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ORIGINAL PAPER

Long-term results of the retrocapital metatarsal percutaneous osteotomy for hallux valgus

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Abstract
Purpose The current trend in hallux valgus surgery is directed toward percutaneous procedures. However, no evidence that any of these methods of treatment are superior to the others has been described, excepting studies in the long term. The aim of this study was to analyse a series of patients who had undergone a percutaneous distal retrocapital osteotomy of the first metatarsal, and had been followed up for ten years.
Methods We carried out a clinical and radiological evaluation of 115 feet ten years after surgery.
Results The AOFAS scale results in the tenth postoperative year remained significantly favourable compared to their corresponding values in the preoperative period, yielding an improvement of 42.2 points overall on average. In relation to radiological findings, the mean hallux angle was maintained below 20 °, with a mean intermetatarsal angle of 8.1 °.
Conclusion Percutaneous retrocapital metatarsal osteotomy for treatment of mild to moderate hallux valgus is effective in the long term, with the advantages of a minimally invasive procedure.

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Introduction

Over 130 different surgical techniques [1–4] to correct hallux valgus deformity have been proposed, although choosing the most appropriate treatment option continues to generate controversy [5–11]. The current trend is directed toward percutaneous procedures with the potential benefits of minimally invasive surgery [2], e.g. reduction of surgical exposure, decreased operative time, the possibility of performing the procedure bilaterally, the use of distal ankle-block anaesthetic techniques, and early weight-bearing. Distal metatarsal osteotomies performed percutaneously or by open surgery have been classically indicated for mild to moderate deformities with an intermetatarsal angle of up to 20° [12]; however, after a systematic review of the published literature, Ferrari et al. [13] concluded that there was no evidence that any of these methods of treatment was superior to the others, except for studies in the long term. The aim of our study was to analyse a series of patients who had undergone a percutaneous distal retrocapital osteotomy of the first metatarsal and had been followed up for ten years.

Materials and methods

We carried out a historical prospective study where we evaluated patients who underwent hallux valgus surgery in 2001 through percutaneous retrocapital osteotomy of the first metatarsal and met the following inclusion criteria: (1) all operations were performed by the same surgeon, (2) the medical history was complete, including preoperative data corresponding to the scale for hallux metatarsophalangeal-

Table 1 AOFAS scale for pain. Ten years after surgery

Pain	Score (points)	No. (%) of feet ($N = 115$)
None	40	88 (76.5 %)
Mild, occasional	30	19 (16.5 %)
Moderate	20	8 (6.9 %)
Severe, constant	0	0 (0 %)

Table 3 AOFAS scale for alignment of the hallux. Ten years after surgery

Alignment	Score (points)	No. (%) of feet ($N = 115$)
Excellent/good	15	101 (87.8 %)
Mild asymptomatic misalignment	8	12 (10.4 %)
Symptomatic misalignment	0	2 (1.7 %)

interphalangeal angles proposed by the American Orthopaedic Foot and Ankle Society (AOFAS) [14], (3) absence of previous surgery in the area affected, (4) hallux valgus angle of 20–40° and intermetatarsal angle up to 20°, (5) absence of diabetes mellitus, rheumatoid arthritis, peripheral vascular disease, peripheral neuropathy and metatarsophalangeal osteoarthritis, and (6) absence of re-operations in later years.

We initially collected 89 patients, but two were excluded because they needed surgery in the subsequent years, one for osteonecrosis of the first metatarsal head, the other for painful recurrence of the hallux deformity. Therefore the final study concerned 87 patients (115 operated feet), after obtaining informed consent from all of them and the approval of the Hospital Ethics Committee.

Initial treatment based on patient education, shoe modifications and orthotic devices over at least six months failed. The operation was performed using a minimally invasive technique, according to the method first described by Bösch [15], and ankle block anaesthesia. A skin incision less than one centimetre was made proximal to the metatarsal head; the plantar and dorsal periostium was detached using this minimal approach. The osteotomy was then performed through the subcapital region of the first metatarsal using a 2.2-mm diameter bone-cutter, perpendicularly to the longitudinal axis of the first metatarsal in the sagittal plane. We stabilised the osteotomy site by placing it in an extraperiosteal position with a 2-mm diameter Kirschner wire inserted from the medial edge of the base of the distal phalanx of the first toe. In this way, the alignment of the metatarsophalangeal joint was corrected with lateral displacement of the metatarsal head, and the Kirschner wire was introduced into the

Table 2 AOFAS scale for functional capacity. Ten years after surgery

Functional capability	Score (points)	No. (%) of feet ($N = 115$)
Activity limitation		
None	10	98 (85.2 %)
No limitation of daily activity, limitation of recreational activity	7	17 (14.8 %)
Limitation of daily and recreational activity	4	0 (0 %)
Severe limitation of all activity	0	0 (0 %)
Footwear		
Normal	10	93 (80.9 %)
Comfortable and/or insole	5	22 (19.1 %)
Orthopaedic	0	0 (0 %)
Metatarsophalangeal joint motion		
>75º	10	17 (14.8 %)
30–74º	5	82 (71.3 %)
<30º	0	16 (13.91 %)
Interphalangeal joint motion		
Normal	5	111 (96.5 %)
<10º	0	4 (3.5 %)
Joint stability		
Stable	5	115 (100 %)
Unstable	0	0 (0 %)
Callus		
None or asymptomatic	5	112 (97.4 %)
Symptomatic	0	3 (2.6 %)

Table 4 Overall results of the AOFAS scale: preoperative versus postoperative long term

Variable	Preoperative score (points) Mean (SD)	Score (points) ten years after surgery Mean (SD)	P value
Pain (0–40 points)	18.4 (6.1)	36.5 (5.2)	0.000*
Functional capability (0–45 points)	22.5 (5.4)	40.6 (3.9)	0.000*
Alignment (0–15 points)	6.2 (3.3)	12.2 (2.8)	0.000*
Total (0–100 points)	47.1 (7.2)	89.3 (7.4)	0.000*

* Statistically significant results: $p<0.05$

metatarsal shaft to reach its base in order to improve stabilisation.

No associated soft tissue procedures were performed. Postoperatively, functional taping was used in order to maintain a slight overcorrection; it was maintained for four weeks, after which the wire was also removed. Weight bearing was allowed from the first day after surgery, with appropriate footwear.

In 2011, as in the preoperative period, we conducted a clinical and radiological assessment:

1. Clinical evaluation by AOFAS Scale. Additionally, we evaluated the degree of satisfaction of each patient in the postoperative long-term (satisfied/not satisfied).
2. Radiological evaluation, which included anteroposterior and lateral forefoot loading views. We evaluated the hallux angle, intermetatarsal angle and distal metatarsal articular angle [16]. The extension of the lateral displacement of the capital fragment was expressed as the percentage of the transverse diameter of the osteotomy line. The position of the first metatarsal head in the sagittal plane relative to the shaft was defined as plantar, neutral or dorsal. The relative lengths of the first metatarsal and postoperative development of metatarsophalangeal osteoarthritis were also evaluated. Radiological outcome was considered "poor with recurrence" for a hallux angle greater than 20° [17].

Statistical analysis was performed with SPSS 12.0 software, using the Student's paired *T* test for comparison of means. Previously we had calculated the need for a sample size of 62 individuals in order to detect a difference of 20 % in the evaluated variables. In the descriptive analysis of the studied population, it was found that the mean age at time of surgery was 44.7 years (SD 9.6), with 86.2 % women (75 patients) and 13.8 % men (12 patients). The procedure was bilateral in 28 cases. All patients had pain due to footwear bunion preoperatively and in 42.6 % of the cases (49 feet) there was little pain under the metatarsal.

Results

The postoperative results made reference to a mean follow-up period of 10.1 years (SD 0.7). Favourable results were recorded in all sections of the AOFAS scale [14] in the postoperative long-term period (Tables 1, 2 and 3). In this sense the majority of patients were pain free or with minor and occasional pain (93 % of the interventions, 107 feet). The mean degree of functional capacity up to ten years after surgery was 40.6 points (SD 3.9) out of a maximum of 45 points. A level of excellent or good hallux alignment was obtained in 88 % of cases (101 feet). A clinical recurrence of hallux valgus with a symptomatic misalignment was recorded just three times (2.6% of the cases).

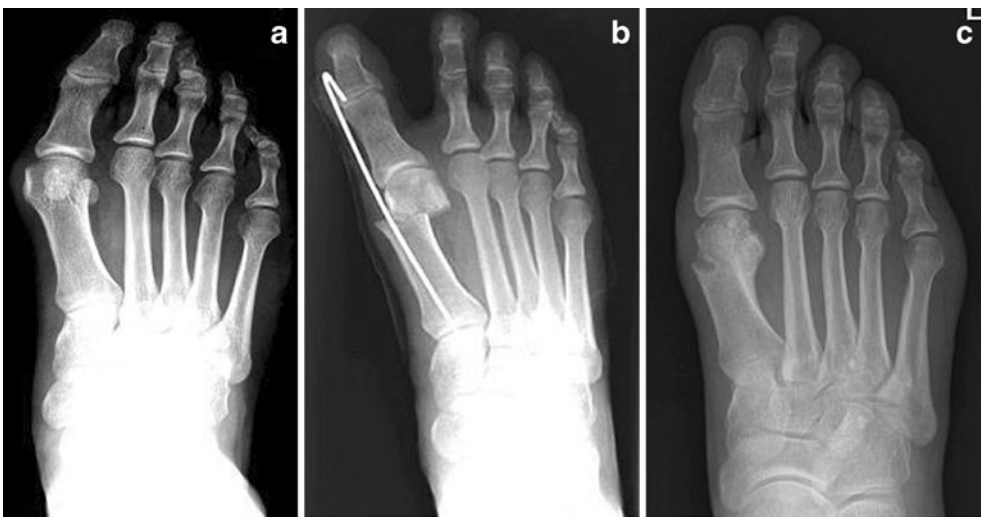

Fig. 1 Retrocapital percutaneous osteotomy. Preoperative (**a**), immediate postoperative period (**b**), tenth year postoperative (**c**)

Table 5 Radiological results: preoperative versus postoperative

Variable (degrees)	Preoperative period Mean (SD)	Ten years after surgery Mean (SD)	P value
Intermetatarsal angle	17.6 (2.3)	8.1 (3.2)	0.000*
Hallux valgus angle	34.2 (4.4)	14.6 (5.2)	0.000*
Distal metatarsal articular angle	15.4 (6.2)	7.2 (3.6)	0.000*

* Statistically significant results: $p<0.05$

The AOFAS scale [14] results in the tenth postoperative year remained significantly favourable compared to their corresponding values in the preoperative period, yielding an improvement of 42.2 points overall on average (Table 4). In relation to radiological findings (Fig. 1), the mean hallux angle was maintained below 20°, with a mean intermetatarsal angle of 8.1° (standard deviation 3.2) (Table 5). However, three patients presented a hallux angle value of 25°, 32° and 39°, indicating recurrence of deformity. We obtained a neutral position of the metatarsal head in 72 feet (62.6%), plantar deviation in 14 feet (12.2%) and dorsiflexion of the capital fragment in 29 cases (20.9%). However, in most of the cases the dorsal deviation of the metatarsal head was mild. Therefore, the patients affected only presented an occasional transfer metatarsalgia of the lesser metatarsals, which was managed conservatively. Only three patients (five feet, 4.3 %) needed surgical treatment for persistent metatarsalgia and a modified Weil osteotomy was performed in the affected metatarsals, with satisfactory results.

Osteoarthritic changes were observed in the metatarsophalangeal joint in 24 of the operated feet (20.9%). The average lateral displacement of the first metatarsal head was 29.4 % (SD 17.4). Relative shortness of the first metatarsal was recorded in 35.7% of cases (41 feet). All osteotomies consolidated well, with evidence of callus after a mean period of three months. The degree of patient satisfaction up to ten years after surgery was 92.2% (106 operated feet).

With regard to recorded complications, there were three superficial skin irritations as a result of the Kirschner wire (2.6%), two deep infections at the site of the osteotomy that were treated and resolved conservatively with intravenous antibiotics (1.7%), and 16 cases with limited mobility (less than 30°) of the metatarsophalangeal joint (13.9%). No cases of hallux varus were reported.

Discussion

Our results suggest that the percutaneous retrocapital osteotomy of the first metatarsal allows the long-term correction of mild to moderate hallux valgus deformity.

Absolute contraindications to this procedure are hallux rigidus with metatarsophalangeal stiffness and those feet with previous Keller-Brandes osteotomy [2].

Since the first descriptions of the techniques implemented by Bosch et al. [15] the outcomes of the surgical procedure considered in our study have been controversial. In a radiological review of postoperative outcomes in 13 patients, Kadaia et al. [18] concluded that percutaneous distal osteotomy of the first metatarsal presented unacceptable percentages of complications, particularly osteonecrosis, nonunion, delayed union and recurrence. These authors stated that the correction achieved intraoperatively was frequently lost after removal of the Kirschner wire, leading to a high rate of recurrence of the deformity, estimated at 38 % for a follow-up period of three months. In a similar study, Huang et al. [17], based on a sample of 82 patients with 18 months of follow-up until re-radiological evaluation, recommended against the use of this surgical technique for treatment of hallux valgus deformities of moderate–severe degree (angle hallux greater than 30°), and noted that the traditional open osteotomy, accompanied by a formal capsulorrhaphy, would be a better therapeutic option. On the other hand, Magnan et al. [2] demonstrated clinical and radiological success after studying 118 feet that underwent percutaneous retrocapital osteotomy of the first metatarsal (mean follow-up of 35 months), with a patient satisfaction rate of 91 %. The recurrence of the deformity was 2.5 %, the rate of metatarsophalangeal stiffness around 7 %, but it was not painful, and the infection rate was only 0.8 %. The authors considered the percentage of complications, clinical and radiological results comparable to those obtained with open surgery or minimally invasive techniques [19–21].

Similarly, Enan et al. [3] reported short-term results of percutaneous distal metatarsal osteotomy after studying 24 patients with a mean follow-up period of 21 months. The authors found this technique was effective, easy and safe for the correction of painful, mild to moderate hallux valgus deformity. In their series, there were no cases of nonunion, malunion, osteonecrosis or overcorrection. Valles-Figueroa et al. [22] also reported favourable clinical and radiological results with the studied technique, in the sixth postoperative month.

In our initial series of patients, we recorded a case of osteonecrosis of the first metatarsal head after retrocapital osteotomy, 12 months after the surgical procedure. Theoretically the percutaneous technique avoids the potential risks of this major complication, by preserving the metatarsophalangeal capsule [23]. Although it has been suggested that the lateral release increases the risk of necrosis [24, 25], it was not performed in the aforementioned case. Overall, we found a recurrence rate of deformity of 2.6% (four

patients, one of them before completing the follow-up period, as discussed in the "Materials and Methods"). The decreased mobility of the metatarsophalangeal joint to less than 30° found in 16 cases (13.9%) may relate to the failure of the rehabilitation program indicated after removal of the bandage, the maintenance of the Kirschner wire for four weeks, or the infections recorded in our study.

In summary, percutaneous retrocapital metatarsal osteotomy for treatment of mild-moderate hallux valgus is effective in the long term, with the advantages of a minimally invasive procedure.

Conflict of interest No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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