

# Morton Neuroma Surgery: Relation Clinical Results to Excised Sample Length

metin uzun (✉ [drmetinuzun@gmail.com](mailto:drmetinuzun@gmail.com))

acibadem maslak <https://orcid.org/0000-0002-2911-4031>

Fatma Tokat

Acibadem Maslak Hastanesi

---

## Research

**Keywords:** Morton neuroma, Excision, level

**DOI:** <https://doi.org/10.21203/rs.3.rs-56639/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

# Abstract

## Background:

Morton's neuroma (MN) is mechanical neuropathy of plantar interdigital nerve. It is one of the most common causes of forefoot pain. One of the most undesirable complications of MN surgery is recurrent neuroma. Excision level of MN is important to prevent recurrence. In this study, we aimed to find the relation resection length of MN to clinical results of MN surgery cases.

## Methods:

76 samples sent with the diagnosis of Morton neuroma to the pathology department of our hospital between years 2010-2019. 66 patients whose clinical results were available were included in the study. Mean age was 41,5 (between 21 to 70). All of 66 patients were primary diagnosed 22 of them was left foot and the other 170 were right foot. 50 of them were female, and 16 were male. Recurrent neuromas, pathological sample more than one piece from one surgical site were excluded from the study. 72 of them were evaluated as a clinically and compare the sample length.

## Results:

76 pathological specimens were prepared and examined by the same pathologist. Gross pathological appearance and histopathology findings were recorded. Mean sample length was 2,05 cm (between 0,7cm and 3,5 cm). 68 samples was smaller (89.5%) than 3 cm and only 8 sample (10.5%) was bigger than 3 cm. Average interdigital neuroma score improved from 20 to 62 points following the surgery ( $p < 0.05$ ).

## Conclusion:

We recommend that, the common digital nerve should be cut from the proximal as much as possible to bury the proximal stump into the lumbrical muscles regardless of the sample size and using loupe magnification, careful and sharp dissection can be prevent injury to the PDNB.

Level of Evidence: 2

# Introduction

Morton's neuroma (MN) is mechanical neuropathy of plantar interdigital nerve. It is one of the most common causes of forefoot pain (1). MN is located usually at third intermetatarsal space and affects social life of patients. The pain is often worse when walking or wearing shoes that squash the feet. Patients suffer from burning pain and tenderness usually over the 3rd and 4th metatarsophalangeal joints, with pain radiating along other toes.

Conservative treatment modalities for MN consist of shoe modifications, orthotic use, corticosteroid injections (2). Surgical applications that can be selected from one of two surgical entry points as either dorsal or plantar may be last chance for failed treatments. Surgical techniques may be either decompression or excision with either open or endoscopic manner (2).

One of the most undesirable complication of MN surgery is recurrent neuroma. Recurrence causes are well-known and often worked on it. It may occur due to inadequate surgical resection or inappropriate transposition of the proximal nerve stumps (3, 4). Each common digital nerve has plantarly directed nerve tetherings (4). These nerve tetherings are probably the most ignored and little-known cause of high incidence of recurrence. Resection level and techniques of MN is important for this reason.

Few specific recommendations and studies have been made so far regarding appropriate resection level of the nerve to prevent recurrent neuroma. Some surgeons prefer resection as far proximally as possible while others prefer 1 to 2 cm proximal to the bifurcation of the proper digital branches (5–8). Most of the surgeons found it appropriate to exclude the neuroma from the section where it is visibly; but in this case plantar nerve tetherings may be overlooked.

There aren't certain answers in the current literature concerning how far proximal nerve should be resected to prevent recurrence as far as we know. In this study, we aimed to find the relation resection length of MN to clinical results of MN surgery cases.

## Materials And Methods

We searched Morton neuroma as a keyword at our pathology center's database. We aimed to compare the macroscopic dimensions of pathological samples and clinical results sent with a pre-diagnosis of morton neuroma. We operated 66 patients (76 feet) with diagnosed interdigital neuroma between years 2010 and 2019. All patient's diagnoses were confirmed with clinical evaluation and magnetic resonance imagination. Surgical treatment was applied to the patients who complained resolved with 1 cc local anesthesia. Clinical outcomes of 66 patients were assessed using the interdigital neuroma score and compared the sample length (5).

The most common interspace affected was the third at 60 patients, followed by the second at 16. Mean age was 41,5 (21 to 76). All of 66 patients were primary diagnosed and 22 of them were left foot and 44 of them were right foot, rest of 10 were bilateral. 1 was. 50 of them were female, and 16 were male. Recurrent neuromas, pathological sample more than one piece from one surgical site were excluded from the study.

All 72 cases surgeries were made by three surgeon. All of the cases were performed under general anesthesia and under ankle tourniquet control. Loupe magnification is not routinely used by the all the surgeons. Dorsal exposure was done for all cases. The deep transverse metatarsal ligament was transected carefully. Neuroma usually was found under the distal part of the deep transverse ligament (Fig. 1) (4). Interdigital nerve distal to the bifurcation point is observed macroscopically. Nerve is

transected distal to the bifurcation to the level of normal-appearing nerve and transected sharply as proximally as possible to the neuroma at the point where it exits the muscle. We preferred to bury the proximal end of the nerve into the adjacent interosseous muscle.

## Results

76 pathological specimens were prepared and examined by the same pathologist. Gross pathological appearance and histopathology findings were recorded. Total length of the excised nerve (proper digital branches + common digital branches- from the distal end of the distal metatarsal transverse ligament) was recorded. Mean sample length was 2,05 cm (between 0,7 cm and 3,5 cm). 68 samples was smaller (89.5%) than 3 cm and only 8 sample (10.5%) was bigger than 3 cm. 76 of them were evaluated as a clinically and compare the sample lenght. All records was given as a table and graphics ( Table 1 and Graphic 1) Average interdigital neuroma score improved from 20 to 62 points following the surgery ( $p < 0.05$ ). Fair in one patient and two patients had a poor result with a similar pain prior to surgery. Postoperative complaints increased more in one patient. The complaints did not pass with local injection and EMG tests were found to be normal; but EMG performed in the postoperative 1st year, and revealed that diabetes-related polyneuropathy. Neuroma development was detected in 2 patients who had a poor results; in the early period and revision surgery was performed with using loupe magnification. The length of the removed pathological parts of these two patients was 2 and 2.1 cm.

Table 1

Sample lenght	0-0.99 cm	1-1.99 cm	2-2.99 cm	3-3.99 cm
Sample count	2	30	36	8
Compare the clinical and anatomical Level of excision results in Morton neuroma surgery.				
GRAPHICS				

## Discussion

The cause of MN has not clearly been established (2, 9, 10). This confusion also leads to confusion in the choice of treatment. First of all, we need to know the reasons for the occurrence of MN to decide the treatment method. There are several anatomical explanations try to explain the cause. The most commonly known theory is compression at tunnel theory. The tunnel is anatomical box composed of two metatarsal heads, tendons and distal metatarsal transverse ligament (DTML) (4). The theory is based on compressing and pulling of interdigital nerve by DTML during walking in both the mid-stance and the heel-off stage (9). Unlike this knowledge, Kim's anatomical study showed that; neuroma occurs more distally than DTML and does not change nerve-length with foot movements (4).

Another anatomical explanation for Morton neuroma is about neural anatomy (4). Tibial nerve divides into two medial and lateral plantar branches below medial malleolus. Medial plantar nerve also is divided

to hallux digital nerve and common digital nerves for first, second and third interspace. Lateral plantar nerve forms fifth toe digital nerve and fourth interspace digital nerve. Anatomic nerve variation, present 66.2% of the cases, arises from the 4th interspace make anastomosis with the common digital nerve at 3th interspace. A bulge before bifurcation in the digital nerves just distal to DTML creates MN clinics (9).

In the light of this theories; staged treatment program began with footwear modification, progressed to steroid injection, and finally to surgical treatment (11).

Dorsal approach is more preferable because of its technically simple than plantar approach except revision for surgical treatment (5). However dorsal approach also has its own disadvantages (12, 13). Recurrent neuromas occur more at dorsal approach due to inadequate visualization of nerve tracts because of not fully transected metatarsal ligament or metatarsal heads and adjacent soft tissue swelling (3).

Recurrence after MN surgery is an undesirable outcome. Amis et al. found an anatomical cause in a cadaver study which aimed to investigate the causes of recurrence (3). They found plantarly directed nerve branches (PDNB) along the course of common digital nerves of second and third web spaces. Resected nerve stump may not move away from weight bearing area of the foot because of PDNB and this might be a cause of recurrence. Any injury to PDNB during excision of Morton neuroma may lead to formation of traumatic neuroma with similar clinical findings to Morton neuroma. In the light of revision surgery literature search is made; In revision surgery, it is not stated whether recurrence is stump-induced or traumatic PDNB-induced neuroma. Kim showed that, MN detected level of bifurcation and does not under DTML and length of DTML + interdigital nerves from the bifurcation of the common digital nerve to the anterior margin of the DTML were recorded 29,5 mm at second; 25,7 mm at third interdigital nerve and No statistical difference was found in the common digital nerve length between the foot movement position (4).

Amis stated that to prevent recurrence, after achieving a good visualization nerve must be resected at least 3 cm proximal to the deep transverse ligament because there are plantar directed nerve tetherings at 3 cm proximal to the proximal edge of DTML (3, 13). Anatomic studies showed that; mean DTML length recorded 11,7 mm and stated that MN was found to be an average of 7.5 mm beyond DTML (14). As a results Amis recommend to remove 4,92 cm ( $3 + 1,17 + 0,75$  cm). On the other side, Kim stated that it is sufficient to remove 3 cm in total nerve resected length (4). In all of these anatomic studies; while these measurements were being made, the foot length was neglected. The length of the foot will affect the length of the nerve and therefore the length of the nerve to be excised. In our study, the mean value was found to be 2.05 and only 8 sample (10.5%) was bigger than 3 cm. Only two patients results only who had poor results; revision surgery was performed. The sizes of the samples taken in these patients were 2 and 2,1 cm. Although all diagnostic steps are applied correctly; one patient was a incorrect diagnosis as a polyneuropathy. Our results showed that our complication rate was 4,5% and revision surgery rate was 3%. Although the current literature gives revision rates of 15–50%; our cases samples were taken at a shorter size than the length suggested by the literature and our revision rates were found to be lower (15).

During surgery, we removed the nerve as much as possible, regardless of foot size. It is a weak point of our study that the foot length is not specified in our study.

## **Conclusion**

We recommend that, the common digital nerve should be cut from the proximal as much as possible to bury the proximal stump into the lumbrical muscles regardless of the sample size and using loupe magnification, careful and sharp dissection can be prevent injury to the PDNB.

## **Abbreviations**

MN: Morton Neuroma; DTML: distal metatarsal transverse ligament; PDNB: plantarly directed nerve branches

## **Declarations**

## **Authors' contributions:**

Metin Uzun designed the study. Yalın Dirik and Fatma Tokat searched the literature and interpreted the data. Metin Uzun wrote the manuscript. The authors read and approved the final manuscript.

## **Funding:**

No funds have been received for this study.

## **Availability of data and materials:**

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## **Ethics approval and consent to participate:**

informed consent was obtained from the participants. Consent for publication: Not applicable.

## **Consent for publication:**

Written informed consent was obtained from each patient to authorize the publication of their data.

## **Competing interests:**

The authors declare that they have no competing interests.

## References

1. Zelent ME, Kane RM, Neese DJ, Lockner WB. Minimally invasive Morton's intermetatarsal neuroma decompression. *Foot Ankle Int.* 2007;28(2):263–5.
2. Gougoulas NLV, Sakellariou A. Morton's interdigital neuroma: instructional review. 2019;4.
3. Amis JA, Siverhus SW, Liwnicz BH. An anatomic basis for recurrence after Morton's neuroma excision. *Foot Ankle.* 1992;13(3):153–6.
4. Kim JY, Choi JH, Park J, Wang J, Lee I. An anatomical study of Morton's interdigital neuroma: the relationship between the occurring site and the deep transverse metatarsal ligament (DTML). *Foot Ankle Int.* 2007;28(9):1007–10.
5. Giannini S, Bacchini P, Ceccarelli F, Vannini F. Interdigital neuroma: clinical examination and histopathologic results in 63 cases treated with excision. *Foot Ankle Int.* 2004;25(2):79–84.
6. Wu KK. Morton's interdigital neuroma: a clinical review of its etiology, treatment, and results. *J Foot Ankle Surg.* 1996;35(2):112–9. discussion 87 – 8.
7. Thomson CE, Gibson JN, Martin D. Interventions for the treatment of Morton's neuroma. *Cochrane Database Syst Rev.* 2004(3):CD003118.
8. Hassouna H, Singh D. Morton's metatarsalgia: pathogenesis, aetiology and current management. *Acta Orthop Belg.* 2005;71(6):646–55.
9. Bennett GL, Graham CE, Mauldin DM. Morton's interdigital neuroma: a comprehensive treatment protocol. *Foot Ankle Int.* 1995;16(12):760–3.
10. Di Caprio F, Meringolo R, Shehab Eddine M, Ponziani L. Morton's interdigital neuroma of the foot: A literature review. *Foot Ankle Surg.* 2018;24(2):92–8.
11. Schreiber KKM, Poddar S, Tweed EM, Inquiry C. What is the best way to treat Morton's neuroma? *J Fam Pract.* 2011;60:157–68.
12. Mann RARJ. Interdigital neuroma—a critical clinical analysis. *Foot Ankle.* 1983;3:238–43.
13. Weinfeld SB, Myerson MS. Interdigital Neuritis: Diagnosis and Treatment. *J Am Acad Orthop Surg.* 1996;4(6):328–35.
14. Morscher E, Ulrich J, Dick W. Morton's intermetatarsal neuroma: morphology and histological substrate. *Foot Ankle Int.* 2000;21(7):558–62.
15. Richardson DRDE. The recurrent Morton neuroma: what now? *Foot Ankle Clin.* 2014;19(3):437–49.

## Figures

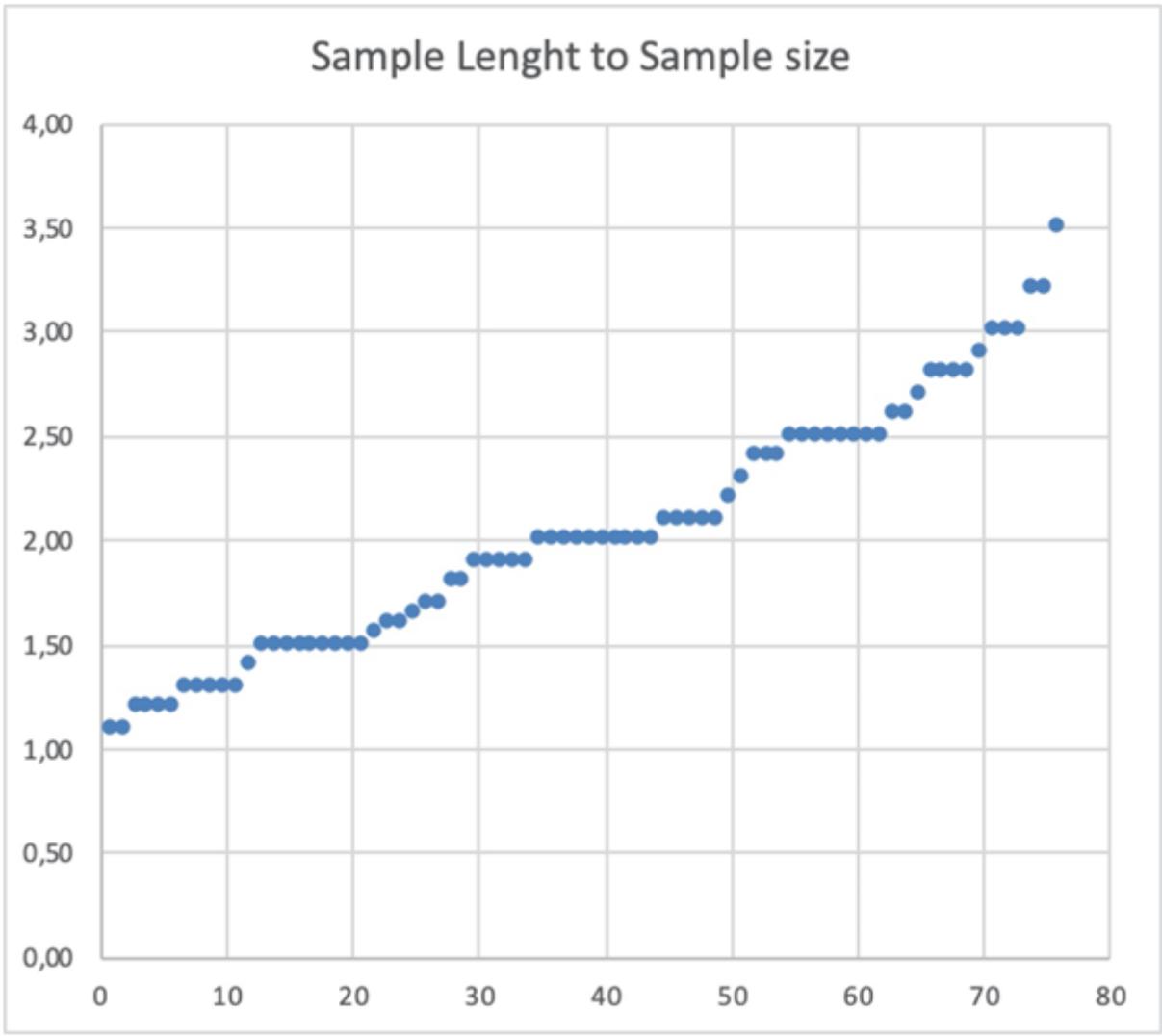


Figure 1

X-Y graphic compares the sample length and sample count.