Original Article

Morton's Neuroma (Interdigital Neuralgia) Treated with Metatarsal Sliding Osteotomy

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Abstract

Background: Morton's neuroma is a common cause of metatarsalgia and many treatments had been described in literature. However, there have been only a few reports that treat the neuroma with an osteotomy on the proximal, not distal portion of the metatarsal bone using a plate. This study describes the clinical outcome of sliding osteotomy on the proximal metatarsal bone for the treatment of Morton's neuroma. **Materials and Methods:** Sixty five consecutive patients (85 feet) who underwent surgery for Morton's neuroma between November 2010 and February 2013 were identified from hospital records to include in this retrospective study. Average followup period was 37.3 months (range 24–51 months). Mean patient age at surgery was 50.2 years (range 23–75 years). Metatarsal sliding osteotomies were only performed on the third metatarsal bone. Clinical evaluations with the American Orthopaedic Foot and Ankle Society Lesser Metatarsophalangeal Interphalangeal Scale (AOFAS LMIS) and Foot Function Index (FFI) were performed. The length of the lesser toe was measured for radiologic evaluation. **Results:** Postoperatively, AOFAS LMIS and FFI were improved from 52.1 (range 45–60) and 62.4 (range 54–73) to 74.2 (range 68–86) and 31.3 (range 26–37). At the last followup, preoperative pain was dissolved in 79 feet (93% of overall 85 feet). A shortened 3.2 mm (±1.1) metatarsal bone following osteotomy was radiographically measured. There were six cases of complications (soft tissue infection, early numbness, delayed union, limitation of dorsiflexion and metal failure, etc.). **Conclusions:** This proximal metatarsal sliding osteotomy can be a relatively effective operative method in relieving pain from Morton's neuroma.

Keywords: *Interdigital neuralgia, metatarsal sliding osteotomy, Morton's neuroma, plate, proximal metatarsal osteotomy*
MeSH terms: *Osteotomy, metatarsalgia, neuroma bone plates*

Introduction

Morton's neuroma is a common cause of metatarsalgia, and it is associated with causalgia and plantar tenderness.[1] It usually occurs in the second and third web space, with pain radiating along the corresponding toes. Various conservative and operative treatments for Morton's neuroma have been reported. In particular, there have been numerous reports detailing the results of operative treatment for Morton's neuroma.[2] Risk factors, are far from conclusive.[2]

Recently, the opinion was expressed that the best terminology of Morton's neuroma would be interdigital neuralgia because of the predominance of pain symptoms and the lack of inflammation rather than the combining and thickening of interdigital nerve, and the mechanical compression is more widely accepted theory as a pathogenesis of Morton's neuroma.[3] Thus, the treatments include various osteotomies which could decompress the interdigital nerve and correct the anatomical structures that contribute to the pain, while walking.[4] Mostly there have been only a few of reports that treat the neuroma with an osteotomy on the proximal portion of the metatarsal bone using a plate. It was hypothesized that sliding osteotomy on the proximal metatarsal bone for the treatment of Morton's neuroma was effective treatment option for Morton's neuroma.

This study investigates the clinical and radiological outcomes of sliding osteotomy on the proximal metatarsal bone for the treatment of Morton's neuroma.

Materials and Methods

A computer-assisted search of the surgical database at our hospital was performed from November 2010 to February 2013 to identify patients who had a preoperative diagnosis of Morton's neuroma and underwent sliding

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osteotomy on the proximal metatarsal bone for treatment of Morton's neuroma. Sixty five consecutive patients (85 feet) were identified. The Institutional Review Board for human research approved this retrospective study. All the diagnoses of Morton's neuroma were based on the patient's history and the physical findings. Radiographs and ultrasounds were performed to help with diagnosis and to rule out other pathologies and bony anomalies. If there were suspicions of peripheral neuropathy or radiculopathy, nerve conduction studies were performed (5 cases).

Inclusion criteria included persistent pain and loss of function despite various conservative treatments (such as nonsteroidal anti-inflammatory medications, shoe wear modification, use of orthotic devices, and twice or three times corticosteroid injection with lidocaine into the involved intermetatarsal space) for more than 6 months after the initial diagnosis of Morton's neuroma. Exclusion criteria included a history of previous surgery for Morton's neuroma, accompanying abnormalities of other toes, subluxations and dislocations of joint, accompanying arthritis, infection, and other diseases. Average followup period was 37.3 (range 24–51 months) months; the minimum followup was 2 years. There were 41 women and 24 men. Mean age at surgery was 50.2 (range 23–75 years) years.

In all patients, the size of the neuroma was measured, and other pathologic factors were ruled out through a preoperative ultrasonography. Twenty one cases had surgery on their right foot, 24 cases had surgery on their left foot, and 40 cases (twenty patients) had surgeries on both feet. Metatarsal sliding osteotomies were only performed on the third metatarsal bone.

With anterior-posterior and lateral weight-bearing radiography, the length of the lesser toe was measured according to the guidelines of Maestro *et al*. [Figure 1].[5] Clinical evaluations with the American Orthopaedic Foot and Ankle Society Lesser Metatarsophalangeal Interphalangeal Scale (AOFAS LMIS) and Foot Function Index (FFI) were performed preoperatively. The patients were assessed postoperatively by telephone interview or direct interview at the clinic. The questions corresponded to the AOFAS LMIS. In addition, the patient's satisfaction and whether the patient had the same surgery again after developing the same symptoms were evaluated.

The IBM SPSS 22.0 (IBM Co., Armonk, NY, USA) statistical program was used performing statistical analysis. Data were expressed as a mean ± standard deviation. Data from paired samples (preoperative and postoperative scores) were subjected to the nonparametric Wilcoxon signed rank test. Differences between groups were analyzed by the paired *t*-test for continuous variables. $P < 0.05$ was considered statistically significant.

Figure 1: A radiograph of foot anteroposterior view showing the method for the measurement of the metatarsal lengths of lesser toes. Metatarsal lengths were determined by the distances from the apex of each metatarsal to the transmetatarsal line crossed the center on the lateral sesamoid and perpendicular to the second metatarsal axis

Operative procedure

The patient was placed in supine position, painting and draping were performed in a routine manner. We performed the metatarsal sliding osteotomy without distal transverse metacarpal ligament (DTML) release. For the osteotomy, an incision was made over the corresponding metatarsal bone along the proximal one-third of the corresponding metatarsal shaft. After detachment of the soft tissue, the osteotomy was performed using an oscillating saw toward the plantar and distal aspects at an angle of 45° to the axis of metatarsal bone [Figure 2]. After the osteotomy, the distal portion was slid up about 3 mm, without angulation of the proximal portion. After temporary fixation with one Kirschner wire, bony bump area was trimmed. The final fixation was performed using a plate. After confirming the exact osteotomy, the skin was sutured, and a gauze dressing was applied alongwith a short leg splint. The patients were fitted with hard soled shoes. Immediate weight-bearing walking was allowed.

Results

The average length of the neuromas was 9.4 (range 5.6–15.2 mm) mm. Regarding the distribution of preoperative neuromas, 11 cases had neuromas in the second intermetatarsal space, 70 cases had neuromas in the third intermetatarsal space, and 4 cases had

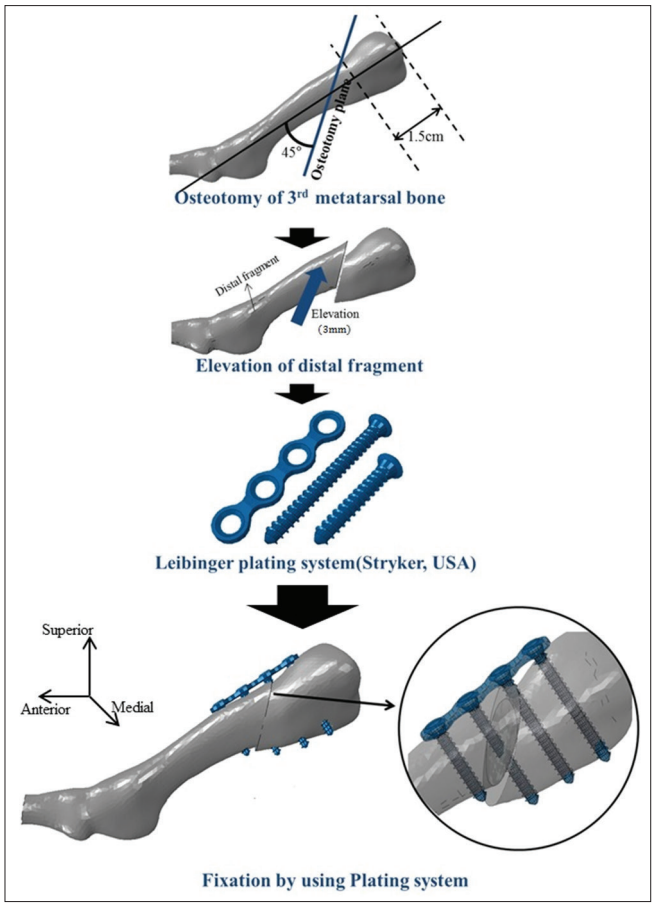

Figure 2: A diagramatic representation of oblique osteotomy through the proximal half of the shaft of the metatarsal. It is important that the distal fragment should slide up and not angulate

neuromas in both the second and third intermetatarsal spaces.

Postoperatively, AOFAS LMIS and FFI were improved at the final followup, mean improvements from the preoperative scores were 22.1 and 31.1, respectively [Table 1]. Regarding overall patient's satisfaction with the operation, 40 patients answered their satisfaction as excellent (47%), 28 good (32%), 11 fair (13%), and 6 poor (7%). At the last followup, preoperative pain was dissolved in 79 cases (93% of all 85 cases), and 58 patients (90% of all 65 patients) answered that they would undergo the same surgery if they developed the same symptoms again. A shortened 3.2 mm (±1.1) metatarsal bone following osteotomy was radiographically measured.

There were six complications in this series. One case of soft tissue infection which was improved with antibiotic treatment and dressings for 2 weeks. One case had more than 3 months of numbness in the web space around osteotomy. It was gradually improved after 6 months. Two cases of delayed union and lasting pain at the osteotomy site underwent a second surgery at the request of the patients. One case showed the limitation of dorsiflexion of the toe, but there was no functional discomfort when walking. There was a nonunion as a result of a metal failure in one case. Bone grafting was performed in this case.

Table 1: Comparison of clinical outcomes

Variable	Preoperative	Postoperative	*P*
AOFAS LMIS	52.1±7.3	74.2±9.5	0.001*
FFI pain subscale	53.8±6.4	28.5±3.8	0.001†
FFI disability subscale	52.8±6.5	28.4±3.4	0.001†
FFI activity limitation subscale	34.4±2.8	16.6±3.1	0.001†
FFI score	62.4±7.0	31.3±4.2	0.001*

*Paired *t*-test, †Wilcoxon signed-rank test. AOFAS LMIS=American Orthopaedic Foot and Ankle Society Lesser Metatarsophalangeal Interphalangeal Scale, FFI=Foot Function Index

Discussion

There are several theories (the chronic trauma theory, the ischemic theory, the intermetatarsal bursitis theory, the nerve entrapment theory, etc.) of the etiology of Morton's neuroma.[1,6] Gauthier insisted that Morton's neuroma resulted from nerve irritation and entrapment due to repeated compression between the soft tissue of the plantar aspect and the intermetatarsal ligament when walking,[7] and this nerve entrapment theory was accepted as the dominant cause of Morton's neuroma.

Conservative treatments (shoe adjustments, metatarsal pads, baths of hot and cold water, local steroid injections, etc.) were tried as the treatments of Morton's neuroma.[3] However, they did not alleviate the symptoms, and therefore, multiple surgical treatments were considered.[6-11] Each method of treatment has its merits, as well as its drawbacks.[6]

Traditionally, neuroma excision was widely used as it is a simple method although the results were inconsistent, and there were many complications, such as a recurrence of neuroma and numbness.[12,13] Frequently lasting preoperative symptoms after insufficient neuroma excision were reported by Johnson *et al*.,[14] and there were reports of frequently accompanying paresthesia around lesser toes after neuroma excision.[15,16] Moreover, there was a report of difficulties regarding the choice of shoes in 75% of patients after complete neuroma excision.[13] There were reports that overall patient satisfaction after neuroma excision did not generally exceed 80%.[12,13]

Incisions of DTML, regardless of neurolysis, instead of neuroma excision, was recommended.[7,17,18] Some authors suggested advantages as numbness, recurrence, and the additional development of impractical neuromas were not likely to occur when releasing DTML without neurolysis.[7,19] However, few long term studies have addressed this issue.[6] Recently, Kim *et al*. insisted that if Morton's neuroma was caused by irritation of the surrounding tissue and increasing pressure, the pressure developed in a more distal area than DTML.[20] Therefore, they insisted that neuromas developed via pinching of the interdigital nerve between

the metatarsophalangeal joint and the intermetatarsal heads during walking. At this point, there were attempts to treat Morton's neuroma with decompression of the intermetatarsal heads by upward migration of the metatarsal head with metatarsal shortening, which showed good results.[15] However, attempts to treat Morton's neuroma with metatarsal osteotomy were usually performed at a distal area of the metatarsal bone.[4,21] Proximal metatarsal osteotomy has a larger corrective power than distal metatarsal osteotomy due to a long lever arm.[22] If the metatarsal osteotomy is performed at the proximal metatarsal bone, it will reduce the possibility of nonunion because of small angulation by a longer radius. However, there was no angulation of metatarsal osteotomy in our study.

In addition, proximal metatarsal osteotomy has the advantage of extraarticular osteotomy. Namely, distal metatarsal osteotomy has been recognized as a significant complication of avascular necrosis,[23,24] and proximal metatarsal osteotomy can reduce damage to the surrounding soft tissue as it does not restrict blood flow to the metatarsal bone.[22] In this respect, we thought that proximal metatarsal osteotomy showed more effective decompression of the intermetatarsal space.

However, a concern about proximal metatarsal osteotomy is that it could impede bone healing by increasing strain via a long lever arm.[1] Therefore, we tried to overcome this disadvantage through rigid fixation using a metal plate. Moreover, the flexible, thin metal plate used in osteotomy could introduce an equal distribution of plantar pressure during postoperative, weight-bearing walking.

In this study, by treating Morton's neuroma with proximal metatarsal osteotomy, we obtained good clinical results in the treatment of 79 cases. Most osteotomies were performed on the third metatarsal bone because the neuromas usually existed in the second and third intermetatarsal spaces; thus, decompression could be achieved via a third metatarsal osteotomy [Figure 3]. We think that proximal metatarsal osteotomy with a metal plate is an effective surgical method for the treatment of Morton's neuroma.

This present study had some limitations. First, this study was retrospective. For an accurate evaluation of the effect of the metatarsal sliding osteotomy in Morton's neuroma, it needs a prospective study with long term followup. Second, we performed the metatarsal sliding osteotomy without DTML release in this study. It needs to be compared with additional studies of the proximal metatarsal sliding osteotomy with DTML release. Third, we did not excise the neuromas and there was no histological diagnosis. Fourth, we could not define the association between the amount of metatarsal modification and the effectiveness of decompression of neuroma like as the study of Park *et al*.[4] In this study, we could not quantify the amount of metatarsal shortening to achieve the effective decompression. Finally, we also could not show the exact measurement of dorsal shifting after osteotomy.

Figure 3: A radiograph of foot anteroposterior view showing a sliding osteotomy for the third metatarsal bone. (a) Preoperative, (b) postoperative x-rays

Conclusion

This study showed encouraging results for the proximal metatarsal osteotomy and fixation with a metal plate in Morton's neuroma. Hence, proximal metatarsal osteotomy with metal plate is another good option for the treatment of Morton's neuroma.

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Conflicts of interest

There are no conflicts of interest.

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