton's neuroma is one of the most common causes of metatarsalgia. Despite this, it remains little studied, as the diagnosis is clinical with no reliable instrumental diagnostics, and each study may deal with incorrect diagnosis or inappropriate treatment, which are difficult to verify. The present literature review crosses all key points, from diagnosis to surgical and nonoperative treatment, and recurrences.

Nonoperative treatment is successful in a limited percentage of cases, but it can be adequate in those who want to delay or avoid surgery. Dorsal or plantar approaches were described for surgical treatment, both with strengths and weaknesses that will be scanned.

Failures are related to wrong diagnosis, wrong interspace, failure to divide the transverse metatarsal ligament, too distal resection of common plantar digital nerve, an association of tarsal tunnel syndrome and incomplete removal. A deep knowledge of the causes and presentation of failures is needed to surgically face recurrences.

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1. Introduction

Morton's neuroma is a very common cause of metatarsalgia, and consists in an interdigital nerve disease of the foot, classically located at the third intermetatarsal space.

Despite its high incidence, Morton's neuroma was little studied. For this reason we performed this literature review, with the first author being involved in literature search, paper drawing up, introduction and diagnostics. The second author in surgical treatment. The third in conservative and infiltrative treatment. The fourth in discussion and final supervision.

Interdigital neuroma is a clinical syndrome of the forefoot which has often been described in the last two centuries. It was first reported by Civinini [1,2] in 1835 and later by Durlacher in 1845 [3], who described the clinical complex of symptoms. Thomas George Morton described "a peculiar and painful affection of the fourth metatarsophalangeal articulation" in 1876 [4,5]. He attributed the pain to the fourth metatarsophalangeal joint. It was Hoadley who first actually excised an interdigital neuroma from the third webspace of a foot in 1883 [6].

Morton's neuroma prefers the female sex, with a female:male ratio of 4:1 [7], with an average age of 50 years at surgery [8]. The neuroma is bilateral in 21% of cases, it affects third space in 66% of

* Corresponding author at: U.O. Ortopedia e Traumatologia, Ospedal Ceccarini, Viale Frosinone, 47838, Riccione (RN), Italy. Fax: +39 0541 608837.
E-mail address: francesco.dicaprio@auslromagna.it (F. Di Caprio).

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cases, the second in 32%, and the fourth in 2% [8]. Multiple locations are rare [9].

The most common symptom is a burning pain in the plantar aspect of the foot, located between the metatarsal heads, often radiating to the two corresponding toes. Sometimes the patient reports a shooting sensation on the plantar side, associated with sharp pain. Occasionally the pain radiates proximally along the plantar or dorsal surface of the foot. The pain is exacerbated when the patient is wearing a tight shoe or a heel, which is why the patient is forced to remove the shoe and massaging the foot. The patient may report a sensation of numbness in the toes or shock sensation.

Below the medial malleolus the tibial nerve divides into two plantar branches, medial and lateral. These are distributed to the sole up to the intermetatarsal spaces. In particular, the medial plantar nerve is divided into the own digital hallux nerve and the common digital nerves for first, second and third interspace, while the lateral plantar nerve form the own digital nerve for the fifth toe and the common digital nerve for the fourth interspace. An anastomotic branch, present in 66.2% of cases, arises from the common digital nerve for the fourth interspace, passing below the fourth metatarsal, in communication with the common digital nerve to the third interspace, whereby the latter is formed by an anastomosis between branches from both nerve trunks [10]. Each interdigital nerve passes below the corresponding distal metatarsal transverse ligament (DMTL), which is just proximal to the metatarsal heads, and then divides into the two digital nerves.

Morton's neuroma [11] consists of a bulge in the interdigital nerve just distal to the DMTL, and before the bifurcation in the digital nerves (Fig. 1). Macroscopically it has a typically fusiform configuration, a glistening and white to yellowish appearance and a relatively soft consistency. Histological findings include neural degeneration, epineural and endovascular hyalinization, and perineural fibrosis [12–14].

It was suggested that the common digital nerve to the third interspace is thicker than the others, as it results from an anastomosis between branches from the two nerve trunks [15–17]. Another anatomical factor is the increased mobility of the fourth radius (moving on the cuboid), compared to the third (fixed to the cuneiform). Some believe that taut DMTL play a critical role in compressing the interdigital nerve [12]. In this sense, the use of high heels is another predisposing factor since the extension of the metatarsophalangeal forces the digital nerve just beneath the DMTL [1,17,18]. This latter theory was debated on the basis of anatomical studies [19] and imaging [20].

Some studies described the relationship with trauma [21,22].

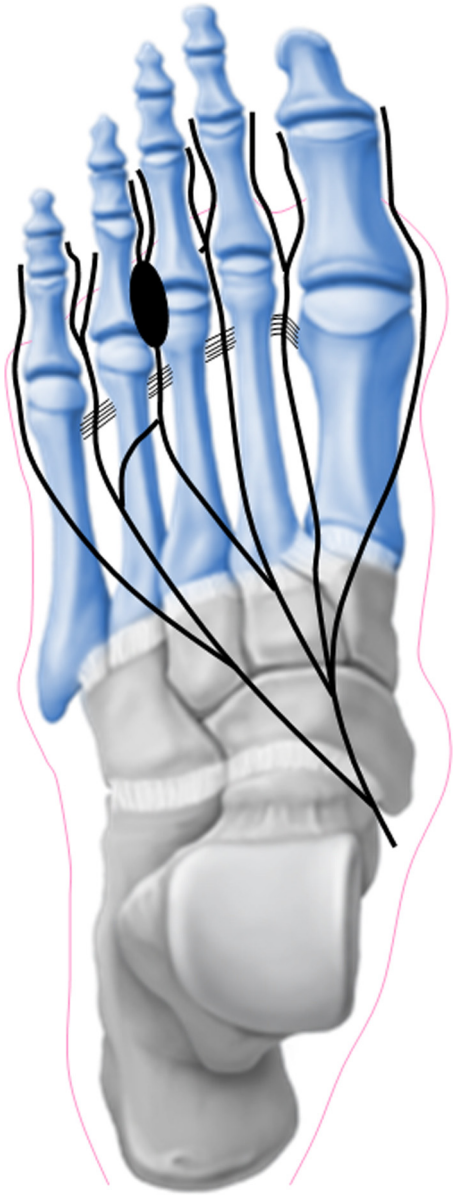

Fig. 1. Subdivision of plantar nerves.
Illustration showing the anastomotic branch from the common digital nerve for the fourth interspace (branch from the lateral plantar nerve), to the common digital nerve to the third interspace (branch from the medial plantar nerve). The interdigital nerve passes below the corresponding intermetatarsal ligament, which is just proximal to the metatarsal heads, and then divides into the two digital nerves. Morton's neuroma consists of a fusiform bulge in the interdigital nerve just distal to the intermetatarsal ligament, and before the bifurcation in the digital nerves.

2. Diagnosis

The diagnosis of Morton's neuroma is eminently clinical [23–25]. It's important to accurately locate the pain. In fact, patients with Morton's neuroma do not experience pain on the metatarsal heads. In the latter case it will be important to highlight the forefoot deformities, instability or arthritis in the metatarsophalangeal joint, Frieberg's disease.

Clinically there may be tenderness and a dorsal bulging may be found. It may also be present an enlargement of the interdigital space. When pressure is applied axially to the intermetatarsal space acute pain is induced. The pressure can be exerted while tightening the metatarsals with the other hand, and this may be associated with a painful and palpable clicking sensation (Mulder's sign) [25]. This test demonstrated a 94–98% sensitivity [26–28].

X-rays are essential to investigate other causes of metatarsalgia [29,30] (metatarsal hypermetria, tarsal–metatarsal joint stiffness, Frieberg's disease, toe deformities, metatarsal–phalangeal instabilities).

Ultrasound and MRI have always been considered not reliable in the diagnosis of Morton's neuroma [13,26,31–34]. The MRI recently showed a sensitivity 93% with specificity 68%, while the ultrasound sensitivity was 90% and specificity 88% [35]. Ultrasound, even in highly skilled hands, has a high rate of incidental finding of an asymptomatic interdigital nerve enlargement, which can lead to a false diagnosis of a Morton's neuroma. Moreover small lesions are difficult to diagnose by imaging, but are still able to cause symptoms as larger lesions [32,33]. Clinical examination is still the gold standard for the diagnosis of a Morton's neuroma [32,33].

There is no absolute requirement for imaging patients who clinically have a Morton's neuroma. The two main indications for

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