FOOT AND ANKLE

A comparison of proximal and distal Chevron osteotomy, both with lateral soft-tissue release, for moderate to severe hallux valgus in patients undergoing simultaneous bilateral correction

A PROSPECTIVE RANDOMISED CONTROLLED TRIAL

Moderate to severe hallux valgus is conventionally treated by proximal metatarsal osteotomy. Several recent studies have shown that the indications for distal metatarsal osteotomy with a distal soft-tissue procedure could be extended to include moderate to severe hallux valgus.

The purpose of this prospective randomised controlled trial was to compare the outcome of proximal and distal Chevron osteotomy in patients undergoing simultaneous bilateral correction of moderate to severe hallux valgus.

The original study cohort consisted of 50 female patients (100 feet). Of these, four (8 feet) were excluded for lack of adequate follow-up, leaving 46 female patients (92 feet) in the study. The mean age of the patients was 53.8 years (30.1 to 62.1) and the mean duration of follow-up 40.2 months (24.1 to 80.5). After randomisation, patients underwent a proximal Chevron osteotomy on one foot and a distal Chevron osteotomy on the other.

At follow-up, the American Orthopedic Foot and Ankle Society (AOFAS) hallux metatarsophalangeal interphalangeal (MTP-IP) score, patient satisfaction, post-operative complications, hallux valgus angle, first-second intermetatarsal angle, and tibial sesamoid position were similar in each group. Both procedures gave similar good clinical and radiological outcomes.

This study suggests that distal Chevron osteotomy with a distal soft-tissue procedure is as effective and reliable a means of correcting moderate to severe hallux valgus as proximal Chevron osteotomy with a distal soft-tissue procedure.

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Hallux valgus is reported to be the most common pathological condition affecting the great toe: its prevalence increases with advancing age.1,2 Numerous surgical techniques for correcting hallux valgus have been proposed. However, the selection of the most appropriate procedure is crucial to achieving an adequate result and durable correction of the deformity.6-8

Distal metatarsal osteotomy is popular due to its simplicity, low invasiveness, lower complication rate, and shorter rehabilitation period.7,9-11 It has mostly been used for mild to moderate hallux valgus because it can only correct lesser degrees of deformity.12-14 By contrast, proximal metatarsal osteotomy is recommended for moderate to severe hallux valgus; however, it is a technically more demanding procedure than distal metatarsal osteotomy with a longer incision, longer operation time, and higher rate of complications.6,7,15 Several recent studies have shown that the indications for distal Chevron osteotomy with a distal soft-tissue procedure could be extended to include moderate to severe deformity.6,15-17 These studies show that distal Chevron osteotomy can achieve a greater degree of correction by the addition of a distal soft-tissue procedure.16,18 Although these studies have shown that this produces an outcome comparable with that of proximal Chevron osteotomy, most were performed retrospectively in a heterogeneous group of patients.6,16,18,19

We therefore designed the present study to compare the outcomes of the two techniques in patients undergoing simultaneous bilateral correction, thereby compensating for the variability introduced by differences in gender, age, body mass index, comorbidity, bone quality, and activity level.
We hypothesised that the outcome from distal Chevron osteotomy with a distal soft-tissue procedure would be comparable with, and as satisfactory as, that of a proximal Chevron osteotomy.

The purpose of this study was, therefore, to compare the clinical and radiological outcomes of proximal and distal Chevron osteotomy, both with lateral soft-tissue release, in patients with moderate to severe hallux valgus who were undergoing simultaneous bilateral correction. No previous study has addressed this.

Patients and Methods
This study was approved by the institutional review board of our hospital, and informed consent was obtained from all patients.

Between May 2005 and December 2009, 50 female patients (100 feet) underwent simultaneous bilateral correction. No previous failed hallux valgus who were undergoing simultaneous bilateral correction. No previous study has addressed this.

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shaft to obtain a stable reduction. We took great care to avoid damage to the blood supply to the metatarsal head and metaphysis. The osteotomy was then fixed with two medially placed 1.4 mm K-wires, passed from medial to lateral. The small shelf of bone left after displacement of the metatarsal head was removed.15,16,18

The distal soft-tissue procedure was carefully performed using a dorsal first web space approach. The adductor hallucis tendon was released from its attachments at the base of the proximal phalanx and the fibular sesamoid, the fibular sesamoid-metatarsal ligament was detached, the transverse metatarsal ligament divided, and the lateral first metatarsophalangeal joint capsule perforated with several puncture wounds. The hallux was then reduced into a neutral position and the tension of the medial capsule checked to confirm congruency of the metatarsophalangeal joint. The plantar flap of the medial capsule was pulled dorsally to reposition the sesamoid, and the medial capsule closed longitudinally after excising its redundant edges.

Post-operatively, a gauze dressing was applied, taking care not to pronate the toe or to force it into varus. After surgery, patients were allowed to walk using a post-operative shoe and bearing weight on the heel and outer aspect of the foot. Early active and passive metatarsophalangeal stretching exercises were encouraged. The dressing was changed weekly for two weeks, at which time the sutures were removed. An elastic bandage was used to hold the corrected toe position for a further two weeks. The K-wires were usually removed in outpatients six to eight weeks after surgery, after which patients were allowed to wear a soft shoe.

The American Orthopedic Foot and Ankle Society (AOFAS) hallux metatarsophalangeal interphalangeal score (MTP-IP)20 was administered pre-operatively and at the time of final follow-up. The 100-point AOFAS scoring system combines subjective and objective data to evaluate clinical parameters: pain (40 points); function (45 points) and alignment (15 points). To evaluate subjective patient satisfaction with the procedure, we asked the patients for their subjective response. Responses were graded as: “very satisfied”, “satisfied”, “improved”, or “dissatisfied”.21,22

We also noted any post-operative complications, including first metatarsophalangeal joint stiffness (defined as a range of movement < 30°); displacement after fixation (defined as movement of the capital fragment from its original site); a short hallux (defined as > 2.5 mm of metatarsal shortening); delayed union or nonunion (defined as successful healing not occurring within six months); deep infection (defined as purulent discharge from the wound with abnormal blood indices); avascular necrosis (defined radiologically as the presence of crescent-shaped subchondral luencies, cysts, bony collapse, fragmentation, and joint space narrowing), or first metatarsophalangeal joint arthritis (defined as joint space narrowing).23-25

Weight-bearing anteroposterior (AP) and lateral radiographs of the foot were taken pre-operatively and at final follow-up to measure the hallux valgus angle, first-second intermetatarsal angle, tibial sesamoid position, first metatarsal length and sagittal alignment of the first metatarsal. All radiological measurements were measured accurately using the Picture Archiving and Communication System (PACS version 5.4; Marotech, Seoul, Korea). The hallux valgus angle was defined as the angle formed by the intersection of the longitudinal axis of the proximal phalanx and that of the first metatarsal, which was determined by connecting the centres of the first metatarsal head and the centre of the proximal articular surface.26 The first-second intermetatarsal angle was obtained by determining the angle formed by a line bisecting the second metatarsal shaft and a line drawn between the centre of the first metatarsal head and the centre of the proximal articular surface (Fig. 2).16,27 The position of the sesamoids was defined by the position of the medial sesamoid in relation to a longitudinal line bisecting the first metatarsal shaft and was classified as grade 0, 1, 2, or 3.28 First metatarsal length was measured
The alignment of the head of the first metatarsal in the sagittal plane in relation to the shaft of the first metatarsal was defined as being in neutral, dorsal, or plantar angulation.

Clinical and radiological assessments were undertaken pre-operatively and post-operatively at three, six, and 12 months, and annually thereafter. All follow-up assessments were performed by independent blinded assessors with no direct involvement in the surgical procedures.

Statistical analysis. The sample size estimate was based on the AOFAS score, which was the primary outcome variable in the present study. A minimum of 35 patients were needed per group to ensure 80% power based on a ten-point (standard deviation (SD) 15 points) minimal clinically important difference between the groups. We recruited approximately 10% more patients to account for possible dropouts. Additionally, a post-hoc analysis showed that the sample size was sufficiently large to compare clinical and radiological outcomes.

The independent t-test was used to determine the significance of intergroup differences in age and follow-up duration. The Mann–Whitney U test was used to determine the significance of intergroup differences in the AOFAS scores, hallux valgus angle, first-second intermetatarsal angle, and tibial sesamoid position. The paired t-test was used to assess the intragroup differences of clinical and radiological results before and after surgery. Pearson’s chi-squared test was performed to determine the significance of intergroup differences for the prevalence of complications. Significance was defined at p-value < 0.05.

Results
Pre-operative and post-operative AOFAS scores for both groups are shown in Table I. The AOFAS scores of Groups P and D at final follow-up were not significantly different (Mann–Whitney U test, p = 0.818). The results of the survey of patient satisfaction at final follow-up were as follows: In Group P, 25 patients (54.3%) were very satisfied; 18 (39.1%) were satisfied; and three (6.5%) were dissatisfied. In Group D, 27 patients (58.7%) were very satisfied; 17 (37.0%) were satisfied; and two (4.3%) were dissatisfied with the results of their operation.

Overall, 43/46 (93.5%) patients in Group P and 44/46 patients (95.7%) in Group D were “very satisfied” or “satisfied” with the results of their operation. Two patients in each group were classified as “dissatisfied” because of

| Table I. Comparison of clinical outcomes between proximal and distal Chevron osteotomies* |
|---------------------------------|------------------|------------------|---------|
| Mean (sd) AOFAS score           | Proximal Chevron | Distal Chevron   | p-value |
| Pre-operative score             | 55.2 (13.3)      | 55.7 (13.6)      | 0.560   |
| Pain subscale                   | 23.3 (4.9)       | 23.2 (6.4)       | 0.801   |
| Function subscale               | 29.7 (6.4)       | 30.6 (6.1)       | 0.476   |
| Alignment subscale              | 2.1 (3.6)        | 1.9 (3.5)        | 0.767   |
| Final follow-up score           | 91.7 (8.8)       | 91.8 (8.0)       | 0.818   |
| Pain subscale                   | 36.7 (6.0)       | 37.1 (5.1)       | 0.470   |
| Function subscale               | 40.3 (4.0)       | 40.7 (3.9)       | 0.705   |
| Alignment subscale              | 14.7 (1.7)       | 14.2 (2.5)       | 0.288   |
| p-value‡                        | < 0.001          | < 0.001          |         |

* Values are expressed as the mean and the standard deviation
† Mann-Whitney U test for comparison between groups
‡ Paired t-test for comparison between preoperative and final follow-up total American Orthopaedic Foot & Ankle Society score. Significance was accepted for p-values of < 0.05

| Table II. Comparison of radiographic outcomes between proximal and distal Chevron osteotomies* |
|---------------------------------|------------------|------------------|---------|
| Mean (sd) radiographic outcome  | Proximal Chevron | Distal Chevron   | p-value |
| Hallux valgus angle (°)         |                  |                  |         |
| Pre-operative                   | 37.0 (7.6)       | 34.3 (7.6)       | 0.096   |
| Final follow-up                 | 13.3 (5.8)       | 11.3 (5.6)       | 0.391   |
| p-value‡                        | <0.001           | <0.001           |         |
| Intermetatarsal angle (°)       |                  |                  |         |
| Pre-operative                   | 16.7 (2.6)       | 16.2 (2.7)       | 0.415   |
| Final follow-up                 | 7.2 (2.2)        | 7.6 (2.0)        | 0.256   |
| p-value‡                        | < 0.001          | < 0.001          |         |
| Tibial sesamoid position (grade 0 to 3) |    |                  |         |
| Pre-operative                   | 2.8 (0.4)        | 2.7 (0.5)        | 0.122   |
| Final follow-up                 | 1.5 (0.5)        | 1.5 (0.6)        | 0.477   |
| p-value‡                        | <0.001           | <0.001           |         |

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persistent bunion pain and a symptomatic hallux valgus. One patient in Group P was dissatisfied due to a painful plantar callosity under the second metatarsal head and numbness of the medial aspect of the hallux.

Pre-operative and post-operative radiological results of the two groups are shown in Table II. Significant improvements in the hallux valgus angle, the first-second intermetatarsal angle, and the position of the medial sesamoid were seen at final follow-up in each group. No significant differences between the two groups were observed for the mean values of the hallux valgus angle (p = 0.391), intermetatarsal angle (p = 0.256), or sesamoid position (p = 0.477) at final follow-up. The mean first metatarsal shortening was 2.2 ± 1.5 mm (0 to 3.2) in Group P and 2.4 ± 1.3 mm (0 to 4) in Group D at final follow-up.

No patient complained of having a short hallux. At final follow-up, a neutral position of the first metatarsal head was seen in 43/46 (93.5%) feet in Group P, dorsal angulation of the first metatarsal head was seen in one foot (2.2%) and plantar flexion of the first metatarsal head in two feet (4.3%). A neutral position of the first metatarsal head in the sagittal plane was seen in 42/46 (91.3%) feet in Group D, dorsal angulation in two feet (4.3%) and plantar flexion in two feet (4.3%). No patient complained of dorsal or plantar angulation.

A total of 11 complications occurred, six (13%) in Group P and five (10.8%) in Group D (chi-squared test, p = 0.89). In Group P, there were three patients with recurrent asymptomatic hallux valgus and one patient each with numbness along the medial side of the great toe, persistent bunion pain and superficial wound infection. In Group D, there were three patients with first metatarsophalangeal joint stiffness and one each with persistent bunion pain and recurrent asymptomatic hallux valgus. There were no cases of displacement after fixation, nonunion, deep infection, avascular necrosis, or first metatarsophalangeal joint arthrosis in either group at final follow-up.

Discussion

A proximal metatarsal osteotomy has long been considered the mainstay of treatment for more severe hallux valgus even though more recent trials of treating moderate to severe hallux valgus using a distally-based metatarsal osteotomy have shown satisfactory results.

This is the first prospective randomised controlled trial of simultaneous bilateral hallux valgus correction to use two different techniques, a proximal or distal Chevron osteotomy with distal soft-tissue procedure. Its most important finding is that distal Chevron osteotomy with a distal soft-tissue procedure can be used to treat more severe deformity. Several investigators have reported various types of osteotomy for moderate to severe hallux valgus. Our study revealed excellent outcomes compared with these previous reports. However, the strength of our study is that the outcome comparison for simultaneous bilateral hallux valgus correction was designed to compensate for the variability introduced by differences in age, gender, body mass index, comorbidity, bone quality, and activity level.

A proximally-based metatarsal osteotomy is the treatment of choice for more severe hallux valgus, and our results also suggest that a proximal Chevron osteotomy allows more correction than a distal osteotomy. However, no significant difference was seen in the clinical or radiological outcome of the two procedures and several surgical modifications of the traditional distal Chevron osteotomy increased the amount of correction. First, we were able to translate the head fragment laterally by 6 to 9 mm although most surgeons still consider 2 to 5 mm or one-third of the metatarsal width at the osteotomy site to be the maximum possible degree of translation. Second, the distal soft-tissue procedure played a supplementary role in correction of the deformity which remained after osteotomy. Third, reefing of the medial capsular helps to realign the position of the sesamoids and restore pronation of the hallux even though this cannot be addressed by the distal Chevron osteotomy. Last, a thorough post-operative hallux valgus dressing and patient education anecdotally appeared to help with deformity correction in this study.

A recurrent hallux valgus deformity was the most common complication in both groups. Several factors contribute to this, including inadequate soft-tissue release; inadequate sesamoid reduction; abnormal shape of the metatarsal head; and inappropriate post-operative protocol and inadequate correction of the intermetatarsal angle. Four cases of recurrent hallux valgus in that study showed that the sesamoid remained incompletely reduced; those cases also had inadequate correction of intermetatarsal angle. This suggests that both of these factors are of importance in preventing the recurrence of a hallux valgus deformity.

Metatarsophalangeal joint stiffness was the most common complication in Group D. It may have been the result of the three concomitant procedures undertaken around metatarsophalangeal joint, the distal soft-tissue release, the greater displacement of the head fragment, and the medial capsular repair. Consequently, early post-operative active and passive range of movement exercises should be encouraged to prevent metatarsophalangeal joint stiffness in the distal Chevron group.

We did not experience any catastrophic complication such as avascular necrosis of the metatarsal head, although some studies have reported this with distal Chevron osteotomy. To prevent this we try to preserve the blood supply to the metatarsal head by avoiding stripping the soft tissues proximal to the capsular attachment, using the power saw carefully to prevent thermal damage and excessive penetration of the lateral aspect of the metatarsal head, and carrying out a meticulous lateral soft-tissue release.

There are some limitations to this study. First, the follow-up period was relatively short. Second, we used the AOFAS score as the main clinical outcome measurement to evaluate patient satisfaction and the cosmetic result of the procedure.
- this scale may not be valid and reliable. Finally, the subjective outcomes may have been influenced by the patients comparing one foot with the other.

In conclusion, the clinical and radiological outcomes of proximal and distal Chevron osteotomy for moderate to severe hallux valgus are comparable. Accordingly, this study suggests that distal Chevron osteotomy with a distal soft-tissue procedure is an effective and reliable way of correcting moderate to severe hallux valgus as a proximal Chevron osteotomy with a distal soft-tissue release.

References


