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Original Article

Minimally Invasive Distal Metatarsal Osteotomy in the Treatment of Primary Metatarsalgia

遠端蹠骨微創截骨術治療原發性蹠骨痛症

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ABSTRACT

Introduction: Metatarsalgia is a common presentation to orthopaedic surgeons. Primary metatarsalgia is caused by chronic imbalance in weight-bearing distribution across the forefoot or between the forefoot and midfoot. Management of primary matatarsalgia is mainly conservative. Metatarsal osteotomy can be considered if conservative treatment has failed. Minimally Invasive Distal Metatarsal Osteotomy technique can achieve satisfactory outcomes.
Method and material: From April 2009 to May 2010, we performed distal metatarsal osteotomies using minimally invasive technique in four patients (3 females and 1 male). Stab incision was made, and metatarsal neck osteotomy was achieved with a burr. No internal fixation was performed. Full weight bearing walking was allowed on the first day after operation. Radiographs were taken before and after operations, and forefoot scores were documented by using the American College of Foot and Ankle Surgeons score.
Result: The average age of the four patients was 55.8 years (range 46–62). The average operation time was 40 minutes (range 24–65). Blood loss was minimal in all patients. The length of hospital stay was 4 days in all patients. All osteotomies healed uneventfully in 4 months. There was no major complication. The average metatarsal index decreased from 3.125 to 2.8 mm, and the average first/second inter-metatarsal angle on lateral X-ray decreased from 6° to 2°. The average American College of Foot and Ankle Surgeons score improved from 66.25 (range 56–74) preoperatively to 96.25 (range 93–99) postoperatively.
Conclusion: Minimally Invasive Distal Metatarsal Osteotomy without internal fixation is a viable alternative to open procedure in the management of recalcitrant metatarsalgia.

中 文 摘 要

蹠骨痛症是一種骨科醫師經常遇到的表徵。原發性蹠骨痛症起因是前足或前足和中足之間的慢性負重分配不平均。原發性蹠骨痛症主要是以保守方法治療。如果保守治療失效，可以考慮蹠骨截骨術。遠端蹠骨微創截骨術（MIDMO）可以取得令人滿意的效果。
方法和材料：從　2009年4月至2010年5月間，我們為四病人（3女1男）進行遠端蹠骨微創截骨術。利用一枚,鑽孔器經過微創切口完成，並沒有進行內固定術。手術後的第一天允許完全負重行走。手術前後分別拍X光片，並使用美國足部外科醫生學會指數(ACFAS) 紀錄得分。
結果：4例患者的平均年齡為55.8歲（由46至62），平均手術時間為40分鐘（由24至65）。所有患者的失血量極小。所有患者的住院時間均為四天。所有截骨於術後四個月順利地癒合，並且沒有重大的併發症。術後的平均蹠骨指數從3.125毫米降至2.8毫米，從X光側面量度1st/2nd平均蹠骨間角從6度降至2度。平均ACFAS得分從術前66.25（由56至74）改善至手術後96.25（由93至99）。
結論：無內固定的遠端蹠骨微創截骨術 (MIDMO)是開放性手術以外，於頑固蹠骨痛症的一個可行治療方法。

Introduction

Metatarsalgia is a common presentation to orthopaedic surgeons. It is a symptom instead of a diagnosis. It is more common in middle-aged women, and its prevalence is around 10% in the

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Figure 1. Plantar callosities over second and third metatarsal heads.

general population.[1] Primary metatarsalgia is caused by chronic imbalance in weight-bearing distribution across the forefoot or between the forefoot and midfoot. This can be functional or structural. Functional metatarsalgia is usually caused by high-heeled or ill-fitting shoes. Structural metatarsalgia can be due to pathologies over the forefoot, midfoot or hindfoot. Excessive length or plantar flexion of the metatarsals (MT) can cause plantar prominence and painful callosities underneath the metatarsal heads. Management of primary matatarsalgia is mainly conservative. A brief period of rest, non-steroid anti-inflammatory drugs, activities modification, weight reduction, physiotherapy, proper footwear and metatarsal pads[2] are all simple and effective ways of relieving the symptoms. It is only after a prolonged period of conservative treatment has failed that operative measures can be considered.

Metatarsal osteotomy is one of the operative treatments. The aim of the osteotomy is to correct the imbalance of weight distribution, which can be achieved by shortening the MT or by realigning the MT heads in order to relieve their plantar pressure. There are several types of metatarsal osteotomy, with or without

Figure 2. The preoperative radiographs showed the measurement of metatarsal index and lateral first/second intermetatarsal angle. (a) Case 1, (b) case 2.

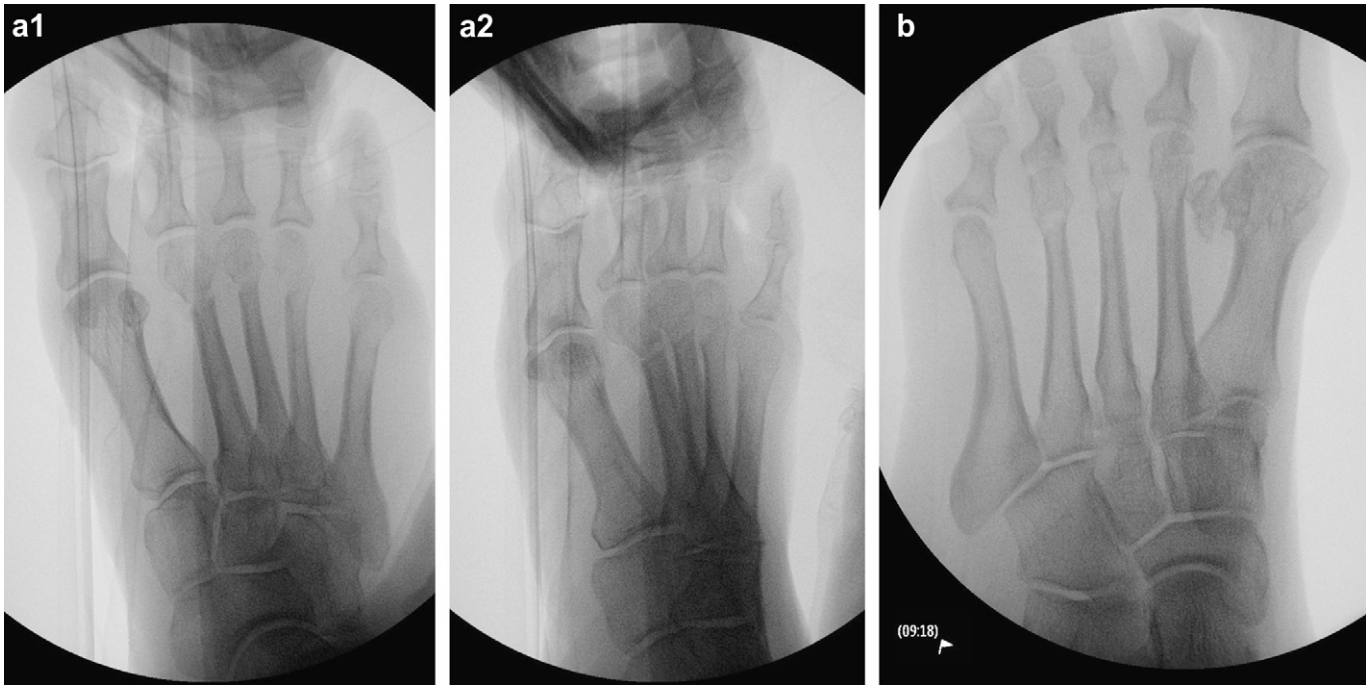

Figure 3. Intraoperative radiographs showing orientation of osteotomies: (a) case 1, (b) case 2.

internal fixation, like the Weil osteotomy,[3–5] Helal osteotomy, Wolf osteotomy,[6] midshaft osteotomy[7] and dorsal closing-wedge osteotomy at the base of metatarsal.[8] Complications of osteotomy include wound infection, malunion, nonunion, hardware problem, MT head osteonecrosis, floating toes, recurrent deformity and transfer metatarsalgia.[9] Distal metatarsal osteotomies using minimally invasive measure is a relatively new technique. We report four cases of primary metatarsalgia receiving Minimally Invasive Distal Metatarsal Osteotomy (MIDMO) with satisfactory outcomes.

Method and Material

From April 2009 to May 2010, we performed distal metatarsal osteotomies using minimally invasive technique in four patients (3 females and 1 male). The indication of the operation was primary metatarsalgia with no clinical improvement after 6 months of conservative treatment including activities and shoes modification, non-steroidal anti-inflammatory drugs and physiotherapy. Patients with metatarsalgia secondary to moderate to major hallux deformity or those with subluxed metatarso-phalageal joints were excluded from this study. All patients had received injection test to exclude Morton's neuroma. Preoperative scores using the American College of Foot and Ankle Surgeons (ACFAS) scoring system[10] were recorded. Dorso-plantar, oblique and lateral radiographs in the standing position were taken. The metatarsal index was measured on the dorso-plantar view to compare the relative length of first and second MTs. Two lines were made along the shafts of first and second MTs, and the lengths from the intersection point of these two lines and the MT heads were measured. The difference of these two lines was calculated as the metatarsal index. In addition, the first/second inter-metatarsal angle was measured on the lateral view to compare the relative plantar flexion of the first and second metatarsals. The reference line for measuring the inter-metatarsal angle is from the centre of the metatarsal base to the centre of condyle (Figure 1).

All four patients had plantar callosities over the second and third MT heads (Figure 2); the second, third and fourth metatarsal osteotomies were performed following the principles suggested by Leventen and Pearson.[11] The operations were performed under general anaesthesia and with the use of tourniquet. Three stab incisions were made on the dorsum of foot at MT neck region. To minimise periosteal stripping and facilitate the use of burr of the right-handed surgeon, periosteal stripping was performed only on medial side of the neck of the MTs on the right foot or lateral aside on left foot. A 2-mm Isham straight fluted burr (Vilex®) was utilised for the osteotomies. The sites of osteotomies at the metatarsal neck were identified under X-ray guidance. The orientation of ostetomy was 45° to the shaft of MT dorsal-distally to plantar-proximally. Complete cuts were confirmed with intraoperative X-ray control (Figure 3), and the MT was allowed to shorten itself by the pull of surrounding muscles. No internal fixation was added. The wounds were closed primarily (Figure 4). Pressure dressing was applied with gauze between the toes. No specific strapping was applied. The operative time and the length of hospital stay were recorded.

Figure 4. Three stab incisions with primary wound closure.

Figure 5. A pair of hard-bottom shoe was used postoperatively.

Full weight bearing walking was allowed with hard-bottom shoes on the first day after the operation for 4–6 weeks until signs of fracture healing were noticed (Figure 5). Radiographs were taken on follow-ups. Postoperative ACFAS score was also recorded at 3 months' time after operation.

Results

The average age of the four patients was 55.8 years (range 46–62). Two patients had left side affected and the other two had right side affected. Two patients suffered from excessive second metatarsal length (4.2 and 3.6 mm) resulting in pain during toe-off and the other two suffered from plantar-flexed second MT (7° and 9°) resulting in pain on weight-bearing. The average operation time was 40 minutes (range 24–65). Blood loss was minimal in all patients. The length of hospital stay was 4 days in all patients. The average follow-up period was 18.5 months (range 14–24 months). All osteotomies healed uneventfully in 4 months (Figure 6). There was no wound infection, neurovascular injury or metatarsal head

Figure 6. Radiographs showing the healed osteotomies: (a) case 1, (b) case 2.

osteonecrosis. The average metatarsal index decreased from 3.125 to 2.8 mm, and the average inter-metatarsal angle on lateral X-ray decreased from 6° to 2°. The average ACFAS score improved from 66.25 (range 56–74) preoperatively to 96.25 (range 93–99) postoperatively.

Discussion

MIDMO is a relatively new technique. Only a minimal number of reports on this topic are available in the English literature. One study compared MIDMO with Weil's osteotomy, which showed a similar outcome in both groups of patients, where MIDMO patients suffered from more oedema and recurrent metatarsalgia.[12] The IDMO technique mentioned in this report is similar to ours. In our series, all patients suffered from oedema for about 3 months which subsided gradually, and had no recurrent symptoms in an average of 18 months follow-up.

MIDMO has a few major advantages over the traditional open osteotomy with internal fixation. Firstly, it is a minimal invasive technique with tiny wounds. Soft tissue stripping is kept to a minimal degree to prevent disturbance of bone healing. Secondly, it is an extra-articular osteotomy at the metatarsal neck region resulting in less metatarsal–phalangeal joint stiffness and less disturbance of blood supply to the metatarsal head so that the risk of avascular necrosis is reduced. The orientation of oblique osteotomy allows proximal sliding at the osteotomy site, in addition to the 2-mm shortening created by the special designed burr. Thirdly, it does not require internal fixation and the associated implant complications including impingement, infection and implant displacement or breakage in the past could be avoided. Some suggested the use of bio-absorbable pin for fixation with good result,[13] but there was also one study showing no difference in the outcome with or without internal fixation after osteotomy.[14] Without any fixation device together with immediate weight bearing, it can mold the metatarsal heads' position according to the weight-bearing pattern of the patients. There is a good amount of trabecular bone for bone healing, so nonunion is not a common complication. However, the potential complications of MIDMO include wound infection, neurovascular injury, malunion especially medial–lateral translation, over-correction, nonunion, recurrent deformity; moreover, transfer metatarsalgia should be closely observed (although this did not occur in our cases).

We use the ACFAS score instead of the American Orthopaedic Foot and Ankle Society score because the former has a more detailed scoring of pain, taking the cosmetic outcomes and radiographic parameters into account.

The limitation of our study is the small sample size due to the strict indications of the surgery. It is difficult to conclude whether the decrease in metatarsal index and that in inter-metatarsal angle are statistically significant or not. A larger sample size is necessary for future study. In addition, no control group was used for comparison. However, we believe that this serves as a pilot study of the feasible treatment option for primary metatarsalgia.

Conclusion

MIDMO without internal fixation is a viable alternative to open procedure in the management of recalcitrant metatarsalgia, with the potential advantages of less surgical trauma and avoidance of implant complications. As it is a relatively new technique, further studies are necessary for evaluation.

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