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# Are MR imaging and pathologic tissue sizes compatible in morton neuroma?

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**Abstract**

It is claimed that Morton Neuroma (MN) is symptomatic if it is greater than 5mm. In contrast, significant amounts of Morton neuroma that do not reach this critical level may become symptomatic. Therefore, it is thought that MN size and intensity of symptoms do not show a positive correlation. Twenty patients who were operated at Medipol University School of Medicine between 2015-2019 for the diagnosis of Morton neuroma and whose disease was diagnosed as Morton Neuroma by MRI and pathological evaluation and were evaluated retrospectively. Pathological tissue size measurements and MRI measurements were compared. The mean age of the operated patients was 47, 14 were female and 6 were male. The average of the pathological tissue dimensions after the measurements was 16,6 mm. The average of the radiological image dimensions after the measurements was 8,5 mm. The pathologic dimension was significantly higher ($p<0.05$) than the radiological dimension. After comparative measurements of MR images and pathological dimensions of Morton Neuroma, it was determined that there was a difference between them. Therefore, the surgical treatment option should not be determined according to the severity of clinical symptoms rather than size.

**Keywords:** Morton neuroma, radiological dimension, pathology, MRI

## Introduction

Morton's neuroma is a non-neoplastic condition that typically affects middle-aged women more frequently than men at a ratio of 5:1. It involves the entrapment of the common plantar digital and proper plantar digital nerves and is characterized by degeneration, perineural fibrosis, and symptoms such as burning sensation, tingling, and numbness [1,2]. The condition is often caused by excessive stretching of the interdigital nerve due to forced pronation and hyperextension of the metatarsophalangeal joint, which occurs when wearing high-heeled shoes in a non-orthopedic position [3]. Morton's neuroma most commonly occurs in the third web space, less frequently in the second web space, and rarely in the first and fourth web spaces [4]. This is attributed to anatomical factors such as the thickness of the third metatarsal nerve and the relative movement of the fourth metatarsal head [1,5]. Diagnosis of Morton's neuroma does not rely on a single pathognomonic clinical test, and caution should be exercised as other foot pathologies may result in false positive results in clinical tests [6].

Several studies have shown that there is no direct relationship between the size of Morton's neuroma and the severity of symptoms, indicating that the size of the neuroma alone is not the sole factor affecting symptom severity. According to Sharp et al., symptoms of Morton's neuroma are not necessarily

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dependent on the size of the neuroma [7]. Furthermore, the diagnosis of Morton's neuroma based on MR imaging does not always correlate with symptomatology, underscoring the importance of careful correlation between clinical and imaging findings [8]. Some authors argue that a neuroma size greater than 5mm is symptomatic, but significant numbers of Morton's neuromas that do not reach this critical size threshold may still cause symptoms. Therefore, it is believed that there is no positive correlation between the size of Morton's neuroma and the intensity of symptoms.[9] Although clinical evaluation may be sufficient for the diagnosis of Morton neuroma, MRI and USG have advantages in determining the exact location [10,11].

Morton neuroma treatment should be initially treated with conservative methods such as shoe modification, use of insoles and use of anti-inflammatory drugs. Percutaneous methods can be considered in the second step and if the previous treatments fail, surgical treatment will be considered [12]. Our aim in this study is to examine the correlation of pathological and radiological dimensions of MN.

## Material and Methods

This study was unanimously approved by the ethics committee of Medipol University Animal Experiments Local Ethics Committee (İMÜ-HADYEK) with the decision no: E-10840098-604.01.01-8229 in 27.02.2019. Twenty patients who were operated at Medipol University School of Medicine between 2015-2019 for the diagnosis of Morton neuroma and whose disease was diagnosed as Morton Neuroma by MRI and pathological evaluation and were evaluated retrospectively. Pathological tissue size measurements and MRI measurements were compared. Patients with a diagnosis of Morton neuroma who could not reach MR images and developed mortal neuroma distal to the amputate were excluded from the study.

After being delivered to the pathology laboratory, hematoxylin-eosin stained preparations with a thickness of 0.4 micron, macroscopically described and sampled by the same pathologist and diagnosed as Morton neuroma, were examined again. The boundaries of the lesion were determined at the widest point and transverse and coronal millimeters (mm) diameter were measured on the two axes on the slide. The largest size was taken from these measurements.

## MR Imaging Technique

MR imaging was performed with a 1.5-T systems (Philips Achieva; Philips Healthcare, Best, the Netherlands) with a high-spatial-resolution extremity coil with the patient in supine position.

The standard MR imaging protocol consisted of sagittal, transverse and oblique coronal T1-weighted spin-echo sequences (TR range/TE range, 500–900/15–20) and transverse and oblique coronal short inversion time inversion recovery (STIR) sequences (TR range/TE range, 2700-3700/30). T1-weighted fat-suppressed spin-echo MR images (TR range/TE range, 600-900/12-15) were also obtained before and after the injection of 0.1 mmol of gadopentetate per kg body weight. The field of view was 12–14 cm, and the slice thickness was 3–4 mm with an interslice gap of 1 mm on transverse and oblique coronal MR images by the same radiologist with a picture archiving and communication System (Centricity Universal Viewer, GE Medical Systems, Milwaukee, Wis, USA). (Figure 1) (Figure 2)

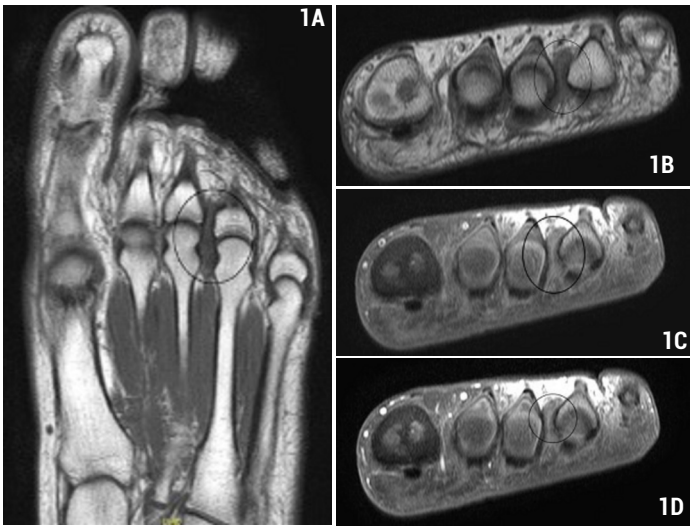


**Figure 1.** 40-year-old woman with surgically proven Morton's neuroma. Transverse T1-weighted (1A), oblique coronal T1-weighted (1B) and oblique coronal fat-suppressed T1-weighted (1C) MR images show well-demarcated soft-tissue mass (circle) isointense to muscle in third intermetatarsal space. Oblique coronal fat-suppressed contrast-enhanced T1-weighted (1D) MR image shows mild enhancement in the soft-tissue mass

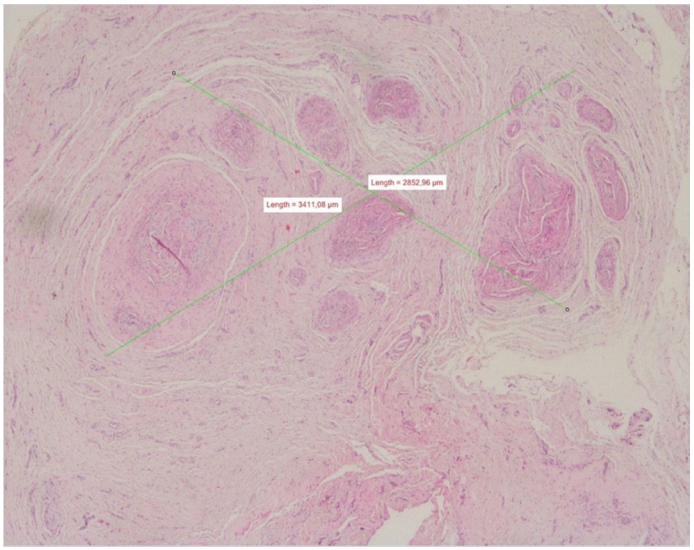


**Figure 2.** Pathological tissue examination of Morton neuroma at highest length and width under Hematoxilen-Eosin stain

## Statistical Analysis

Mean, standard deviation, median lowest, highest, frequency and ratio values were used as descriptive statistics of the data. The distribution of variables was measured by the Kolmogorov

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Smirnov test. Wilcoxon test was used for the analysis of dependent quantitative data. SPSS 22.0 program was used in the analyzes.

## Results

The mean age of the operated patients was 47, 14 were female and 6 were male. (Table 1)

**Table 1.** Age and gender distribution of patients

| | | Min-Max | Median | Average.±s.s./n-% | |
|---|---|---|---|---|---|
| **Age** | | 30-70 | 46.0 | 47.3±11.9 | |
| **Sex** | Female | | | 14 | 70.0% |
| | Male | | | 6 | 30.0% |

The average of the pathological tissue dimensions after the measurements was 16.6 mm. The average of the radiological image dimensions after the measurements was 8.5 mm. The pathologic dimension was significantly higher ($p<0.05$) than the radiological dimension (Table 2).

**Table 2.** Comparison of pathological and radiological dimensions of Morton's Neuroma

| | Min-Max | Median | Average.±s.s. | p |
|---|---|---|---|---|
| **Pathological Dimension** | 5-38 | 16.5 | 17.9±7.7 | 0.000[w] |
| **Radiological Dimension** | 4.0-14.0 | 8.6 | 8.5±3.1 | |

[w]Wilcoxon test

## Discussion

Morton neuroma is a non-neoplastic structure characterized by neural degeneration and perineural fibrosis [2]. The exact pathogenesis of Morton neuroma is controversial. Recurrent compression of the plantar nerve against the deep intermetatarsal ligament and subsequent perineural fibrosis is generally accepted [13]. This is one of the main causes of forefoot pain in middle-aged women wearing modern high-heeled shoes that do not fit the physiological structure of the foot [14]. Sensitivity, sensational variability in the affected webspace and positive Mulder click test are the most useful clinical findings [15,16]. Morton neuroma should be initially treated with conservative methods such as shoe modification, insoles and antiinflammatory drugs. Percutaneous methods can be considered in the second step and if the previous treatments fail, surgical treatment will be considered [12].

Some authors claim that it is symptomatic if the size of the Morton neuroma is greater than 5 mm. Nevertheless, significant amounts of Morton that do not reach this critical value may become symptomatic in neuroma. Therefore, it is thought that MN size and intensity of symptoms do not show a positive correlation [9]. Classen and colleagues in their studies investigating the role of MRI in the detection of Morton neuroma suggest that the effectiveness of clinical diagnosis in diagnosing Morton neuroma is superior to that of MR [17]. However, although MRI is weaker than clinical diagnosis, it has an important contribution to the exclusion of other pathologies such as stress fracture, MTP joint synovitis, plantar plate injury, true neoplastic structures, and sesamoid bone necrosis [18]. Symptoms may not always depend on the size of the neuroma. Besides, neuroma diagnosed by MRI may not always be symptomatic; therefore, the correlation between clinical and MRI is essential [16,19].

In our study, we aimed to determine whether the pathological tissue dimensions and the size measurements of MR images are compatible with the patients who underwent neurectomy due to their symptoms and whose pathology results were identified as Morton neuroma. In literature, it can be controversial that Morton Neuroma-related pain is independent of size [9,11,19,20].

Zanetti et al. performed a surgical approach to the relatively large diameter (mean 6.3 mm diameter) and a conservative approach to the smaller size (mean 4.5 mm diameter) in the Morton neuromas detected by MRI. Besides, when neuromas were detected relatively large on MR images, surgeons felt more confident in their diagnostic and therapeutic decisions [11]. Biasca et al. reported that intermetatarsal neurectomy would provide better clinical results in the treatment of Morton neuromas measured on transverse MRI scans greater than 5 mm [10]. A recent retrospective series of case studies showed that Morton neuromas larger than 6.3 mm did not respond to corticosteroid treatment [21]. It is suggested that the correct determination of the size of the mass is important in guiding the treatment and the greater the size of the mass, the higher the chance of success of surgical treatment. In present study, when the pathological and radiological measurements of the same cases diagnosed with Morton neuroma compared, the pathological dimension was significantly higher than the radiological dimension ($p<0.05$) (Table 2). According to this result, we are confronted with the fact that measurements of MR and pathological tissue dimensions may be inconsistent. In addition, the mass size measurements made by MRI are inaccurate; in particular, expressing the size of the larger mass with a smaller volume may also lead the surgeon to conservative treatment and reduce the chance of treatment success. Because of that; we suggest that the treatment decision should be based on the severity of clinical symptoms rather than mass size measurements.

## Conclusion

After comparative measurements of MR images and pathological dimensions of Morton Neuroma, it was determined that there was a difference between them. Therefore, the surgical treatment option should not be determined according to the severity of clinical symptoms rather than size.

**Conflict of interests**

*The authors declare that there is no conflict of interest in the study.*

**Financial Disclosure**

*The authors declare that they have received no financial support for the study.*

**Ethical approval**

*This study was unanimously approved by the ethics committee of Medipol University Animal Experiments Local Ethics Committee (İMÜ-HADYEK) with the decision no: E-10840098-604.01.01-8229 in 27.02.2019.*

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