

A Simple Method for Fixation of Proximal Opening-Wedge Osteotomy of the First Metatarsal for Correction of Hallux Valgus

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Abstract: A simple, inexpensive technique for fixation of proximal opening-wedge osteotomy of the first metatarsal for correction of moderate or severe hallux valgus (HV) is described. After the opening-wedge osteotomy and bone grafting of the first metatarsal have been performed, 2 Kirschner wires are introduced for internal fixation and removed 8 weeks postoperatively. Twenty-three patients with symptomatic HV who had a proximal medial opening-wedge osteotomy of the first metatarsal in combination with a distal soft tissue procedure and bunionectomy were evaluated retrospectively. All osteotomies healed without complications and satisfaction was achieved in 22 patients. Hallux varus developed in 1 patient. Preoperatively, mean HV angle (HVA) was 41° (range, 35°-61°) and mean 1-2 intermetatarsal angle (IMA) was 19° (range, 16°-24°). Postoperatively, mean HVA was 14° (range, 10°-17°) and mean 1-2 IMA was 7° (range, 5°-9°). The mean decrease in the HVA was 27° ($P<.001$) and the mean decrease in the 1-2 IMA was 12° ($P<.001$). [*Orthopedics*. 201x; xx(x):xxxx-xxxx.]

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More than 150 different techniques and more than 100 first metatarsal osteotomy procedures have been described for the surgical treatment of hallux valgus (HV) because of the need to address various anatomic forefoot peculiarities. Although proximal first metatarsal osteotomies are common, the proximal opening-wedge osteotomy, first described in 1923,¹ has become less popular, probably due to its challenging internal fixation fraught with problems with displacement or loss of initial correction.²⁻⁴ However, there are significant advantages of proximal opening-wedge osteotomy of the first metatarsal. When metatarsus primus varus is present in conjunction with a congenitally shorter first metatarsal, proximal opening-wedge osteotomy of the first metatarsal would prevent further shortening. Shortening of the first metatarsal may cause new problems, such as transfer metatarsalgia, in up to 28% of patients.^{4,5}

In recent years, with the advent of opening-wedge plates designed exclusively for this surgical technique, there has been renewed interest in this procedure. Opening-wedge plates have helped solve the problems of secondary displacement or loss of initial correction with their considerably rigid fixation features. These plates incorporate a spacer that is positioned on the medial side of the metatarsal to mechanically block the osteotomy at the requested angular correction, and they have gained popularity due to their mechanical superiority.⁶⁻⁸ However, these implants are not problem free.^{2,4,8-12}

The authors propose a simple, inexpensive method for fixation of proximal opening-wedge osteotomy of the first metatarsal for correction of HV.

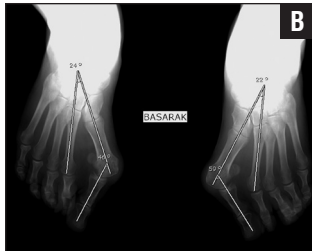


Figure 1: Preoperative clinical appearance of a 47-year-old woman with severe hallux valgus (A). Full weight-bearing radiographs of the feet showing severe hallux valgus with incongruent metatarsophalangeal joints and pronated halluces. The hallux valgus angle was 46°. The 1-2 intermetatarsal angle was 24° on the right foot and 59° and 22° on the left foot (B).

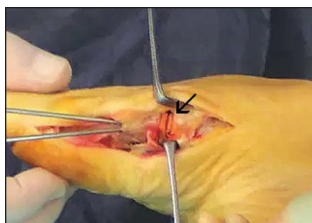


Figure 3: The opening in the osteotomy was filled with bone graft (arrow). Two Kirschner wires were introduced beginning from the first metatarsal shaft and passing through the opened-up osteotomy site and metatarsal base into the tarsal bones.

INDICATIONS

In patients with symptomatic moderate or severe HV (HV angle [HVA] greater than 30°, with normal being less than 15°) and metatarsus primus varus (1-2 intermetatarsal angle [IMA] exceeding 13°, with normal being less than 9°) in the weight-bearing position,² a proximal medial opening-wedge osteotomy of the first metatarsal for reduction of the IMA in combination with a distal soft tissue procedure

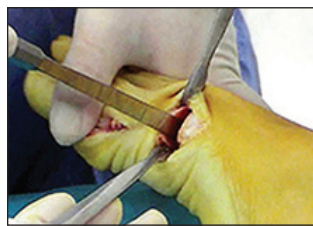


Figure 2: The osteotomy was gradually opened using an osteotome, leading to a greenstick fracture of the lateral cortex.



Figure 4: Clinical appearance at 8 weeks postoperatively, just before Kirschner wire removal (A). Weight-bearing radiograph of the right foot. The hallux valgus angle was 7°. The 1-2 intermetatarsal angle was 8° (B).

mal medial opening-wedge osteotomy of the first metatarsal for reduction of the IMA in combination with a distal soft tissue procedure

and bunionectomy was performed (Figure 1).

The absolute and relative contraindications to this procedure were instability at the first metatarsocuneiform (MTC) joint, severe osteoarthritis of the metatarsophalangeal (MTP) joint, a long first metatarsal compared with the second metatarsal,¹³ MTP joint stiffness, severe osteoporosis, and a large distal metatarsal articular angle (DMAA). As this is a rotational osteotomy, in patients with a large DMAA (normal being 6° or less of lateral deviation), rotation would further increase the DMAA, resulting in incongruence of the joint and subluxation.² In patients with a large DMAA, a double osteotomy incorporating a distal medial closing-wedge metatarsal osteotomy of the first metatarsal may be needed to correct the DMAA.²

SURGICAL TECHNIQUE

A distal soft tissue release of the contracted lateral joint structures (adductor hallucis tendon, lateral joint capsule, and transverse metatarsal ligament) was performed through a dorsal incision in the first web space. Capsulotomy of the first MTP joint and bunionectomy were performed through a medial incision. Then, using either a 1-cm medial incision over the proximal first metatarsal or a longer incision reaching the first MTC joint in small feet, an osteotomy was performed perpendicular to the axis of the metatarsal 1 cm distal to the MTC joint, with care taken to avoid transecting superficial

nerves. Periosteal stripping of the metatarsal was kept to a minimum so as not to compromise bone healing. The lateral cortex was spared when possible and the osteotomy was then gradually opened using a spreader device or an osteotome, leading to a greenstick fracture of the lateral cortex (Figure 2). The size of wedge needed to correct the deformity was checked and reduction of the IMA was confirmed under fluoroscopy. An average of 3° of correction usually corresponds to 1 mm of opening of the osteotomy.⁴ Utmost attention was paid not to create a sagittal plane deformity, such as dorsiflexion of the distal fragment, during the opening of the osteotomy. Bone graft obtained from the medial eminence previously resected was used to fill the opening in the osteotomy. Then, two 1.6-mm Kirschner wires were introduced beginning from the metatarsal shaft and passing through the opened-up osteotomy site and metatarsal base into the tarsal bones (Figure 3). Kirschner wires were placed subcutaneously. A medial capsulorrhaphy was performed, holding the hallux in a neutral position while repairing the capsule. Weight bearing was allowed immediately postoperatively with patients wearing a hard-soled shoe that permits weight bearing on the heel and lateral foot. Kirschner wires were removed 8 weeks postoperatively under local infiltration anesthesia after radiographic control for bony union (Figure 4).

MATERIALS AND METHODS

Thirty-eight feet of 28 consecutive patients with HV who underwent a proximal medial opening-wedge osteotomy of the first metatarsal in combination with a distal soft tissue procedure and bunionectomy were evaluated retrospectively. Patients who had had additional procedures such as a Reverdin (a distal medial closing-wedge osteotomy of the first metatarsal) or an Akin (a medial closing-wedge osteotomy of the proximal phalanx) osteotomy were excluded. All osteotomies were fixed with the abovementioned technique using 2 Kirschner wires.

Five patients (8 feet) were lost to follow-up. The study included 30 feet of 23 patients (22 women and 1 man). Mean patient age at the time of surgery was 41 years (range, 33-73 years). Mean follow-up was 5 years (range, 4-7 years).

Preoperative radiographic criteria that were evaluated included HVA, 1-2 IMA, DMAA, and the length of the first metatarsal compared with the second metatarsal. Patients were asked to rate their satisfaction with the surgery as very satisfied, satisfied, or not satisfied.

Results were evaluated with the paired *t* test using the PASW Statistics 18 statistical software package (SPSS Inc, Chicago, Illinois). *P* values of less than .05 were considered statistically significant.

RESULTS

All osteotomies healed without additional intervention. Compared with the sec-

ond metatarsal, the first metatarsal was not longer in any of the patients on the preoperative radiographs. Preoperatively, the mean HVA was 41° (range, 35°-61°), the mean 1-2 IMA was 19° (range, 16°-24°), and the mean DMAA was 4° (range, 3°-7°). Postoperatively, the mean HVA was 14° (range, 10°-17°) and the mean 1-2 IMA was 7° (range, 5°-9°). The mean decrease in the HVA was 27°, which was statistically significant (*P*<.001). The mean decrease in the 1-2 IMA was 12°, which was statistically significant (*P*<.001) (Figures 5-6).

Patient satisfaction was achieved in 22 (95.6%) of the patients, with 17 being very satisfied and 5 being satisfied, entailing 29 (96.6%) of the 30 operated feet. Only 1 (4.4%) patient was not satisfied. This was because of the hallux varus deformity that developed as a result of overcorrection of the IMA that required further intervention. Moderate MTP joint stiffness developed in 1 patient but did not alter her satisfaction level. At the last follow-up, all patients were able to continue their activities of daily living with no restriction.

Pin migration, breakage, or irritation, nonunion, skin problems, or secondary displacement or loss of initial correction were not seen in the patients.

DISCUSSION

The ideal HV repair should realign the MTP joint without disrupting the biomechanics of the first metatarsal head. Because plantar pressure increas-



Figure 5: Full weight-bearing radiograph of the right foot showing severe hallux valgus in a 42-year-old man. The hallux valgus angle was 42° and the 1-2 intermetatarsal angle was 17° (A). The hallux valgus angle was reduced to 10° and the 1-2 intermetatarsal angle was reduced to 7° on the immediate postoperative radiograph (B). At 5 years postoperatively, there was no loss in either value (C).

es under the lesser metatarsal heads and decreases under the first metatarsal after shortening of the first metatarsal or dorsal displacement of the metatarsal head that eventually leads to transfer metatarsalgia, techniques resulting in these undesired consequences should be avoided.^{2,5,14} Only 2 to 3 mm of first metatarsal shortening has been reported to have adverse effects on the forefoot.¹⁵

Moderate to severe HV has traditionally been managed with a diaphyseal or proximal metatarsal osteotomy. The proximal opening-wedge osteotomy was first described by Trethowan in 1923 and was historically used in adolescent HV,^{1,16} but was abandoned due to instability and nonunion problems.^{2,6,8,10} Trethowan used the resected medial eminence of the first metatarsal as a structural autogenous bone graft and a plaster cast for immobilization. However, the forces acting across the osteotomy can be marked, even in the sufficiently immobilized lower extremity, necessitating



Figure 6: Clinical appearance of the patient in Figure 5 at the fifth postoperative year. The patient was very satisfied with the result.

internal fixation. With the development of opening-wedge plates designed exclusively for this surgical technique, this procedure has started to regain popularity.^{2,4,8-11}

Another concern with this osteotomy is the lengthening of the first metatarsal. In recent studies, a mean increase in the first metatarsal length of 2.3 mm⁸ and a mean lengthening of the first ray of 1.9 mm⁴ were reported after proximal opening-wedge osteotomy, with neither being statistically significant. In an in vitro study,⁹ creation of a 2-mm opening-wedge resulted in a mean lengthening of 0.48 mm with a 1% increase in length, a 4-mm wedge resulted in a

mean lengthening of 0.91 mm with a 1.9% increase in length, and a 6-mm wedge resulted in a mean lengthening of 1.31 mm with a 2.7% increase in length, probably with no clinical significance.

This minimal lengthening would also prevent the risk of transfer metatarsalgia, which was not observed in the patients of this study. This finding supports the use of this technique for patients with a short first metatarsal or even length first-second metatarsals, as well as patients with a history of failed HV surgery with associated shortening.

Although sparing the lateral cortex seems important for stability, disruption of the lateral cortex has been reported to have no adverse consequences.⁴ Range of motion was not affected postoperatively, disproving assertions that the lengthening may cause excessive compression of the joint and inevitable osteoarthritis. Postoperative hallux varus, which results from overcorrection of the IMA, is the most common complication, proving the correction capacity of the proximal opening-wedge osteotomy. This complication was seen in 1 of the authors' patients and was managed with extensor hallucis brevis tenodesis.

Previously, several techniques for the fixation of proximal opening-wedge osteotomy were recommended, including the use of staples, first to second metatarsal transfixation screws, one-third tubular plates, screws, and a mini external fixator.^{3,17,18} The current

authors were unable to find an example of internal fixation with the use of Kirschner wires, although it was mentioned in the literature.¹⁷

Before the development of opening-wedge plates, the foot was usually immobilized in a cast postoperatively to prevent instability at the osteotomy site. Nevertheless, the rates of displacement leading to loss of correction or dorsal displacement of the metatarsal head and pseudoarthrosis were still high. The metatarsals are the only long bones in humans that support load perpendicular to their longitudinal axis, rendering first metatarsal osteotomies unstable and making fixation critical to avoid complications due to high lever forces acting on the osteotomy site.¹⁹

Opening-wedge plates have helped solve these problems with their considerably rigid fixation features. However, these implants are not problem free.^{2,4,8-11,17} First, they are technically demanding, especially for inexperienced surgeons. Second, prominence of hardware problems occur in up to 12% of cases. This necessitates surgical removal under anesthesia, as these plates are placed on the medial side of the metatarsal, where soft tissue coverage is poor.^{8,10,11,17} Prominent hardware is more pronounced in patients with small feet and adolescents, and hardware removal is usually performed in very young patients even if the problem of prominence is absent. Finally, these plates are considerably expensive. Internal fixation

with Kirschner wires and removal of them, on the other hand, are technically easy, fast, inexpensive, and easily accessible. Opening-wedge plates may be biomechanically more reliable than Kirschner wires in the biomechanics laboratory, but the authors believe that, on clinical grounds, Kirschner wires provide sufficient fixation. Kirschner wires should be placed divergently to increase the degree of stability they achieve.

Although some studies have reported a high incidence of recurrent HV with proximal opening-wedge osteotomy of the first metatarsal despite good initial correction,²⁰ the current authors have not observed this complication. The rate of recurrence of HV and an increase in the IMA after proximal opening-wedge osteotomy of the first metatarsal has been previously reported to range from 1.8% to 64.7%.^{7,8,10,17,20} However, recurrence of the deformity was found to be associated with the preoperative severity of the deformity and greater DMAA.²⁰ Although the current series of patients had severe HV, the authors strictly adhered to the contraindications to this procedure—a long first metatarsal compared with the second metatarsal and a large DMAA—and believe that this led to no recurrences.

This study, like all observational studies, had methodological limitations, such as a retrospective nature and the lack of a clinical outcomes scoring system. On the other hand, this study had several

strengths. The mean follow-up was 5 years (range, 4-7 years), and none of the patients had an additional procedure, rendering a standardized patient population. The authors believe that their data are sufficiently encouraging to permit them to advocate the use of Kirschner wires for fixation of proximal opening-wedge osteotomy of the first metatarsal for correction of HV. Further biomechanical studies with this technique would support the clinical data.

CONCLUSION

Proximal first metatarsal opening-wedge osteotomy is a technically straightforward procedure for correcting moderate to severe HV. The authors have described a simple, effective, inexpensive technique for fixation of proximal opening-wedge osteotomy of the first metatarsal with Kirschner wires for correction of HV that led to good results.

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