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Original Research

Is Double Metatarsal Osteotomy Superior to Proximal Chevron Osteotomy in Treatment of Hallux Valgus With Increased Distal Metatarsal Articular Angle?

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A R T I C L E I N F O

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A B S T R A C T

We compared the results of proximal chevron osteotomy and double metatarsal osteotomy for hallux valgus with an increased distal metatarsal articular angle (DMAA). From October 2008 to December 2012, first metatarsal osteotomies were performed in 64 patients (69 feet) with symptomatic hallux valgus associated with an increased DMAA. Proximal chevron with Akin osteotomy and lateral soft tissue release was performed in 46 feet (PCO group); double metatarsal osteotomy and Akin osteotomy without lateral soft tissue release was performed in 23 feet (DMO group). Clinical assessments were performed using the American Orthopaedic Foot and Ankle Society (AOFAS) scale and visual analog scale (VAS). The hallux valgus angles, intermetatarsal angles, sesamoid positions, metatarsus adductus angles, and DMAAs were compared at different postoperative times. Postoperative shortening of first the metatarsal and complications were compared. The mean AOFAS scale and VAS scores showed significant improvement in both groups after surgery; however, no significant difference was observed between the 2 groups. The immediate postoperative hallux valgus angle and sesamoid position were significantly larger in DMO group; however, no intergroup difference was observed at the last follow-up visit, with the hallux valgus angle gradually increasing in the PCO group. The postoperative DMAA was significantly smaller in the DMO group. The mean shortening of the first metatarsal after surgery was significantly larger in the DMO group than in the PCO group. Transfer metatarsalgia developed in 1 foot (2.2%) in the PCO group and 2 feet (8.7%) in the DMO group. Partial avascular necrosis of the metatarsal head with advanced arthritis of the first metatarsophalangeal joint developed in 1 foot (4.3%) in the DMO group. In conclusion, no differences in the clinical and radiographic results were observed between the 2 groups for hallux valgus deformity with an increased DMAA.

Inadequate correction of the distal metatarsal articular angle (DMAA) can result in recurrence of hallux valgus (1–3). Several surgical techniques, such as distal chevron osteotomy with Akin osteotomy (4,5), uniplanar chevron osteotomy (6), biplanar chevron osteotomy (3,7), and double metatarsal osteotomy (2,8,9), have been used for correction of the DMAA. Of these, biplanar chevron osteotomy is a straightforward procedure for DMAA correction; however, because biplanar chevron osteotomy results in a relatively small intermetatarsal angle correction, it is only indicated for mild to moderate deformity (3). Proximal metatarsal osteotomy has been widely used for moderate to severe hallux valgus deformity (10–21), and the Akin osteotomy can be added for correction of residual hallux valgus or pronation deformity. However, the DMAA can increase after proximal metatarsal osteotomy, because the technique is primarily based on angulation of the metatarsal. Therefore, several investigators have used double metatarsal osteotomy of the first ray to treat moderate to severe hallux valgus deformity with an increased DMAA (1,2,8,9). However, this technique presents the theoretical risk of avascular necrosis (AVN) of the metatarsal head and transfer metatarsalgia due to shortening of the first metatarsal.

Most previous reports of double metatarsal osteotomy have addressed adolescent hallux valgus with a congruent joint; thus, these investigators had not performed simultaneous lateral soft tissue release (2,8,9,22). In contrast, lateral soft tissue release is commonly performed in adult hallux valgus, because the metatarsophalangeal joint

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is incongruent. However, double metatarsal osteotomy combined with soft tissue release might not be preferable because lateral soft tissue release could jeopardize the blood supply to the metatarsal head. Therefore, double metatarsal osteotomy might be less effective at reducing the sesamoid position, which is one of the causes of recurrence, compared with proximal chevron osteotomy with lateral soft tissue release. Recently, Park et al (23) reported that double metatarsal osteotomy without lateral soft tissue release to treat adult hallux valgus deformity resulted in high postoperative recurrence and complication rates. However, to the best of our knowledge, no previous study has compared the results of proximal chevron and double metatarsal osteotomies for hallux valgus deformity with an increased DMAA.

We hypothesized that double metatarsal osteotomy would show better clinical and radiographic results than proximal chevron osteotomy to treat hallux valgus deformity with an increased DMAA. The purpose of the present study was to compare the results after double metatarsal osteotomy and proximal chevron osteotomy for hallux valgus deformity with an increased DMAA.

Table 2
Patient characteristics at baseline (N = 69 feet in 64 patients)

Characteristic	PCO Group (n = 46 feet)	DMO Group (n = 23 feet)	*p* Value
Female gender (%)	97.8	95.7	.612
Age (y)	51.6 ± 9.7	51.3 ± 7.9	.631
Follow-up period (mo)	30.2 ± 7.9	26.8 ± 4.6	.122
Preoperative AOFAS scale score	49.4 ± 6.3	51.6 ± 6.0	.133
Preoperative VAS score	6.3 ± 1.1	7.1 ± 1.2	.105
Preoperative dorsiflexion of first MTP joint (°)	60.3 ± 4.6	62.5 ± 5.2	.302
Preoperative plantarflexion of first MTP joint (°)	40.2 ± 6.9	41.5 ± 7.2	.198
Preoperative HVA (°)	38.7 ± 9.8	40.6 ± 5.6	.389
Preoperative IMA (°)	15.2 ± 2.5	15.4 ± 2.5	.857
Preoperative sesamoid position	6.7 ± 0.7	6.9 ± 0.5	.199
Preoperative DMAA (°)	20.1 ± 2.3	21.6 ± 4.0	.181
Preoperative MAA (°)	18.7 ± 5.3	19.4 ± 6.8	.709

Data presented as mean ± standard deviation, unless noted otherwise.
Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society; HVA, hallux valgus angle; IMA, intermetatarsal angle; DMAA, distal metatarsal articular angle; DMO, double metatarsal osteotomy; MAA, metatarsus adductus angle; MTP, metatarsophalangeal; PCO, proximal chevron osteotomy; VAS, visual analog scale.

Patients and Methods

Patient Selection

The institutional review board of our hospital approved the present study. We performed a retrospective analysis of the outcomes after proximal chevron and double metatarsal osteotomy to treat hallux valgus deformity with an increased DMAA. A first metatarsal osteotomy was performed in 70 patients (76 feet) with symptomatic hallux valgus associated with an increased DMAA (≥15°) by a single surgeon (W.-C.L.) from October 2008 to December 2012. The inclusion and exclusion criteria are listed in Table 1. Of the 70 patients, 4 (5 feet) were lost to follow-up and 2 (2 feet) were excluded owing to the absence of the medial sesamoid bone. Thus, the study cohort comprised 64 patients (69 feet). The first 43 patients (46 feet) were intentionally treated using proximal chevron osteotomy and Akin osteotomy with lateral soft tissue release (PCO group), regardless of age, gender, or deformity severity. The latter 21 patients (23 feet) were intentionally treated using double metatarsal osteotomy and Akin osteotomy without lateral soft tissue release (DMO group). All patients, except for 2 (2 feet) were female. The mean patient age was 51.6 ± 9.7 years in the PCO group and 51.3 ± 7.9 years in the DMO group. The mean follow-up duration was 30.2 ± 7.9 months in the PCO group and 26.8 ± 4.6 months in the DMO group. Gender, age, and follow-up duration were not different between the 2 groups. The demographic data for both groups are listed in Table 2.

Clinical Evaluation

The scores from the hallux metatarsophalangeal interphalangeal scale developed by the American Orthopaedic Foot and Ankle Society (AOFAS) (24) and a visual analog scale (VAS) were evaluated preoperatively and at the last follow-up visit. The range of motion of the first metatarsophalangeal (MTP) joint was passively measured using a goniometer preoperatively and at the last follow-up visit and compared between the 2 groups. Postoperative complications, including AVN, transfer metatarsalgia, and malunion, were documented by review of the medical records.

Radiographic Evaluation

Radiographs were taken using the same facility and the same technique. Nonweightbearing dorsoplantar radiographs of the foot were taken immediately postoperatively and at 6 weeks after surgery. Weightbearing dorsoplantar radiographs of the foot were taken preoperatively, at 3, 6, and 12 months after surgery, and at the last follow-up visit. Radiographic measurements were conducted by 1 observer (C.H.P.) independently of the operative team.

Table 1
Inclusion and exclusion criteria

Criteria
Inclusion
First metatarsal osteotomy by a single surgeon
Symptomatic hallux valgus associated with increased DMAA (≥15°)
Primary hallux valgus surgery
Exclusion
Absence of medial sesamoid bone
Rheumatoid arthritis
Hallux rigidus
Failed previous hallux valgus surgery

Abbreviation: DMAA, distal metatarsal articular angle.

Changes in the hallux valgus angle, intermetatarsal angle, and sesamoid position during the follow-up period were analyzed by comparing the values measured preoperatively, immediate postoperatively, at 6 weeks postoperatively, at 3, 6, and 12 months postoperatively, and at the last follow-up visit in both groups. The DMAA was measured preoperatively and at the last follow-up visit. The preoperative metatarsus adductus angle was measured and compared between the 2 groups to determine whether a difference was present in the factors affecting the postoperative recurrence of hallux valgus. The relative length of the first metatarsal versus the second metatarsal was calculated as described by Hardy and Clapham (25) preoperatively and at the last follow-up visit, and changes in the first metatarsal length were compared between 2 groups.

The hallux valgus angle was defined as the angle between the longitudinal axis of the first metatarsal and the proximal phalanx. The intermetatarsal angle was defined as the angle between the longitudinal axis of the first and second metatarsals. The longitudinal axis of the first metatarsal was defined as the line connecting the center of the proximal articular surface of the first metatarsal to the center of the first metatarsal head (26). The longitudinal axis of the proximal phalanx and the second metatarsal was defined as the line connecting the centers of the proximal and distal ends of the diaphysis (26). The sesamoid position was defined as the position of the medial sesamoid in relation to the longitudinal axis of the first metatarsal and was graded from 1 to 7, as described by Hardy and Clapham (25).

For the DMAA measurement, 2 points were placed at the most medial and most lateral extent of the metatarsal articular surface, and a line was drawn connecting these points. Another line was drawn perpendicular to this line. The DMAA was defined as the angle between the perpendicular line and the longitudinal axis of the first metatarsal (Fig. 1A) (10). The metatarsus adductus angle was measured from the position of the lesser metatarsus relative to the midfoot (27). Lines connecting the most distal medial point of the first cuneiform and the proximal point of the navicular and the proximal and distal lateral points of the cuboid were drawn. A third line connecting the midpoint of these first 2 lines was drawn. A fourth line was drawn perpendicular to the third line. The metatarsus adductus angle was defined as the angle between the fourth line and the longitudinal axis of the second metatarsal (Fig. 1B).

Surgical Technique

The procedures were performed with the patient under spinal anesthesia in the supine position. The leg was exsanguinated with an elastic bandage, and a tourniquet was applied to the thigh.

The surgical techniques of proximal chevron and double metatarsal osteotomies have been previously reported in detail (10,23). For the proximal chevron osteotomy, a 7-cm medial incision was made along the inferior margin of the first metatarsal. Lateral soft tissue release combined with proximal metatarsal osteotomy was performed through this incision. The apex of the chevron was placed proximally and 7 mm distally to the first metatarsocuneiform joint. The angle of each arm of the chevron with respect to the metatarsal axis was 30°. After correcting the intermetatarsal angle by translation and angulation at the osteotomy site, stabilization was achieved using 2 or 3 Kirschner wires (Fig. 2A).

The procedures used for double metatarsal osteotomy before distal uniplanar metatarsal osteotomy were the same as those described for proximal chevron osteotomy,