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Moderate to severe hallux valgus deformity: correction with proximal crescentic osteotomy and distal soft-tissue release

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Abstract Between 1991 and 1995, 96 patients (114 feet) were treated with a proximal crescentic metatarsal osteotomy and distal soft-tissue procedure for moderate to severe hallux valgus deformity [intermetatarsal (IM) angle > 15°, or hallux valgus (HV) angle > 30°]. At an average follow-up of 26 months, 8 men and 62 women (86 feet) with a mean age of 53.2 years were retrospectively reviewed. The HV angle averaged 41.1° preoperatively and 14.6° postoperatively. The respective values for the IM angle were 17.8° and 7.8°. Neither the average metatarsal shortening of 3 mm nor the dorsal angulation at the osteotomy site seen in 9% of cases evidenced any clinical significance at follow-up. Patient satisfaction was excellent or good in 91%, and the mean Mayo Clinic Forefoot Score (total 75 points) improved from 37.2 to 61.1 points. Complications included 8 cases of hallux varus and 5 cases of hardware failure. Based on this first study exclusively focusing on moderate to severe hallux valgus deformity, we conclude that proximal first metatarsal osteotomy in combination with a lateral soft-tissue procedure is effective in correcting moderate to severe symptomatic hallux valgus deformity with metatarsus primus varus (IM angle > 15° or HV angle > 30 °).

Introduction

Many authors recommend surgical correction of symptomatic hallux valgus when pain and discomfort persist despite conservative management [2, 14, 15]. In severe cases, metatarsus primus varus is usually a coexisting condition. Most authors agree, that metatarsus primus varus must be corrected for adequate therapy of severe hallux valgus.

Numerous surgical procedures for correction of this deformity have been described, and the choice of procedure depends primarily on severity, location and nature of the pathology. Distal metatarsal osteotomies [2, 13] are typically inadequate in the surgical management of severe hallux valgus associated with metatarsus primus varus and may result in recurrent deformity [1]. Therefore, proximal first metatarsal osteotomies are recommended for moderate to severe metatarsus primus varus (IM angle > 15°). Several conceptually different osteotomies have been described to correct the metatarsus primus varus at the proximal aspect of the first metatarsal, including closing wedge, oblique, crescentic and proximal chevron osteotomies [10, 14, 15, 16]. A proximal closing wedge osteotomy risks shortening and dorsal malunion, leading to impaired weight-bearing of the first ray and the development of transfer metatarsalgia [14, 19]. The proximal horizontal 'V' osteotomy, after its first description by Kotzenberg [16], has been used by several authors since the early 1990s. Initial results are promising, but only short- to midterm results are available [4, 15]. The most commonly performed proximal procedure is the crescentic osteotomy, described by Mann et al. [10, 11]. The osteotomy's rotational design allows triplanar correction [9], and its efficacy to correct any degree of hallux valgus deformity has been well documented in the literature [3, 4, 11, 18].

This procedure has been used at our hospital since 1991 for the correction of moderate and severe hallux valgus deformity (IM angle > 15° or HV angle > 30°). The purpose of this retrospective study was to review the results of all patients undergoing proximal first metatarsal crescentic osteotomy associated with metatarsus primus varus between 1991 and 1995.

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Patients and methods

Ninety-six patients (114 feet) with symptomatic moderate to severe hallux valgus were treated with a proximal crescentic osteotomy and distal soft-tissue procedure between October 1991 and December 1995. Indications for surgery included shoe conflict, persistent pain and discomfort despite conservative management. The operations were performed by 14 different surgeons, including 5 consultants and 9 residents.

Seventy patients (86 feet) were available for an average follow-up of 26 months (range 12–60 months). One patient (1 foot) had died and 25 patients (27 feet) had either moved from the area or been lost to follow up. The mean age of the 8 men and 62 women at the time of operation was 53.2 years (range 17–77 years). Seventy-nine operations were performed as a primary procedure and 7 for recurrent deformity. Of the 86 feet, 40 had simultaneous procedures for lesser toe deformities, including proximal phalanx head resections (n = 36), Helal (n = 7) or Weil (n = 1) osteotomies and extensor tenotomies (n = 7).

For the pre- and postoperative clinical assessment, a standardised questionnaire based on the Forefoot Scoring System (FFSS) of the Mayo Clinic as described by Kitaoka et al. was used [7]. This clinical rating system combines objective and subjective data as follows: pain = 30 points, function = 15 points, footwear restrictions = 10 points, painful callus = 10 points, alignment = 5 points and stiffness = 5 points for a possible total of 75 points. The patients were asked about their overall satisfaction with the outcome of the procedure (range 1, excellent, to 4, dissatisfied), and the presence of transfer lesions was documented.

Weight-bearing dorsoplantar and lateral radiographs of the foot were obtained preoperatively, immediately postoperatively, and at the most recent evaluation (Figs. 1, 2). The HV and IM angles, tibial sesamoid position, and length of the first and second metatarsals were measured from dorsoplantar (dp) radiographs according to the guidelines of the American Orthopaedic Foot and Ankle Society [17]. Hallux valgus deformity was classified as mild: HV angle 21°–30° or IM angle 11°–15°, moderate: HV angle 31°–40° or IM angle 16°–20°, or severe: HV angle > 40° or IM angle > 20°. The sesamoid position was evaluated by measuring the position of the medial sesamoid relative to a longitudinal line bisecting the first metatarsal shaft and was classified as grade 0–3 [17] (Fig. 3). The relative length of the first and second metatarsals was calculated by the method of Hardy and Clapham [6, 17] to determine shortening following the proximal crescentic osteotomy. Healing of the osteotomy site was based on radiographic evidence for bridging callus at the osteotomy site, both in the dp and lateral planes. Degenerative changes of the first metatarsophalangeal (MTP) and metatarsocuneiform (MTC) joint were classified as grade 0: normal, grade 1: mild sclerosis, grade 2: joint space narrowing, grade 3: narrowing plus cysts and osteophytes, or grade 4: joint destruction. Pre- and postoperative values were recorded and changes expressed as a percentage value. Sagittal plane malalignment of the first metatarsal was based on lateral weight-bearing radiographs. A line was drawn through the longitudinal axis of the first metatarsal distal and proximal to the osteotomy site. Angulation between the two lines defined sagittal malalignment.

Fig. 1 Preoperative weight-bearing dorsoplantar (dp) radiograph of a woman aged 65 years. Hallux valgus (HV) angle is 33°, intermetatarsal (IM) angle 15°, and sesamoid position is grade 2 on a scale of 0–3

Fig. 2 Weight-bearing dp radiograph of the same woman as in Fig. 1 at follow-up examination 49 months after the operation. HV angle is 9°, IM angle 4°, and sesamoid position 0

Operative technique

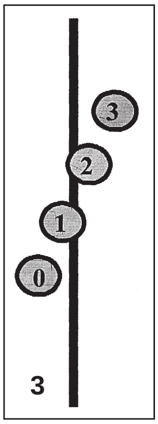
The operation starts with a dorsal incision over the first web space. Then the lateral joint capsule is incised longitudinally just superior to the lateral sesamoid. The adductor tendon is identified and carefully dissected from the lateral joint capsule and the lateral sesamoid and released from its insertion into the base of the proximal phalanx. The transverse metatarsal ligament is stretched and carefully incised to release the tethering effect on the sesamoid complex. The lateral capsule is perforated at the joint line, and the great toe is forced manually into about 20° varus position. One suture is placed through the adductor tendon and the lateral aspect of the first metatarsal to lift the insertion of the adductor muscle and two stabilizing intermetatarsal sutures.

A second skin incision is made at the medial aspect of the first MTP joint. This incision is either extended proximally in a slightly curved manner, or a third longitudinal dorsomedial skin incision is made at the osteotomy site. The medial MTP joint capsule is opened with an inverted L-type incision. The joint is inspected for degenerative changes.

The third step is to expose the osteotomy site. After retraction of the extensor hallucis longus tendon, the osteotomy is performed about 1 cm distal of the MTC joint. Until April 1995, the osteotomy was always performed with a K-wire-guided, oscillating, curved Ender saw. This K-wire guidance automatically directs the convexity of the cut proximally. After May 1995, the oscillating Hall Zimmer saw with a curved blade was available at our institution and routinely used. With this saw, the convexity of the cut is placed distally in all cases. Regardless of the type of saw used, the osteotomy is cut halfway between the planes perpendicular to the metatarsal shaft and perpendicular to ground plane. After manual displacement of the fragments, the correction obtained is checked and the osteotomy fixed with a 4.0-mm cancellous screw (Fig. 4). Additional K-wires (24 cases) or crossed K-wires as the only mode of fixation (1 case) were only used whenever screw placement was impossible. Then the medial eminence is excised in line with the metatarsal shaft, taking care not to excise too much bone off the metatarsal head.

Attention is now directed towards the medial capsule, and a wedge of about 5 mm is removed from the short arm of the L-type capsular incision. While an assistant holds the great toe in a slightly overcorrected position, the medial joint capsule is repaired, and the first web space sutures are tightened.

After skin closure, the foot is wrapped in compression dressing which protects the soft-tissue repair and holds the great toe in its corrected position. The osteotomy is checked by radiography, and the patient can walk without restriction in a postoperative shoe with stiff sole, depending upon tolerance. The dressing is changed after 2 days and then on a weekly basis. Full weight-bearing without a postoperative shoe is allowed after 6–8 weeks. Due to the fact that a high percentage of our patients showed transarticular placement



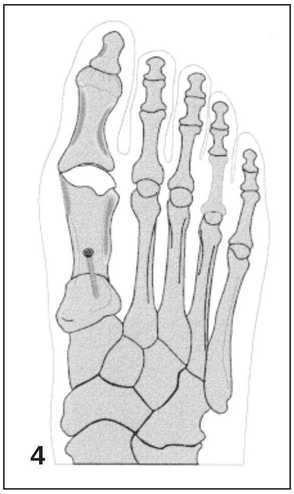


Fig. 3 Sesamoid position: medial sesamoid in relation to longitudinal axis of metatarsal one: *0* normal position, *1* less than 50% overlap, *2* more than 50% overlap, *3* lateral luxation

Fig. 4 Operative procedure: proximal crescentic osteotomy (convexity of saw cut directed distally) performed approximately 1 cm distal to the metatarsocuneiform joint and fixed with a 4.0-mm cancellous screw

of fixation screws, these devices were routinely removed after solid fusion of the osteotomy was established.

Results

Clinical

Mean improvement in Forefoot Score was 23.9 points. The Forefoot score (total 75 points) averaged 37.2 points (range 15–75) preoperatively and 61.1 (range 30–75) points postoperatively.

Preoperatively, 99% of patients experienced some sort of pain, mainly around the medial eminence or the MTP joint. At the most recent follow-up, 95% of patients were either pain-free or had only minor symptoms. In addition, 82% of patients had no limitations concerning shoewear, 18% had minor difficulty with shoe width or heel height, and no patient had to wear orthotic shoes. Subjectively, 91% of the patients rated their satisfaction with the outcome of the operation as excellent or good, 9% was satisfied with reservations, and no patient was completely dissatisfied with the outcome of the procedure.

Preoperatively, 48% of feet had painful callosities under the lesser metatarsal heads. After the operation, 24% of these lesions had resolved, but in 8% new transfer lesions were observed, leaving 32% of feet with metatarsalgia at the latest follow-up. Without concomitant lesser toe surgery (46 feet), 16% of the lesions resolved, but in 11% new transfer lesions were observed at follow-up. With concomitant lesser toe surgery (40 feet), 35% of callosities resolved, and only 5% of feet showed new transfer lesions.

Table 1 Radiographic results (mean ± SD): *HV angle* hallux valgus angle, *IM angle* intermetatarsal I/II angle, *SP* sesamoid position (grade 0–3)

	Preoperative	Postoperative	Ø correction
HV angle	41.1° ± 9.3°	14.6° ± 14.6°	26.5°
IM angle	17.8° ± 2.5°	7.8° ± 4.7°	10°
SP	2.8 ± 0.4	1.3 ± 0.9	1.5

Radiography

All osteotomies presented solid union at the latest follow-up evaluation. Two cases of delayed union were observed, but both of them healed with conservative management (limited weight-bearing).

The mean correction of the HV angle was 26.5°. The angle averaged 41.1° (range 25°–70°) preoperatively and 14.6 ° (range –40° to 46°) at final follow-up (Table 1).

The IM angle was corrected an average of 10°. The angle averaged 17.8° (range 12°–26°) preoperatively and 7.8 ° (–5° to 18°) at final follow-up. Thus, according to our deformity grading, 80% of cases showed normal values for HV and IM angles or presented with a mild residual deformity after the procedure (Table 1).

The average tibial sesamoid correction was 1.5 (on a scale from 0 to 3). The sesamoid position averaged 2.8 preoperatively and 1.3 at final follow-up. Preoperatively, 99% of tibial sesamoids had a lateral position in respect to the line bisecting the metatarsal shaft (positions 2 and 3). This could be corrected to a medial position (positions 0 and 1) in 60% of feet. In the foot with a recurrent hallux valgus deformity, the attempted correction of the tibial sesamoid had failed and remained 3 (Table 1).

The amount of metatarsal shortening following osteotomy could be determined for 66 (77%) feet and averaged 3 mm (range –8 to +2 mm). Twenty feet were not measured due to inadequate radiographs or concomitant metatarsal shortening osteotomies. Five patients had 7 mm or more shortening. None of these feet presented with a transfer lesion at the latest follow-up examination.

Dorsiflexion of the first metatarsal, as measured on lateral radiographs, could be observed in 8 feet (9%). Only one of these patients developed a transfer lesion under the lesser metatarsals.

Preoperative degenerative changes were graded as 0 or 1 in 61% of cases in the MTP joint and in 98% of cases in the MTC joint. Progression of radiographic changes of one or more steps could be observed in 10 feet (12%) concerning the MTP joint and in 23 feet (27%) concerning the MTC joint. Despite this progression of degenerative changes, none of these patients had symptoms related to arthritis.

Complications

The two main complications were hallux varus deformity and failure of fixation screws. Hallux varus deformity developed in 8 feet (9%). In these cases the average hallux valgus angle measured –16° (range –3° to –40°). One patient underwent revision surgery (HV angle –40°), and one patient had difficulty with wearing shoes (HV angle –30°). With milder forms of hallux varus deformity, the patients were pain-free and satisfied with the outcome of the operation. Three patients rated their satisfaction as good and one patient, as moderate. Dissatisfaction with the cosmetic appearance was the reason in three cases (HV angles: –13°, –20°, –30°) and moderate pain in the remaining case (HV angle: –5°). The patient with a varus deformity of 20° had undergone a bunionectomy with resection of the collateral ligaments 14 years ago.

Breakage of fixation screws was encountered in 5 (6%) feet. All screw failures occurred between 3 months and 1 year. All osteotomies united, and only one patient showed a minor loss of correction. In all cases, the screw had been placed across the MTC joint.

A recurrence of hallux valgus deformity was observed in 1 foot and hallux rigidus developed in two other feet. All three feet required revision surgery, the first of which was managed with MTP joint arthrodesis and the other two with a Keller resection arthroplasty.

Deep infection occurred in one patient and was treated by wound debridement and administration of antibiotics and allowed to heal with secondary intention. At the latest follow-up examination, the patient experienced no pain, had no restrictions concerning shoewear, and was satisfied with the outcome of the operation.

Discussion

Numerous procedures have been described for the correction of hallux valgus deformity. Most authors agree, that the severer hallux valgus deformity with marked metatarsus primus varus (IM angle > 15°) is inadequately corrected by distal osteotomies [1]. Although proximal crescentic osteotomies are commonly used in combination with a distal lateral soft-tissue procedure to correct these high-grade deformities, only a few authors have published larger series of patients [3, 4, 11, 18].

This is the first study focusing exclusively on moderate to severe hallux valgus deformity. Our series, with the highest mean preoperative values for HV (41.1°) and IM angles (17.8°) reported in the orthopaedic literature, confirms the potential of the proximal crescentic osteotomy to correct even severe cases of hallux valgus and metatarsus primus varus. Mean correction for HV (26.5°) and IM angles (10°) proved to be sufficient in the majority of cases (80%) in correcting the pathology to normal values or a mild residual deformity. No patient was dissatisfied with the outcome, 82% could wear any type of shoe, and 18% had only minor shoewear restrictions. No patient required orthotic shoewear after the operation.

The reduction of the sesamoid complex (2.8 to 1.3 on a scale from 0 to 3) was less favorable compared to the correction of the HV and IM angles. Comparison with other works is hampered by the fact that many different classification systems for the position of the tibial sesamoid are used [4, 11, 17, 18]. Our correction is slightly superior to the reduction of 6.5 to 4.1 (scale: 0–7) of Thordarson and Leventen [18] and the 58% of medial or central positions (scale: medial, central, lateral) of Easley et al. [4] and equal to the 80% of medial or central positions of Mann et al. [11].

In 1992, Mann et al. [11] published a retrospective review of 75 patients (109 feet) undergoing proximal crescentic osteotomy and distal soft-tissue realignment. After a mean follow-up of 34 months, all osteotomies had healed, the average HV angle correction was 21° (31°–9°) and IM angle correction 8° (14°–6°). Patient satisfaction was high (93%), shortening of the metatarsals averaged 2 mm, and only minor complications (varus, re-valgus, pin tract infection) occurred. Dorsiflexion (28%) and shortening (range –12 to +3 mm) of the first metatarsal were described as potential pitfalls, although no new transfer lesions developed after the procedure.

These favorable results were confirmed in a long-term follow-up study by Dreeben and Mann [3]. After a mean period of 5.5 years, loss of correction averaged 1.4° for the IM angle and 3.8° for the HV angle. The incidence of varus and recurrent valgus deformity had not increased from the initial follow-up study, and patient satisfaction remained high (85%).

Similar results were published in 1992 by Thordarson and Leventen [18]. They reviewed 35 patients (49 feet) after a mean follow-up of 28 months. The average HV angle improved from 37.5° to 13.8° and the IM angle from 14.9° to 4.7°. Patient satisfaction (93%) and rate of complications were similar to the earlier studies, despite different methods of fixation (screws, staples, and K-wires). Dorsal angulation at the osteotomy site averaged 6.2°, and 7 patients developed symptomatic transfer lesions. Two of these required a metatarsal neck osteotomy.

In 1996, Easley et al. [4] compared the results of proximal crescentic (35 patients, 50 feet) and proximal chevron (40 patients, 47 feet) osteotomies in a prospective manner. They found no statistically significant difference for correction of the HV and IM angles, patient satisfaction, clinical outcome, and metatarsal shortening. Radiographic evidence of healing was faster in the chevron (mean 4 weeks) than in the crescentic (mean 6.7 weeks) group. This finding did not alter the postoperative regimen, which was identical for both groups. No cases of postoperative dorsiflexion of the first metatarsal were found in the chevron group compared with an average dorsiflexion of 2.7° in 7 cases (17%) in the crescentic group. The rate of complications was slightly higher in the chevron (21%) than in the crescentic group (17%).

One major pitfall of the crescentic osteotomy is dorsal angulation at the osteotomy site with the subsequent risk of transfer lesions. Our incidence of 9% is lower than the 28% reported by Mann et al. [11] or the 17% reported by Easley et al. [4]. This could possibly be due to the fact that 99% (all except one) of our osteotomies were fixed with screws or screws and K-wires compared with only 34% of Mann et al. [11] and 65% of Thordarson and Leventen [18]. Easley et al. [4], although he did not state the exact figures, used 3 K-wires in cases where the bone stock of the first metatarsal proved insufficient to support screw fixation. Biomechanical works by McCluskey et al. [12] and Lian et al. [8] comparing different modes of fixation for proximal metatarsal osteotomies clearly demonstrated the superiority of screw fixation against K-wires or staples. Lian et al. [8] compared proximal chevron or crescentic osteotomies with single screw fixation against oblique osteotomy with double screw fixation and crescentic osteotomy fixed with either 2 K-wires or multiple staples in 48 cadaver feet. Concerning the crescentic osteotomy, staples were by far the weakest construct, followed by K-wires and screws. Taking these data and our results into account, we favour single screw fixation over the use of staples or K-wires as the fixation method for crescentic osteotomies.

Concerning the proximal chevron osteotomy, studies present conflicting data. Although McCluskey et al.'s study [12] suggested a greater biomechanical strength of the proximal chevron over the crescentic osteotomy using single screw fixation, Lian et al.'s [8] investigation does not support this. Instead, their work did not demonstrate a statistically significant difference between the biomechanical strength of these two osteotomies. Clinical studies support the theory that the proximal chevron osteotomy possesses greater inherent stability, with less potential for dorsal angulation [4, 15].

Metatarsal shortening is considered the second major risk factor concerning the development of transfer lesions. Values for the proximal crescentic osteotomy vary from 2 mm (range –12 to +3 mm) as described by Mann et al. [11] to 3 mm (range –8 to +2 mm) in our investigation using the Hardy and Clapham method [6]. Easley et al. [4], using the Grace et al. method [5], noted 1.95% of shortening with the proximal crescentic osteotomy, which was not statistically significant compared to the 1.07% of shortening produced by the proximal chevron osteotomy. These values are lower than the 3.6–5 mm [19, 20] and 4.7% [14] reported for closing wedge osteotomies and the 6.6–8 mm [13] and 6.3%–6.4% [5] reported for some popular distal osteotomies (Mitchell, Wilson, and Hohmann type).

The clinical significance of shortening and dorsal malangulation is unclear, because studies that observed dorsal angulation in 28% of metatarsals [11] developed no new transfer lesions, while others with fewer cases of dorsal angulation did [4]. Our rate of 8% of new development of transfer lesions after the operation lies well between the reported range of 0%–16% [4, 11, 18]. Our data suggest that severe forms of lesser toe deformities should be simultaneously addressed with first ray surgery. In the group with concomitant lesser toe surgery, roughly twice the number of painful callosities resolved under the lesser metatarsal heads (35% instead of 16%), and only half the number of new callosities developed (5% instead of 11%).

Radiographic progression of degenerative disease between the operation and follow-up was recorded in 12% of MTP joints and in 27% of MTC joints. The high rate of progression of the MTC joint may be explained by transarticular screw fixation. However, none of our patients developed symptoms related to arthritis at the MTC joint, and a correlation between radiographic changes and clinical symptoms is controversial. Mann et al. [11] reported progression in 24% of cases at the MTP joint, which is close to our value at the MTC joint. Wanivenhaus and Feldner-Busztin [20] reported radiographic progression at the MTC joint in 73% of cases. Despite identifying a cause for 58% of cases (transarticular placement of the fixation hardware and close vicinity of the osteotomy site to the MTC joint), radiographic progression of 15% of cases at this joint remained unclear. Although our data suggest that MTC degeneration remains asymptomatic, we currently attempt to avoid violation of the tarsometatarsal joint.

In conclusion, this series dealt with the highest preoperative values for HV (41.1°) and IM (17.8°) angles reported in the orthopaedic literature. Based on this first study exclusively focusing on moderate to severe hallux valgus deformity, we conclude that proximal first metatarsal osteotomy in combination with a lateral soft-tissue procedure is effective in correcting hallux valgus deformity with IM angle >15° and should be considered in the surgical management of patients with moderate to severe symptomatic hallux valgus associated with metatarsus primus varus.

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