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Results of Distal Metatarsal Osteotomy Using Absorbable Pin Fixation

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ABSTRACT

Background: **Metatarsalgia with plantar hyperkeratosis can be a difficult problem to treat. Many different techniques have been reported with the Weil osteotomy very popular currently. Despite good results complications include metatarsophalangeal stiffness, hyperextension of the toe, prehensile deficit and a reduction in strength. We evaluated our results with a distal diaphyseal osteotomy.** ***Materials and Methods:*** **From 1999 to 2005, we performed 66 distal midshaft subtraction osteotomies in 62 patients suffering from metatarsal overload without metatarsophalangeal subluxation. Fixation was obtained with an absorbable pin. Some patients underwent simultaneous corrective surgery for hallux valgus, hallux rigidus or lesser toe deformities. There was an average of 18 months followup.** ***Results:*** **The mean preoperative Maryland score was 52; the mean postoperative score was 86. Seventy-two percent of the patients were very satisfied and 28% felt their condition improved with only occasional pain (VAS 2 to 4). The only complications reported was a loss of correction due to breakage of the pins in three patients (two sustained trauma and the third began walking prematurely without a postoperative shoe).** ***Conclusion:*** **The good clinical results obtained and the low incidence of complications have encouraged us to use this technique to treat symptomatic metatarsal overload. Surgical accuracy, adherence to the postoperative regimen and, where necessary, adequate correction of the first ray were important factors for success.**

Level of Evidence:

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Key Words: Metatarsalgia; Metatarsal Osteotomy; Absorbable Fixation.

INTRODUCTION

Metatarsal overload of the lesser rays is a fairly common pathology. The clinical appearance includes pain over the metatarsal heads, which is exacerbated by weightbearing, accompanied by plantar hyperkeratosis. In the majority of cases the overload and resulting pain are caused by a morphological abnormality in the length or position of the metatarsal. This causes an incorrect stance, and alters the biomechanics of gait.[8,15,19,25] Metatarsalgia can be either primary or secondary. The most frequent causes of primary metatarsalgia are: an abnormal length of the metatarsal bone; hallux valgus which causes a transfer metatarsalgia to the lesser rays; or a fracture which has altered the position of the metatarsal. The most frequent causes of secondary metatarsalgia are a complication of surgery of the first ray, Freiberg's infraction, overload in pes cavus, or rheumatoid arthritis. The corrective surgery for this condition shortens and/or elevates the metatarsal, thus removing the overload from the head, and preserving the joint integrity.[6,10,14] It can be a more difficult operation than correction of the first ray, and either proximal, distal, or midshaft osteotomy techniques can be used.[18] Also various fixation methods can be applied: metal screws, plates and compression staples, and Kirschner wires. Some authors have proposed osteotomies without fixation. Recently, bio-absorbable materials have become popular as they are well tolerated by the body and have good mechanical characteristics.[9]

The purpose of this study was to present the results of a distal midshaft osteotomy using an absorbable intramedullary pin for overload metatarsalgia without metatarsophalangeal subluxation.

MATERIALS AND METHODS

From April 1999 to April 2005, we operated on 62 patients suffering from metatarsal pain combined with

Table 1: Patient data

Number of patients	62
Sex: male: female	4:58
Average age	55 (21–80)
Average Follow up	18 months (12–26)
Osteotomy 2nd metatarsal	47
Osteotomy 3rd metatarsal	13
Osteotomy 2nd+3rd metatarsal	3
Total osteotomies	66
Isolated procedure	30
Combined with correction of hallux valgus	34
Combined with correction of hallux rigidus	1
Combined with correction of claw external toes	1

plantar hyperkeratosis, without metatarsophalangeal subluxation, who had not responded to conservative treatment. The treatment consisted of a distal midshaft subtraction osteotomy. Our objective was to re-establish a correct metatarsal formula, according to the traditional definition of Viladot (second metatarsal greater than first metatarsal greater than third metatarsal greater than fourth metatarsal greater than fifth metatarsal).[24] Fixation was obtained by means of an absorbable intramedullary pin. All the patients had a painful plantar hyperkeratosis. Patients with rheumatoid arthritis and neurogenic pes cavus were excluded from the study. Sixty-six osteotomies were performed (Table 1): 47 of the second metatarsal, 13 of the third, and in three cases the second and third metatarsal were corrected simultaneously. Thirty-four patients underwent simultaneous corrective surgery for hallux valgus, one for hallux rigidus, and one interphalangeal arthrodesis for claw deformities of the third, fourth, and fifth toes.

Of the 62 patients, four were male and 58 female. The mean age was 55 (range, 21 to 80) years. All patients had preoperative weightbearing radiographs of both feet (Figure 1A), in two views and pedobarography. Using these results a preoperative plan was made to quantify the shortening of the metatarsal diaphysis.

The patients underwent periodic radiographic (1–3 to 12 months) and clinical followup (1–3 to 12–18 months). The average followup was 20 (range, 18 to 24) months. The results were evaluated using the University of Maryland 100-point scale preoperatively and postoperatively at 18 months. No patient was lost at followup. We used the Tornier (Stafford, TX) "broche" absorbable pin, which is a polymer made of L-lactic acid. This material keeps its form and stiffness for 3 to 4 months after being implanted. It is absorbed completely within about 18 to 24 months. It is cylindrical in shape, 2.5 mm in diameter and 7 cm long, with a pointed end. Its mechanical properties are excellent and its Young modulus is the same as bone.

Surgical technique

An intravenous antibiotic prophylaxis (2 gm cefazolin) was given 30 minutes before the operation, and then an epidural anesthesia was administered. The lower leg was exanguinated then a calf tourniquet was inflated (250mm Hg pressure). A 4-cm dorsal longitudinal incision was made centered over the third distal metatarsal. A single dorsal incision in the metatarsal space was made for those patients undergoing a simultaneous procedure on the adjacent two rays. The extensor tendons were retracted, exposing the bone. A distal meta-diaphyseal osteotomy was carried out following the preoperative plan (Figure 2A); the intramedullary canal was opened using a 2.7-mm drill. The absorbable pin was then manually inserted into the canal, firstly into the proximal segment and then into the distal (Figure 2, B and C). On average, the second metatarsal was shortened an average 4.5 mm (3.8 mm to 4.8 mm), and the third metatarsal by 3.5 mm (3.2 mm to 3.8 mm). Once the stability of the fixation had been checked, the tourniquet was deflated after an average 20 minutes. The skin was closed using interrupted stitches. A pressure bandage was applied.

Low molecule weight heparin was prescribed as antithrombotic prophylaxis, with the dosage according to the patient's body weight. This was continued for 35 days after the operation. Tramodol was administered to treat any postoperative pain.

All the patients were discharged on the first postoperative day, after the wound had been dressed. Weight-bearing was permitted immediately using a talus, heel weightbearing orthopaedic shoe, which had to be worn for 3 weeks. The first clinical check-up was after 7 days when the skin was inspected and the dressing changed. After 14 days the sutures were removed and the bandage was replaced. Weight-bearing with normal shoes was allowed after 3 weeks.

RESULTS

The University of Maryland 100-point scoring system showed the mean preoperative score was 52 (range, 35 to 68) points, and the mean score after 18 months was 86 (range, 71 to 100) points. Seventy-two percent of patients stated they were very satisfied with the operation and reported almost complete disappearance of symptoms, 28% felt their condition was much improved and complained of only occasional pain (VAS 2 to 4) which did not limit their daily activities. No patient was dissatisfied at followup. No postoperative difference was observed when comparing patients who had undergone combined surgery with those who had undergone an isolated correction of metatarsal overload. At followup, no patient had developed a transfer metatarsalgia due to excessive shortening of the metatarsal. The 3-month X-rays of all the patients showed complete

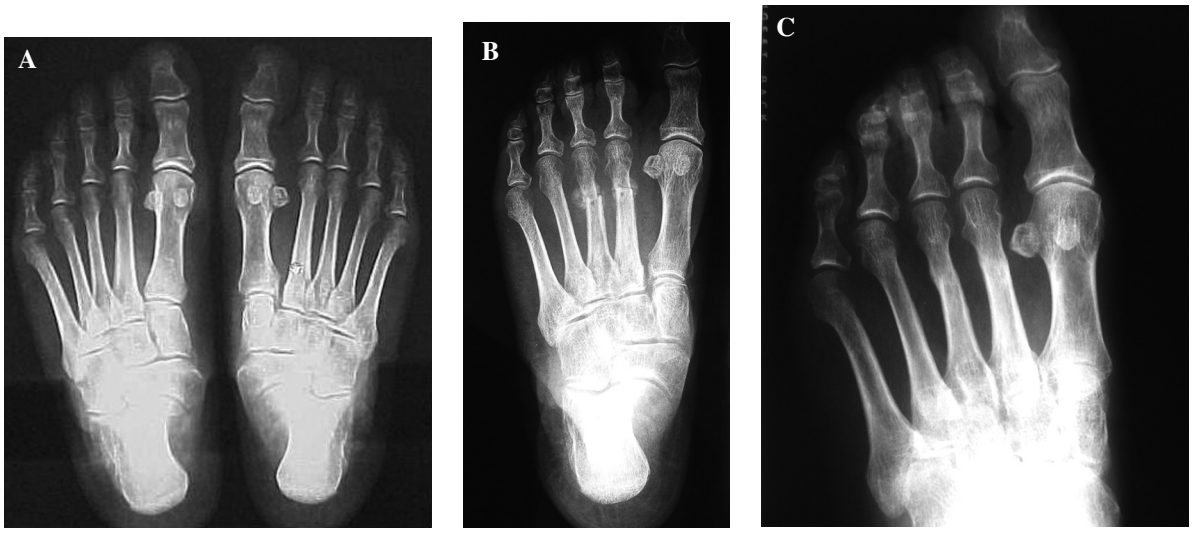

Fig. 1: **A**, Preoperative radiograph of a 62-year-old woman with metatarsalgia of the second and third ray of the right foot. **B**, Postoperative radiographs of the same woman after 3 months. **C**, Postoperative radiographs of the same woman after 6 months.

bone healing (Figure 1, B and C). There were no reports of either superficial or deep infection, nor any reports of metatarsophalangeal joint stiffness, or deep-vein thrombosis. We did not observe cases of bone marrow edema, which has been described.[1] The only short-term complication (within the first 3 weeks of the operation) was a loss of correction in three cases, due to breakage of the fixation pins. Of these three cases, two had sustained a trauma to the forefoot, while the third had begun walking prematurely without using the talus postoperative shoe. All three patients underwent a second operation to replace the pin within 10 days of breaking the original fixation. In all cases, bone healing, as verified clinically and radiographically, was completed within the standard time period.

DISCUSSION

Many different surgical techniques have been reported for the treatment of metatarsal overload. In 1916, Meisenbach reported on transverse midshaft osteotomies without fixation.[12] Some years later, Kelikian reported good results using metatarsal head resection associated with syndactyly for stability. DuVries proposed the condylectomy technique for treating plantar hyperkeratosis, while Giannestras reported a midshaft shortening osteotomy, fixated with cerclage wire.[4,5] In 1974, Thomas presented the advantages of a dorsal closing wedge osteotomy without fixation, while Schwartz et al. reported good results using a double osteotomy stabilized with Kirschner wire fixation.[17] Centrella has recently described excellent clinical results obtained using a distal midshaft osteotomy, and many surgeons including Beech, Trnka and O'Kane have reported their results using the Weil sliding distal osteotomy.[21,22] In the last few years it seems that a consensus has been reached on the necessity of maintaining the metatarsal head while only lifting and/or shortening the metatarsal.[2,3,7,20] Distal osteotomy is now the preferred technique as it provides a wider surgical exposure, which simplifies fixation and osteotomy.[11,16] In comparison, the proximal osteotomy is technically more difficult; the correction is more complex due to the narrow space of the tarsometatarsal joint. The diaphyseal osteotomy, while offering wider possibilities for correcting metatarsal deformities, is not particularly stable, and thus brings a greater risk of delayed bone healing. There are various methods used to perform both the osteotomy and the fixation. This paper describes our technique.

Over the last 10 years, the most common technique reported has been the Weil osteotomy, which realigns the metatarsal with a distal meta-epiphyseal cut parallel to the weight-bearing surface. The Weil technique uses a sliding, intra-articular osteotomy to shorten the metatarsal, which is stabilized with a vertical (dorsoplantar) pin or screw. We have had good clinical results using the Weil osteotomy, but this method has also brought complications. Of these complications, the most frequent are metatarsophalangeal stiffness, hyperextension of the toe, prehensile deficit and a reduction in strength.[13] The stiffness is probably due to the incision in the joint capsule and the resulting scarring. Hyperextension or floating toe occurs in about 30% of cases and causes a problem of the toe rubbing against the shoe with dorsal hyperkeratosis. In 2001, Trnka et al. proposed a biomechanical explanation of this phenomenon after carrying out an anatomical study on cadaveric specimens. The Weil osteotomy modifies the center of rotation of the metatarsophalangeal joint possibly changing the function of the interosseous muscles from extensors to plantarflexors.[23] There has also been criticism of the surgical technique as it can be difficult to achieve a correct osteotomy, as this must be completely parallel to the ground.

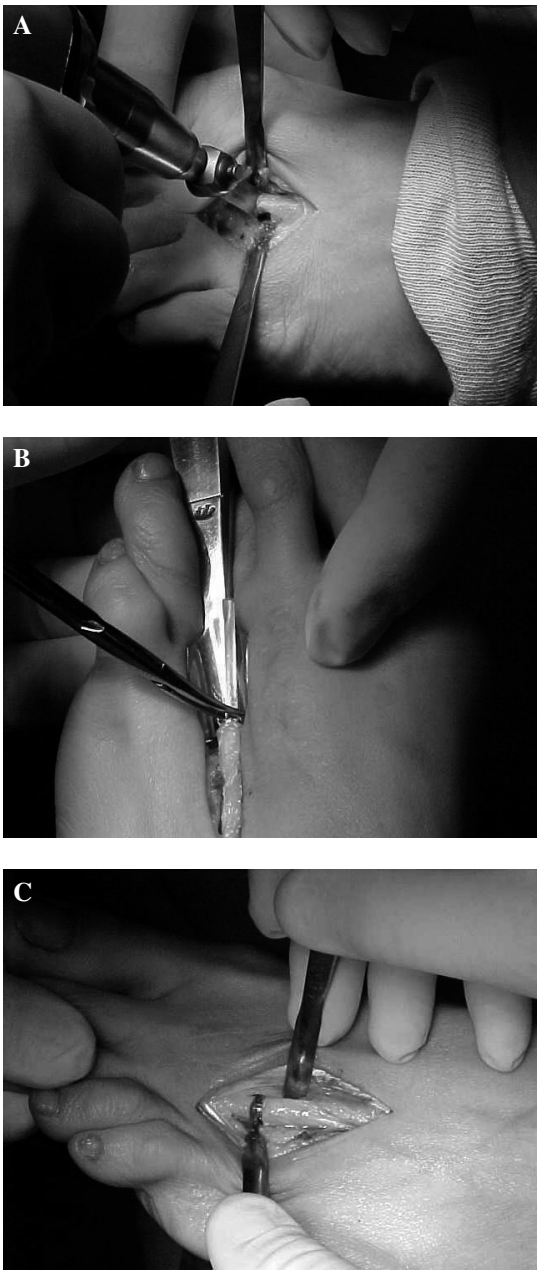

Fig. 2: **A**, Perpendicular osteotomy of the distal mid-shaft metatarsal. **B**, Insertion of the re-absorbable pin in the medullary canal of the metatarsal. **C**, Closing of the osteotomy site.

We chose the diaphyseal osteotomy as it is a simple technique to plan and carry out. It provides easy surgical access and successfully reduces the excess pressure on the metatarsal. We used an absorbable intramedullary pin as fixation because it allows early weight-bearing due to its good mechanical stability. We also believe that the similarity to the elasticity modulus of bone would help healing. The excellent results achieved in pain reduction and improved functionality were demonstrated by the increase in the post-operative score. In particular, there were no cases of transfer metatarsalgia secondary to the corrective procedure, which has been reported with varying incidence in other studies. We reported a low incidence of complications, related mainly to noncompliance. The loss of fixation reported in three cases (4.5%) was corrected swiftly with a second operation.

When comparing the diaphyseal osteotomy with the Weil technique, it is evident that there are many features in common: both techniques use a distal approach with a minimal incision; they both give flexibility for the amount of correction; the clinical results are comparably good; and both methods allow immediate weight-bearing using a postoperative shoe. The biomechanical philosophy behind the two methods is also the same: the overload is relieved by shortening the metatarsal. The main advantage of the diaphyseal over the Weil osteotomy is the absence of metatarsophalangeal stiffness which we believe is due to the extra-articular nature of the procedure. During followup, we have seen no cases of hyper-extension of the toe, nor prehensile deficit of the toes, nor a reduction in strength. We are convinced that an osteotomy performed perpendicular to the midshaft is easier to perform than that proposed by Weil. We also believe that absorbable fixation offers significant advantages over a metallic device: it is an elastic fixation that theoretically ensures swift bone healing while there is no need for a second operation to remove the fixation device. In this study, there were no cases of reaction to the device but it remains a theoretical concern.

In our series, metatarsal realignment has been frequently associated with hallux valgus correction. However, all the patients complained mainly of central metatarsal pain. In all cases, plantar hyperkeratosis and an altered metatarsal formula according to Viladot's description[24] were observed. Hallux valgus, when present, was primarily asymptomatic in almost all of the cases. We are aware of the difficulty to separate the individual role of each surgical procedure in obtaining the final result. However, we believe that the improvements observed were due primarily to re-establishing a correct metatarsal formula which led to the disappearance, in most of the cases, of the metatarsalgia and plantar hyperkeratosis, the primary complaint.

Based on our experience, we used this technique to treat symptomatic metatarsal overload because of the good clinical results, the reproducibility of the procedure, and the low incidence of complications. However, in order to obtain a good clinical result, we must emphasize the importance of surgical accuracy, compliance with the postoperative regimen, and, where necessary, an adequate correction of the first ray.

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