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ORIGINAL PAPER

Comparing proximal and distal metatarsal osteotomy for moderate to severe hallux valgus

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Abstract
Purpose This study compared results of distal and proximal metatarsal osteotomy for moderate to severe hallux valgus in terms of radiographic correction and functional outcome.
Methods We analyzed 125 moderate to severe hallux valgus surgeries. Patients were divided into two groups. Group 1 underwent distal metatarsal osteotomy, and group 2 underwent proximal metatarsal osteotomy. Patients were interviewed for functional scores before and one year after surgery. The anteroposterior (AP) weight-bearing radiography of the foot was taken before and one year after surgery.
Results There were no significant differences in pain and function after one year in either group. Both groups experienced significant pain reduction and increase in all functional scores. There was significant improvement of hallux valgus and intermetatarsal angle corrections in group 2. There was less improvement in radiographic correction in group 1.
Conclusion Either distal or proximal metatarsal osteotomy is an appropriate pain-relieving procedure and can increase functional outcome in moderate to severe hallux valgus. However, distal metatarsal osteotomy provides lower correction power.

Introduction

Hallux valgus surgery has been very common forefoot surgery for the past decade. It relieves pain from deformity, accommodates wearing shoes and prevents secondary complications [1–3] such as ingrown toe nail, abnormal gait, foot ulcers, hammer toes etc. Numerous techniques for hallux valgus (HV) surgery have been proposed and popularized, including proximal and distal metatarsal osteotomy (DMO). Distal metatarsal osteotomy [4] was highly popular in the early stages of HV surgery because of its simplicity, low invasiveness and lower complication rate. On the other hand, proximal metatarsal osteotomy gained popularity because of its better correction power; however, technically demanding techniques and potential complications are still a major barrier for this technique [4–6]. In general, proximal metatarsal osteotomy is always recommended for severe HV deformity, and DMO is always recommended for mild HV deformity [1, 4, 7]. However, many investigators have reported the use of these successful metatarsal osteotomies for HV deformity for many different indications. Robinson et al. [8], Saragas et al. [9] and Adam et al. [10] reported successful and differing proximal osteotomy techniques for moderate to severe HV. Bai et al. [11] reported a series of effective distal metatarsal osteotomies for 76 moderate to severe HV deformities, with a very low incidence of complications. On the other hand, Saro et al. [12] analyzed 100 patients with moderate to severe HV who underwent different techniques of distal metatarsal osteotomies and recommend the procedure only in patients with mild to moderate deformity. To our knowledge, the only investigation comparing distal and metatarsal osteotomy for moderate to severe HV is the Deenik et al. article [13], which reported no different results in a randomised comparison between distal and proximal osteotomy in hallux patients; however, their conclusion was limited by sample size, which leads to a lower power, and clinical outcome comparison. Their conclusion as to whether or not to perform distal or proximal metatarsal osteotomy in moderate to severe HV remains controversial. Therefore, further investigations are necessary to determine whether proximal or DMO is appropriate for moderate to severe HV.

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Materials and methods

All patients with symptomatic HV for which they underwent surgery between January 2002 and December 2010 were included in this study. They all received appropriate conservative treatment, including activity and shoe modification, stretching exercises and orthosis for at least six months and still had undesirable symptoms. Patients who had previous foot injury, foot surgery or mild deformity were excluded. Criteria to define moderate to severe HV were angle >40 ° or intermetatarsal angle >12 ° on anteroposterior (AP) radiography of the weight-bearing foot[1]. The choice of surgery was randomly selected by a blinded nurse at the outpatient clinic. All surgery was performed by two groups of experienced surgeons. One group performed only DMO and another group performed only proximal metatarsal osteotomy. We retrospectively collected patient data from the hospital medical record department with institutional review board (IRB) approval. American Orthopaedic Foot and Ankle Society (AOFAS) score [14], visual analogue scale (VAS) pain score, Roles and Maudsley (RM) pain score [15] and the 12-item Short Form Health Survey (SF-12) score [16], including physical (PCS) and mental (MCS) component scores, were recorded before surgery, six and 12 months after surgery and at the last clinic visit by a blinded research assistant. AP radiography of the weight-bearing foot before surgery and one year after surgery were analysed. Major parameters, including HV angle (HVA) [17], intermetatarsal angle (IMA) [17], distal metatarsal articular angle (DMAA) [17], medial sesamoid position [18] and metatarsophalangeal joint congruency were measured and recorded upon each radiography examination by a blinded orthopaedic surgeon who did not performed the surgery.

In the DMO group, equal-limb chevron osteotomy [1, 19] was performed and fixed with screws and/or Kirschner wire (depending upon bone quality). In the proximal metatarsal osteotomy (PMO) group, a modified Mau technique was used, as mentioned in the article reported by Sammarco et al. [20]. Distal soft-tissue release was also performed in both groups using a modified McBride technique [21] (without lateral sesamoidectomy). Both groups followed the same postoperative protocol, including non-weight bearing with a short-leg cast for six weeks, with early, gentle movement of the ankle and first metatarsophalangeal (MTP) joint three times per day starting two weeks after surgery. All patients returned for postoperative visits at two and six weeks, three and six months and every year thereafter.

Results

One hundred and twenty-five patients (131 feet) were included in this study; 113 patients were were women and 12 were men. Average age was 58.0±12 years old. Fifty patients (52 feet were allocated to the DMO group and 75 (79 feet) to the PMO group. General demographic data indicates no significant difference between groups (Table 1). No pre-operative radiographic parameters showed significant difference between groups (Table 2). All pre-operative functional and pain scores showed no difference between groups, except for the Role and Maudsley pain score and the SF-12 PCS score. The PMO group had minimally inferior result when compared with the DMO group (Table 2). Average follow-up was 29.27±12.5 months.

In the DMO group, average HVA improved from 40.23±6.3° to 21.54±9.6°, average IMA 18.02±3.5° to 11.17±4.2° and average DMAA from 9.23±5.3° to 14.40±8.6°. In the PMO group, average HVA improved from 40.38±6.8° to 11.09±7.3°, average IMA from 18.16±4.3° to 8.62±4.3° and average DMAA from 8.62±5.9° to 8.08±5.9°. All patients had pre-operative incongruity of the first MTP joint, except for three feet in the PMO group. Postoperative first MTP congruity was restored in 48 of 52 patients in the DMO group and in 50 of 79 in the PMO group. The average pre-operative medial sesamoid position was 6.12±0.9 in the DMO group and 6.13±1.1 in the PMO group. , and average postoperative medial sesamoid position was 4.73±1.2 in the DMO group and 3.14±1.9 in the PMO group.

In the DMO group, average AOFAS score improved from 59.44±6.3 to 71.92±6.6, average VAS score from 6.82±1.6 to 3.22±1.5, averaged RM score from 2.48±0.6 to 1.73±0.5, average SF-12 PCS from 45.33±4.4 to 48.53±4.6 and average SF-12 MCS from 56.34±9.1 to 57.87±6.8. In the PMO group, average AOFAS score improved from 57.99±11.3 to 82.96±9.0, average VAS score from 6.64±2.3 to 1.02±1.9, averaged RM score from 2.82±0.6 to 1.38±0.6, average SF-12 PCS from 42.78±8.7 to 50.21±7.5 and average SF-12 MCS from 53.84±10.8 to 61.17±3.6. In before and after surgery comparison, both DMO and PMO groups indicated significant improvement in all radiographic measurement parameters (Table 3). Furthermore, both groups had significant improvement in all recorded functional and pain scores (Table 4).

Table 1 Patient's demographic data

	DMO group	PMO group	*p*-value
Gender			
Male	5 (10.0 %)	7 (9.3 %)	0.999
Female	45 (90.0 %)	68 (90.7 %)	
Age (yrs.)			
Mean (SD)	60.16 (10.65)	56.95 (11.79)	0.124
Range	42–78	30–79	

DMO distal metatarsal osteotomy, *PMO* proximal metatarsal osteotomy

Table 2 Pre-operative radiographic parameters and functional scores between groups

	DMO group	PMO group	Mean difference	*P* value
Pre-operative				
HVA (°)	40.23 (6.29)	40.38 (6.80)	−0.15 (1.18)	0.900
IMA	18.02 (3.45)	18.16 (4.27)	−0.14(0.71)	0.838
DMAA	9.23 (5.28)	8.62 (5.87)	0.61 (1.01)	0.546
Joint congruency	1.00 (0)	1.04 (0.19)	−0.04(0.02)	0.083
Sesamoid position	6.12 (0.94)	6.13 (1.13)	−0.01 (0.18)	0.951
AOFAS score (0–100)	59.44 (6.31)	57.99 (11.31)	1.45(1.60)	0.365
VAS score (0–10)	6.82 (1.59)	6.64 (2.30)	0.18(0.38)	0.648
Maudsley (0–4)	2.48 (0.64)	2.82 (0.64)	−0.34 (0.12)	0.005[a]
SF12-PCS	45.33 (4.38)	42.78 (8.69)	2.55(1.20)	0.036[a]
SF12-MCS	56.34 (9.14)	53.84 (10.82)	2.50 (1.80)	0.168

HVA hallux valgus angle, *IMA* intermetatarsal angle, *DMAA* distal metatarsal articular angle, *AOFAS* American Orthopaedic Foot and Ankle Society, *VAS* visual analogue scale, *SF12-PCS* 12-item Short Form Health Survey physical component score , *SF12-MCS* 12-Item Short Form Health Survey mental component score, *DMO* distal metatarsal osteotomy, *PMO* proximal metatarsal osteotomy

[a] $p<0.05$

Discussion

HV surgery is a proven intervention that improves pain and functional ability in a patient who is not response to conservative treatment [4, 22]. Moderate to severe HV deformity usually has more symptoms and usually requires more complex surgery, such as combination osteotomy [23–26]. From the literature review, proximal metatarsal osteotomy has been chosen as a major operation for moderate to severe HV, due to its superior power of correction; however, potential barriers are complicated surgical technique, longer incision, longer operating time and higher sequential complications when compared with DMO [4, 25, 27]. On the other hand, DMO has been popularized in some regions of the world because it is easier, requires a shorter incision, has fewer complications and improves pain and functional ability in a wider range of deformities [4, 28, 29]. In general, DMO is recommended for mild to moderate HV [4, 29]. However, there are some studies recommended DMO in moderate to severe HV also [11, 13].

Table 3 Pre- and and postoperative comparison of radiographic parameters

	Pre-operative	Postoperative	Mean difference	*P* value
HVA (°)				
DMO group	40.23 (6.29)	21.54 (9.63)	18.69 (11.35)	<0.001[a]
PMO group	40.38 (6.80)	11.09 (7.27)	29.29 (9.68)	<0.001[a]
IMA				
DMO group	18.02 (3.45)	11.17 (4.22)	6.85 (4.55)	<0.001[a]
PMO group	18.16 (4.27)	8.62 (4.26)	9.54 (3.95)	<0.001[a]
DMAA				
DMO group	9.23 (5.28)	14.40 (8.56)	−5.17 (9.07)	<0.001[a]
PMO group	8.62 (5.87)	8.08 (5.86)	0.54 (7.72)	0.533
Joint congruency				
DMO group	1.00 (0)	1.92 (0.27)	−0.92 (0.27)	<0.001[a]
PMO group	1.04 (0.19)	1.59 (0.49)	−0.55(0.50)	<0.001[a]
Sesamoid position				
DMO group	6.12 (0.94)	4.73 (1.21)	1.39 (1.17)	<0.001[a]
PMO group	6.13 (1.13)	3.14 (1.86)	2.99(1.88)	<0.001[a]

HVA hallux valgus angle, *IMA* intermetatarsal angle, *DMO* distal metatarsal osteotomy, *PMO* proximal metatarsal osteotomy, *DMAA* distal metatarsal articular angle

[a] $P<0.05$

Table 4 Pre- and postoperative comparison of functional scores

	Pre-operative	Postoperative	Mean difference	*P* value
AOFAS score (0–100)				
DMO group	59.44 (6.31)	71.92 (6.64)	−12.48 (7.85)	<0.001[a]
PMO group	57.99 (11.31)	82.96 (8.99)	−24.97 (12.29)	<0.001[a]
VAS score (0–10)				
DMO group	6.82 (1.59)	3.22 (1.45)	3.60 (1.31)	<0.001[a]
PMO group	6.64 (2.30)	1.02 (1.89)	5.62(2.79)	<0.001[a]
Maudsley score(0–4)				
DMO group	2.48 (0.64)	1.73 (0.53)	0.75 (0.59)	<0.001[a]
PMO group	2.82 (0.64)	1.38 (0.62)	1.44 (0.75)	<0.001[a]
SF12-MCS				
DMO group	56.34 (9.14)	57.87 (6.81)	−1.53 (2.99)	0.001[a]
PMO group	53.84 (10.82)	61.17 (3.61)	−7.33(9.70)	<0.001[a]

AOFAS American Orthopaedic Foot and Ankle Society, *DMO* distal metatarsal osteotomy, *PMO* proximal metatarsal osteotomy, *VAS* visual analogue scale, *SF12-PCS* 12-item Short Form Health Survey physical component score ,

[a] $p<0.05$

Our study supports results of effective pain relief and increased functional ability in moderate to severe HV patients who underwent either PMO or DMO. Inclusively, our clinical results also are good for DMO. Many factors influence this superior result, such as patient age, intensive pre- and postoperative patient education and close postoperative follow-up. Our patients tended to be older when compared with patients in many studies [11, 30], and functional ability in younger patients is therefore generally less than mild to moderate deformity. This would be a major factor preventing our patients from using their foot aggressively.

In terms of deformity correction, both types of surgery provide significant deformity correction, but it is less in DMO. A recurrence of HV deformity is also reported in the literature. Many confounding factors are involved with this complication, including inadequate soft-tissue release, inadequate sesamoid reduction, abnormal shape of the metatarsal head, inappropriate postoperative protocol and inadequate intermetatarsal angle correction[1, 18, 31]. A cut-off point determining whether the amount of deformity correction is

appropriate has not yet been identified. Our group of patients was followed up for an average of 29 months. We may conclude that DMO is an effective option for relieving pain and improving function in moderate to severe HV, without recurrence of deformity, in short- to moderate-term follow-up. However, long-term follow up still needs to be investigated. Therefore, a DMO for a young patient who has moderate to severe deformity still needs to be reserved until a long-term study is conducted.

Our study provides improved information comparing PMO and DMO for moderate to severe HV in terms of adequate number of patients, random patient selection, blinded data collection and analysis. It is the only study that collected all pain and functional scores and all deformity parameters. However, it still has a limitation, which is the lack of long-term clinical and radiographic follow-up.

This investigation supports a protocol that recommends PMO as a major surgical choice for moderate to severe HV. However, DMO is still has benefits for moderate to severe HV in inactive or aging patients who have only pain relief and improved functional ability as a goal.

Conclusion

Either distal or proximal metatarsal osteotomy is an appropriate pain-relieving procedure that can increase functional outcome in moderate to severe HV. However, DMO provides lower power of correction, which may or may not increase risk of recurrence.

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