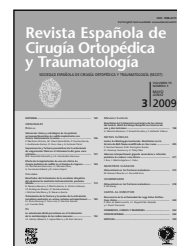




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ORIGINAL PAPERS

Distal percutaneous osteotomy in the treatment of lesser ray metatarsalgia

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KEYWORDS

Metatarsalgia;
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Abstract

Purpose: The purpose of this study is to evaluate the results of distal osteotomy of lesser metatarsals carried out through a percutaneous technique.

Materials and methods: Forty-four feet in 37 patients were reviewed, which the same surgeon had subjected to 110 percutaneous osteotomies between November 2002 and July, 2006. Metatarsalgias of general or traumatic origin were excluded from the study. All patients were assessed functionally (by means of the AOFAS [American Orthopaedic Foot and Ankle Society] Lesser Metatarsophalangeal-Interphalangeal Scale) and radiographically.

Results: After a mean 15-month follow-up, a satisfactory functional result was obtained in 93.2% of cases (41 feet), with a mean final score of 91 (range: 65-100) on the AOFAS scale. The condition recurred in 5 patients, and 2 developed transfer metatarsalgia (these required an osteotomy of the affected metatarsals). Mobility of the metatarsophalangeal (MTP) joint was not significantly disturbed in any of the cases and 7 patients developed a "floating toe" deformity. Radiologically a mean shortening of 2.9 mm was observed. There were 3 cases of delayed healing, but eventually healing was achieved by all patients.

Conclusion: Percutaneous osteotomy affords satisfactory clinical and cosmetic results and leads to no problems in terms of healing or MTP joint stiffness. These results indicate that it is an effective and safe surgical technique that can be recommended for lesser ray metatarsalgia, whether in association with other forefoot procedures or not.

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PALABRAS CLAVE

Metatarsalgia;
Cirugía percutánea;
Cirugía mínimamente
invasiva;
Osteotomía
percutánea;
Metatarsianos menores

La osteotomía distal percutánea en el tratamiento de la metatarsalgia de los radios menores

Resumen

Objetivo: El objetivo de este estudio fue evaluar los resultados de la osteotomía distal de los metatarsianos menores realizada mediante técnica percutánea.

Material y método: Se revisaron retrospectivamente 44 pies de 37 sujetos en los que un mismo cirujano había practicado 110 osteotomías percutáneas desde noviembre de 2002 hasta julio de 2006; se excluyeron previamente las metatarsalgias de origen general o de origen traumático. Todos los sujetos se valoraron radiográfica y funcionalmente (mediante la escala para metatarsianos menores e interfalángicas de la American Orthopaedic Foot and Ankle Society [AOFAS]).

Resultados: Tras un seguimiento medio de 15 meses, se obtuvo un resultado funcional satisfactorio en el 93,2% de los casos (41 pies) y se alcanzó una puntuación final media de 91 puntos (rango de 65 a 100) en la escala de la AOFAS. En 5 sujetos se apreció recidiva de la enfermedad y en 2 sujetos se apreció metatarsalgia de transferencia (que precisaron osteotomía de los metatarsianos afectados). La movilidad de la articulación metatarsifalángica (MTF) no se vio afectada de forma significativa en ningún caso, aunque en 7 casos se observó deformidad en dedo flotante*. Radiológicamente, se apreció un acortamiento promedio de 2,9 mm. Hubo 3 casos de retardo de consolidación, pero finalmente se consiguió en todos los sujetos.

Conclusiones: La osteotomía percutánea obtiene buenos resultados clínicos y estéticos sin presentar problemas de consolidación o rigidez de la MTF. Estos resultados permiten afirmar que es una técnica quirúrgica efectiva, segura y recomendable para las metatarsalgias de los radios menores asociada o no a otras cirugías del antepié.

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Introduction

Lesser ray metatarsalgia is a term used to denote a common condition of the forefoot. It can be the result of numerous diseases, but it is more frequently associated to mechanical forefoot alterations, such as hammertoe, first ray insufficiency or hallux valgus. It is characterized by plantar pain associated to persistent hyperkeratosis below the head of one or more metatarsals^{1,2}. When symptoms do not abate with conservative measures such as non-weight bearing or footwear modification it may require surgical treatment^{3,4}. Nonetheless, there is still certain controversy as to the optimal surgical technique to address this condition⁵⁻⁸. The purpose of this study was to analyze the results of distal lesser metatarsal osteotomy performed by means of a percutaneous technique.

Materials and methods

Retrospective review of 37 subjects (44 feet) of a mean age of 52 years (range: 39-74), 35 females (94%) and 2 males (6%), who had undergone 110 percutaneous osteotomies of the lesser metatarsals. All the procedures had been performed by the same surgeon from November 2002 to July 2006. Subjects in which metatarsalgia could be attributed to general or traumatic processes (diabetes, neuropathy, rheumatoid arthritis, gouty arthritis, metatarsal fracture) were excluded.

Four subjects had been subjected to previous operations in the forefoot as treatment for hallux valgus (2 Keller-

Brandes-type resection arthroplasties) or as treatment for metatarsalgia (a Goldfarb-type basal osteotomy and a Weil-type open distal osteotomy).

Twenty-four feet in the series (54.5%) presented with deformities associated to hallux valgus and 38 feet (86%) presented with deformities in the lesser rays (in 22 of these the deformity was isolated and in 16 it was associated to a hallux valgus deformity). In 3 cases, the deformity was an anteromedial pes cavus.

Preoperatively, 31 feet (70%) presented with an index minus-type metatarsal formula and 13 feet (30%) presented with an index plus minus-type formula. Prior to surgery, all subjects had been treated conservatively (footwear modification, insoles, etc.) for at least 6 months.

Most of the distal osteotomies of the lesser metatarsals (n=99) were performed on the central metatarsals (second, third and fourth metatarsals) whereas 11 distal osteotomies of the lesser metatarsals 10% were performed in isolation because the metatarsalgia was localized (3 of these in the fifth metatarsal).

For all subjects, associated diseases were addressed in the same surgical procedure. Among the surgeries performed with a conventional approach, there were 6 Scarf osteotomies (to treat severe hallux valgus deformities), one Chevron osteotomy (requested by the patient as she had had satisfactory results with this technique in the contralateral foot), one metatarsophalangeal (MTP) arthrodesis (to treat a case of severe hallux rigidus) and 3 basal osteotomies of the first metatarsal (to treat an anteromedial pes cavus). In terms of percutaneous surgeries,

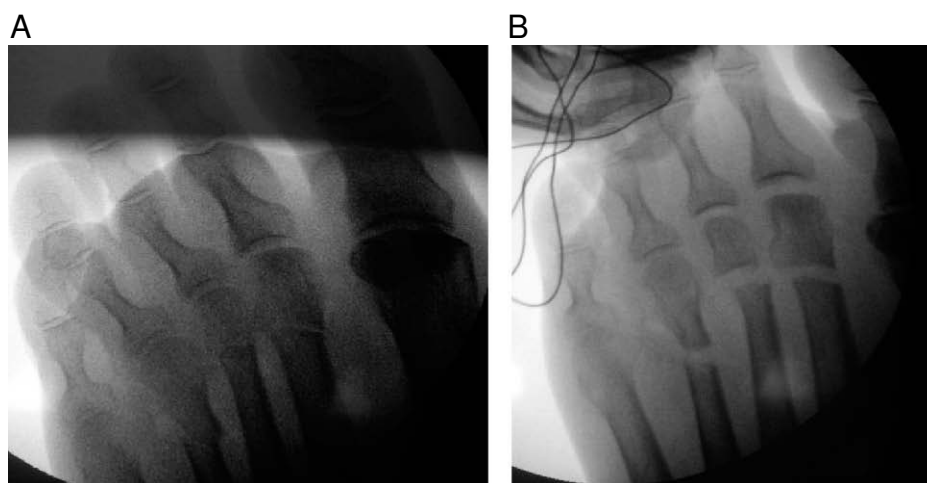


Figure 1 Radiologic control of the osteotomy (A,B). On the right (B) traction is applied on the toes; the fourth metatarsal osteotomy has been performed too proximally.

Table 1 Characteristics of the subjects with poor and fair results according to the lesser metatarsal score of the American Orthopaedic Foot and Ankle Society

| Age (years) | Associated deformities. Surgical history | Location | Score on AOFAS LMTS scale | Complication |
|-------------|--|--------------------------------------|---------------------------------|--|
| 41 | T2, T3 and T4: hammertoe | Second, third and fourth metatarsals | 80, fair | PSH |
| 48 | T4 and T5: clawtoe | Fourth metatarsal | 82, fair | Transfer to the third and fifth metatarsals |
| 57 | T3: hammertoe | Third metatarsal | 75, fair | "Floating toe", PSH |
| 40 | None | Fourth metatarsal | 77, fair | PSH, transfer to the third and fifth metatarsals |
| 55 | Clinodactyly. Keller-Brandes-type resection arthroplasties | Second, third and fourth metatarsals | 57, poor | Cellulitis, "floating toe", PSH |
| 62 | T2 & T3 hammertoe. Keller-Brandes-type resection arthroplasty | Second, third and fourth metatarsals | 62, poor | "Floating toe", PSH |

AOFAS: American Orthopaedic Foot and Ankle Society; T: toe; PSH: Persistent symptomatic hyperkeratosis. LMTS: Lesser Metatarsal Score.

there were 16 Revertin-Isham first metatarsal osteotomies (to treat moderate hallux valgus). Deformities of the lesser toes (27 hammertoes, 6 clawtoes and 5 cases of clinodactyly) were resolved with percutaneous surgery (extensor and flexor tenotomy and an osteotomy of the base of the proximal phalanx of the affected toe).

Surgical technique

All operations were carried out under regional anesthesia with popliteal nerve block, according to the technique described by De Prado⁹: through a minute dorsal incision made with a microscalpel located proximally to the interdigital web and at 45° with respect to the ground, contact is made with the dorsal aspect of the metatarsal

neck that needs to be osteotomized. The percutaneous surgery rasp is introduced to slightly denude the area under radiologic control. A Shannon burr is used to carry out the osteotomy, following a direction oblique to the dorsal plane and distal to the plantar and proximal planes; in all cases, progress is checked radiologically by applying traction on the toes (fig. 1). Subsequently, a suture stitch is placed where the burr was introduced, a metatarsal strap-type bandage is applied and full weight-bearing is immediately allowed with a flat-soled shoe.

Assessment of results

The same researcher assessed all subjects postoperatively. The evaluation included the application of the AOFAS

(American Orthopaedic Foot and Ankle Society) lesser metatarsal scores (LMTS)¹⁰. This scale assigns a maximum number of points to the following clinical parameters: pain (40 points), restrictions to activity (10 points), restrictions to MTP and IP joint mobility (15 point), special footwear requirements (10 points), MTP and IP joint stability (5 points), persistence of hyperkeratosis (5 points) and alignment (15 points). In addition to using this scale, subjects were asked if they would undergo another surgery of their foot and about their opinion on the final functional and cosmetic result.

For the x-ray assessment, weight-bearing dorsoplantar, oblique and lateral radiographs were performed. Here, the pre- and postoperative metatarsal formulas were considered as well as the presence of healing in the osteotomies and metatarsal shortening.

Given the size and the characteristics of our sample, it was decided not to perform a statistical analysis.

Results

Postoperatively, we diagnosed a case of cellulitis, which was cured by oral antibiotic treatment) and 6 cases (13%) of dysesthesia in the ipsilateral phalanx, which had resolved spontaneously by the end of follow-up).

Mean follow-up was months (range: 5-48). During follow-up 2 subjects (5%) were diagnosed with transfer metatarsalgia and 5 subjects (11%) with persistent symptomatic hyperkeratosis; all of them were treated by means of distal percutaneous osteotomy. Moreover, 7 subjects (16%) were diagnosed with "floating toe" deformity.

Mean final score obtained by the patients was 91 points (range: 65-100) on the AOFAS LMTS scale. In 31 cases these functional results were rated as excellent, in 7 cases as good, in 4 cases as fair and in 2 cases as poor. Unsatisfactory results (4 subjects with a "fair" score and 2 with a "poor" score on the AOFAS LMTS scale) can be explained by the presence of one or more non transient complications: persistent symptomatic hyperkeratosis, transfer metatarsalgia and "floating toe" deformity (table 1). The worst results corresponded to 2 of the 3 cases previously subjected to a Keller-Brandes procedure.

The forefeet of 29 subjects (67%) did not present with pain, 13 subjects (30%) only complained of slight occasional pain and only 2 subjects (4%) experimented daily moderate pain. However, none of the subjects had severe pain. Alignment was correct in all cases. From the activity standpoint, 6 feet (13%) limited recreational activities, while 17 feet (40%) required use of comfortable footwear or insoles. MTP joint mobility was moderately restricted (30°-74°) in 3 feet (7%) and there was no forefoot with a severe restriction (over 30°). Five subjects (11%) had persistent symptomatic hyperkeratosis.

From a subjective point of view, the majority of subjects (41 feet, 93.2% of cases) considered their result either excellent or good. All of them were satisfied with their cosmetic result and all would be willing to undergo the operation with the same technique and surgeon.

Radiological healing was achieved in all cases over a mean period of 8.8 weeks (range: 6-15); 6 feet (14%) healed in under 2 months, 35 feet (80%) consolidated over 2-3 months and only 3 feet (6%) required more than 3 months to heal (fig. 2).

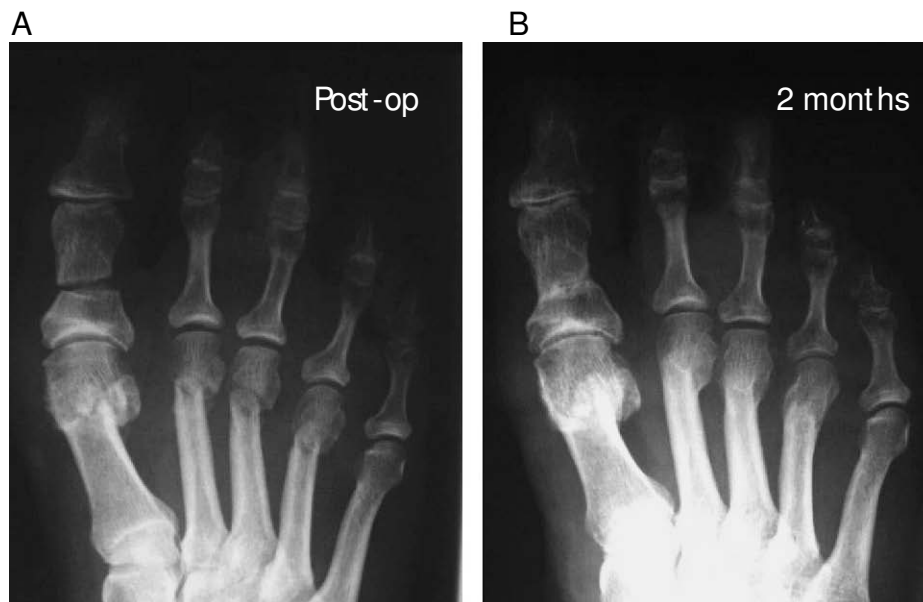


Figure 2 Healing of the multiple percutaneous osteotomies carried out (Akin and Reverdin-Isham osteotomies for the first ray and percutaneous distal osteotomies for the second to fourth metatarsals) (A) At 2 months' follow-up (B).

Mean final shortening was 2.9 mm (range: 0-12 mm). In the second metatarsals mean shortening was 3.4 mm; in the third metatarsals, 2.5 mm; in the fourth metatarsals, 2.8 mm, and in the fifth metatarsals, 2.6 mm. In 9 patients (20%) the metatarsal formula was converted to a more physiological model¹¹, from index minus to index plus minus (fig. 3).



Figure 3 Modification of the metatarsal formula from index minus to index plus minus. A) Pre-op. B) 2 months after the procedure.

Discussion

There are many therapeutic options for treating central ray metatarsalgia. The literature includes several options that have afforded good results with open surgery techniques such as Weil's osteotomy. In a study of 40 patients with a mean follow up of 2.3 years, Ruiz Ibán et al⁵ obtained good or excellent results in 87.5% of cases and reached a mean score of the AOFAS scale of 85 points. In a study of 24 subjects with a mean follow-up of 7 years, Hofstaetter et al¹² obtained good results in 88% of cases and reached a mean score of 83 points on the AOFAS scale. In the present study, percutaneous surgery made it possible to obtain good or excellent results in 86% of cases, a figure in line with the above mentioned series, with a mean score on the AOFAS LMTS scale of 91 points, higher than that reported in the series using conventional surgery^{5,12}. As regards subjects with lower scores on the AOFAS scale, the authors of the present article agree with García-Fernández¹³ that the technique performed in the first metatarsal influences the final result, since subjects subjected to a Keller-Brandes-type resection arthroplasty obtained the poorest results.

MTP joint stiffness persists one of the main problems observed in Weil's osteotomy which, according to some publications, can result in moderate mobility losses (from 30° to 74°) in up to 50% of patients¹⁴ and in severe stiffness (greater than 30°) in up to 33%¹⁵ of patients. In the series described herein, moderate motion losses were seen in only 3 feet (7%), with no cases of severe stiffness being observed.

Another usual problem in lesser ray surgery is the appearance of a "floating toe"¹⁵⁻¹⁸. In our series, it appeared in 16% of subjects, a figure lower than that of other Publications, which report an incidence of 20% to 33%^{5,17}. A review of the results presented herein shows that all patients with a "floating toe" were operated in the same

procedure given the deformity present in the lesser rays. Therefore, as other authors have said¹⁷, there would seem to exist a cause-effect relation between lesser ray surgery and "floating toe".

The main goal in the treatment of metatarsalgia is pain relief. Therefore, persistent symptomatic hyperkeratosis cannot be considered a failure of treatment (provided that it is painless). Migue et al and Hofstaetter et al^{12,17} reported painful hyperkeratosis in 16% and 12% respectively, of their subjects operated with a Weil osteotomy. In the series presented herein, painful hyperkeratosis persisted in 5 feet (11%), 3 of these with metatarsalgia located in the third or fourth metatarsals, which were operated by means of isolated osteotomy. The authors of this paper consider, following De Prado⁹, that osteotomies should be performed according to the criteria of Leventin's formula, i.e. osteotomies of the second to fourth metatarsals should be performed in metatarsalgias at the level of the third metatarsal and osteotomies of the third to fourth metatarsals should be performed in metatarsalgias at the level of the fourth metatarsal.

Similarly to other series^{7,15,17,18}, in the present series transfer metatarsalgias occurred following isolated fourth metatarsal osteotomy in 2 cases (5%); these transfers were resolved by means of percutaneous osteotomies on the third and fifth metatarsals. The low incidence of this problem can be explained by the fact that in the majority of subjects (90%) a simultaneous osteotomy of the 3 central metatarsals (second, third and fourth metatarsals) was performed, which means that transfer would occur –if at all– over the fifth metatarsal (this was resolved with a percutaneous technique). In the first years in which this technique was applied, when doctors were more conservative when deciding how many metatarsals would be osteotomized, a higher number of transfer metatarsalgias was detected.

There were 3 subjects who required 15-20 weeks to heal radiologically. Moreover, there were no cases of

pseudoarthrosis and revision surgery to obtain radiologic healing was unnecessary.

Mean metatarsal shortening in our series (2.8 mm) was less than the mean shortening obtained in other series in the literature^{9,12,17,18}; the design of the osteotomy used is chiefly aimed at achieving a controlled elevation of the metatarsal head. Such elevation harmonizes the position of the metatarsals on the sagittal plane, which is as important as achieving an ideal metatarsal formula on the dorsoplantar plane. Therefore, even if the metatarsal formula advocated by Maestro¹¹ is not generally achieved, the shortening obtained is compensated for by elevating the head. All of this is a result of the osteotomy line (from dorsal and distal to plantar and proximal).

Not all authors refer to the degree of cosmetic and subjective patient satisfaction in their results. Migueles et al report good or excellent subjective results in 35% of cases and good or excellent cosmetic results in 47% of subjects. Ruiz Ibañ et al report good or excellent results in terms of cosmetic satisfaction in 81.3% of subjects. In our series, the degree of cosmetic satisfaction was good in all subjects (even in those where the problem persists); as regards the degree of subjective satisfaction (93.2%), satisfaction exceeds that in the above mentioned series (in which open surgery was used^{5,17}).

Good clinical and cosmetic results can be obtained in patients with lesser ray metatarsalgia with percutaneous distal osteotomy. No problems have been observed related with healing or stiffness of the MTP Joint. Therefore this could be an effective, safe and recommendable procedure, which may or may not be associated to other open or percutaneous surgeries of the forefoot.

Conflict of interests

The authors have not received any financial support in the preparation of this article. Nor have they signed any agreement entitling them to receive benefits or fees from any commercial entity. Furthermore, no commercial entity has paid or will pay any sum to any foundation, educational institution or other non-profit-making organization to which they may be affiliated.

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