Basal Closing Wedge Osteotomy for Correction of Hallux Valgus and Metatarsus Primus Varus: 10- to 22-Year Follow-up

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Foot Ankle Int 1999 20: 171

DOI: 10.1177/107110079902000306

0198-0211/99/2003-0171/0
FOOT & ANKLE INTERNATIONAL

Basal Closing Wedge Osteotomy for Correction of Hallux Valgus and Metatarsus Primus Varus: 10- to 22-Year Follow-up

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ABSTRACT

Between 1974 and 1985, 59 patients (83 feet) underwent basal closing wedge osteotomy in combination with a bunionectomy and a lateral soft tissue release for correction of hallux valgus and metatarsus primus varus at this institution. Of the original 59 patients, 42 patients (60 feet) with at least 10 years of follow-up (average, 194 months; range, 144–266 months) were available for this study. Results were analyzed by review of the medical records and plain radiographs, a standardized clinical questionnaire, and physical examination. Of the 60 feet, patients rated outcomes as excellent or good in 51 feet (85%) and rated cosmesis as excellent or good in 44 feet (73%). Radiographically at final follow-up, hallux valgus and intermetatarsal angles averaged 19.9° (range, 0–40°) and 6.7° (range, 0–18°), respectively. The sesamoid position was corrected from an average preoperative grade of 2.6 to a grade of 0.9 at final follow-up. The average shortening of the first metatarsal was 5 mm. The disadvantages of the closing wedge osteotomy are that it is technically demanding and it entails the risk of shortening, dorsal malalignment, and metatarsalgia. In the current study, long-term complications included hallux varus deformity (16 feet), dorsal malalignment (15 feet), and metatarsalgia (14 feet). Despite good correction of the intermetatarsal angle and sesamoid position, the clinical results and the incidence of complications after basal closing wedge osteotomy were not as favorable as those reported for other procedures in the literature. Therefore, alternative procedures, such as the basal crescentic osteotomy or the basal chevron osteotomy, should be used.

INTRODUCTION

Hallux valgus is one of the most common pathologies in orthopaedic surgery, and numerous causative theories have been presented.[6,18] One important component in the hallux valgus complex is metatarsus primus varus. It may either be congenital or acquired as a degenerative foot defect in splay foot, and it may thus represent a cause of hallux valgus or a symptom of severe deformity. In either case, most authors agree that metatarsus primus varus must be addressed to achieve adequate correction of severe hallux valgus.

More than 130 surgical procedures for the correction of hallux valgus have been described.[5] The choice of procedure depends principally on the nature, location, and severity of the deformity. For mild and moderate hallux valgus, distal osteotomies of the first metatarsal are recommended. From a mechanical standpoint, a proximal metatarsal osteotomy[2,4,7,10,11,15,22–24] can achieve a greater degree of correction and is therefore recommended for more severe hallux valgus deformities. The closing basal wedge osteotomy of the first metatarsal has been used to effectively reduce the metatarsus primus varus component associated with severe hallux valgus deformity. From 1975 until 1985, the authors performed the basal closing wedge osteotomy,[4,13,23,24] combined with adductor tenotomy and bunionectomy or Keller-Brandes resection arthroplasty,[1,8] for correction of moderate-to-severe hallux valgus deformity. The early results of the first 18 patients (25 feet) were published in 1977.[24]

The aim of this retrospective study was to evaluate the long-term outcome (≥10-year follow-up) after this

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TABLE 1
Radiologic and Clinical Results

Parameter	Number
Demographics	
Initial number	59 patients (83 feet)
Patient age (average/range)	30 years (13–61 years)
Number available for follow-up	42 patients (60 feet)
Clinical results (final follow-up)	
HMIS[9] (average)	88.8
Satisfied (excellent/good)	51 (85%)
Cosmesis (excellent/good)	44 (73%)
Metatarsalgia	14 (23%)
Radiographic results (preoperative/final follow-up)	
Hallux valgus angle (mean ° ± SD)	38.9 ± 6.5/19.9 ± 12.4
Intermetatarsal angle (mean ° ± SD)	16.1 ± 3.1/6.7 ± 4.4
Sesamoid position	2.6/0.9
Joint congruity (%)	20/57

HMIS, Hallux Metatarsophalangeal Interphalangeal Scale; SD, standard deviation.

procedure with regard to patient pain, mobility, cosmesis, shoe fit, satisfaction, and radiologic appearance.

MATERIALS AND METHODS

Patient Population

Between January 1974 and August 1984, 59 patients (83 feet) underwent basal closing wedge osteotomy in combination with a bunionectomy and a lateral soft-tissue release for the correction of hallux valgus and metatarsus primus varus. The mean age of the 2 men (3 feet) and 57 women (80 feet) was 30 years (range, 13–61 years) (Table 1). Of the 59 patients (83 feet), 16 patients (21 feet) were lost to follow-up and one patient (two feet) died. The remaining 42 patients (60 feet) had at least 10 years of follow-up (average, 194 months; range, 144–266 months) and formed the study group. All procedures were performed by either the senior author (M.S.) or another experienced orthopaedic surgeon, with peripheral nerve blockade and Esmarch tourniquet.

Adductor tenotomy and bunionectomy. First, a 4-cm long incision was made on the dorsal aspect of the foot in the first intermetatarsal space. The adductor tendon was identified and carefully dissected from the lateral capsule and then released from its insertion into the base of the proximal phalanx. The lateral capsule was perforated at the joint line, and the toe was forced manually into 20° of varus position. The adductor tendon was then sutured to the lateral aspect of the first metatarsal, and two stabilizing sutures were placed.

A dorsomedial incision was then made over the first metatarsal. The tendon of the abductor hallucis muscle was identified and dissected from the flexor hallucis muscle. A dorsoplantar capsulotomy was used to expose the medial eminence. The medial eminence was then excised with an osteotome. After finishing the proximal closing wedge osteotomy, a medial capsulorrhaphy was performed.

Closing wedge osteotomy. The dorsomedial incision was extended proximally, the proximal metatarsal was exposed, and the periosteum was elevated. At 1 cm distal to the metatarsocuneiform joint, a laterally based wedge of bone, whose size was measured on the radiographs preoperatively, was removed with an oscillating saw; care was taken to preserve the medial cortex (Fig. 1A). The resulting osteotomy was closed and temporarily fixed with K-wires. Once proper first metatarsal alignment was confirmed, the osteotomy was fixed with a navicular screw (Fig. 1B).

For the first 8 days, the patients were mobilized with crutches without weightbearing. After suture removal on the ninth postoperative day, patients were permitted to bear weight with short-leg casts for 5 to 6 weeks.

Clinical Assessment

At the time of the final follow-up, patients were personally examined and graded by a standardized questionnaire[20] based on the Hallux Metatarsophalangeal Interphalangeal Scale (HMIS) of the American Orthopaedic Foot and Ankle Society.[9] Patients were also asked to subjectively assess (excellent, good,

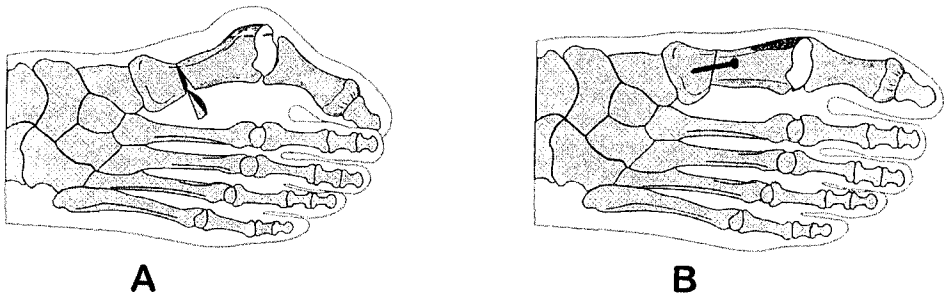

Fig. 1. Basal closing wedge osteotomy procedure. *A*, Laterally based wedge of bone is removed with an oscillating saw, taking care to preserve the medial cortex. *B*, Resulting osteotomy is closed and fixed with a navicular screw.

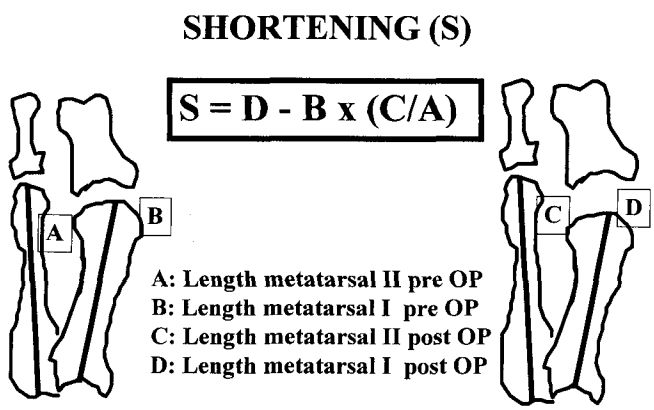

Fig. 2. Formula to measure the first metatarsal shortening.

fair, or dissatisfied) their functional and cosmetic result. Finally, patients were questioned about the use of shoe inlays or arch supports.

Radiologic Assessment

Dorsoplantar (weightbearing and nonweightbearing) and lateral radiographs were performed[17] preoperatively and at the time of the final follow-up. The hallux valgus angle, first intermetatarsal angle, congruency of the first metatarsophalangeal (MTP) joint, metatarsal index, and sesamoid position (grades 0–III) were measured by the methods recommended by the American Orthopaedic Foot and Ankle Society.[19]

To assess first metatarsal shortening, the authors used a formula described by Mitchell[12] (Fig. 2), although this formula has limits because the radiographs were performed at different institutions with different inclinations of the tube.

Dorsal malalignment was examined to determine if there was a deviation between the axis of the medial cuneiform and proximal part of the first metatarsal and the axis of the distal part of the first metatarsal. The authors distinguished between no malalignment, minimal dorsal malalignment (<10°), and severe dorsal malalignment (>10°).

RESULTS

Clinical

By HMIS evaluation, the outcomes were excellent or good in 50 feet (83%), fair in 2 feet (4%), and poor in 8 feet (13%) (Table 2). The average HMIS was 88.8 points (range, 50–100 points). Regarding shoe wear, no custom-made shoes were required; 48 feet (82%) could wear any kind of shoe, and 11 feet (18%) required orthotics.

At the time of follow-up, average plantarflexion was 21° (range, 0–45°; SD, 11.73) and average dorsiflexion was 47° (range, 0–90°; SD, 15.89).

TABLE 2
Clinical Results (42 patients/60 feet)

Measurement tool	Percentage of result graded as:			
	Excellent	Good	Fair	Poor
HMIS[9]	60	23	4	13
Patient satisfaction	68	17	2	13
Cosmesis	50	23	10	17

HMIS, Hallux Metatarsophalangeal Interphalangeal Scale.

At final follow-up, metatarsalgia was noted in 14 feet (23%) and callus formation underneath the adjoining metatarsal heads was noted in 7 feet (12%). In two feet, Helal osteotomies for metatarsalgia were required at 1 and 11 years after the primary surgery. Because of painful arthritis in the first MTP joint, two patients had undergone a Keller-Brandes procedure 11 and 12 years after the primary surgery.[8] Revision surgery was required in two feet for hallux varus and in one foot for recurrent hallux valgus deformity.

Subjective

Patients subjectively rated the outcome of the operation as excellent in 41 feet (68%) and good in 10 feet (17%). One foot was rated as fair because of recurrent valgus deformity, and eight feet (13%) were rated as poor (Table 2). The eight patients with the eight "poor" feet were dissatisfied because of substantial metatarsalgia (two), varus deformity (two), recurrent valgus deformity (two), and the need for a Keller-Brandes procedure (two) for increased painful arthritis in the first MTP joint.

With regard to appearance, 78% of the feet were completely or nearly completely satisfactory (Figs. 3 and 4). The cosmetic results were rated excellent in 30 feet (50%), good in 14 feet (23%), and fair in 6 feet (10%) (Table 2). Ten feet (17%) had clinically poor appearance: four because of extensive varus deformity and six because of recurrent hallux valgus deformity (in two patients, >10 years after surgery).

Radiographic

The radiographic results (Table 1) revealed an average preoperative hallux valgus angle of 38.9° (range, 26–54°; SD, 6.5°). At final follow-up, this angle averaged 19.9° (range, 0–40°; SD, 12.4°), which was an average correction of 19°. The first intermetatarsal angle averaged 16.1° (range, 10–21°; SD, 3.1°), preoperatively, and 6.7° (range, 0–18°; SD, 4.4°) at final follow-up, which was an average correction of 9.4° (Figs. 4 and 5).

The sesamoid position was corrected from an average grade of 2.6 before surgery to 0.9 at final follow-up. Preoperatively, sesamoid position was graded as

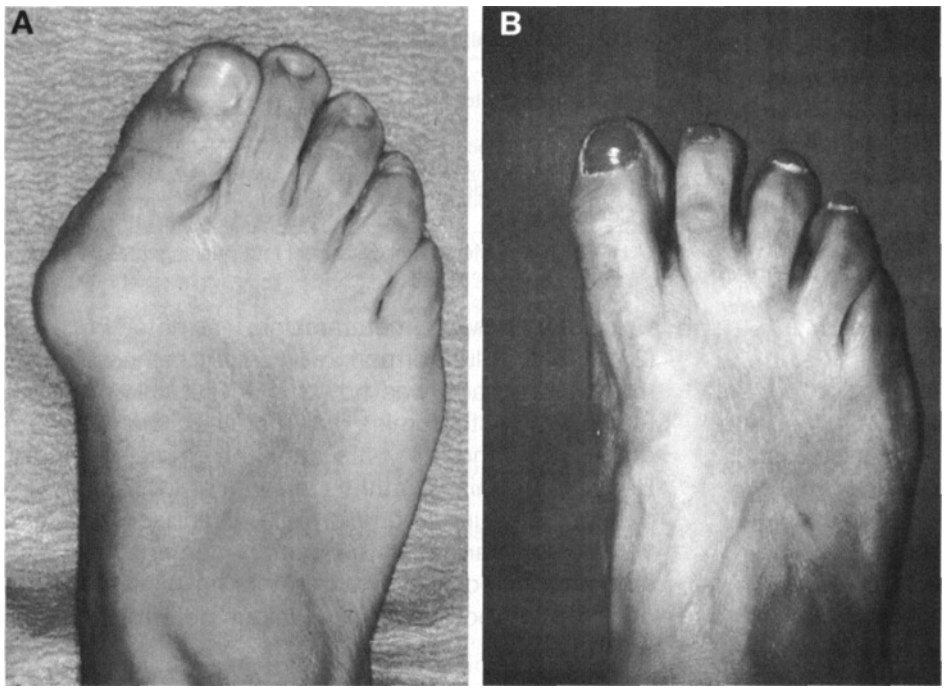

Fig. 3. This 30-year-old woman underwent basal closing wedge osteotomy with bunionectomy. *A*, Preoperative clinical photograph. *B*, Clinical photograph 21 years after surgery.

0 (none), I (9%), II (19%), and III (72%). At final follow-up, sesamoid position was graded as 0 (43%), I (33%), II (13%), and III (11%).

Although the issue of congruency was not considered a prompt for surgery, our results showed that, preoperatively, only 20% of first MTP joints were congruent, whereas at follow-up, 57% of the feet had a congruent first MTP joint.

Of 60 feet, 42 had radiographs at final follow-up that were adequate for measuring shortening and dorsal malalignment. Shortening of the first metatarsal after the closing wedge procedure averaged 5 mm (range, 1–26 mm). The one patient with 26 mm of shortening suffered from severe metatarsalgia and was dissatisfied with the procedure. Dorsal malalignment was present in 15 feet (25%). Six (including the four with severe angulation) had metatarsalgia, and four had callus formation.

Complications

Early complications recorded in the charts included deep wound infection (one), superficial wound infection (one), sesamoiditis that required sesamoidectomy (two), and delayed union of the osteotomy (one foot; solid union was present after 8 weeks).

Late complications included callus formation underneath adjoined metatarsal heads (seven feet; 12%) and painful metatarsalgia (14 feet; 23%: two feet required Helal osteotomies). Hallux varus deformity (hallux valgus angle, $<0°$) developed in 16 of 60 feet. In all cases, it had developed within the first 2 years and did not increase in severity. The hallux varus angle of these 16 patients averaged 11.8° (range, $-2°$ to $-24°$). One foot underwent a salvage procedure for correction of hallux varus, and the patient was very satisfied at long-term follow-up; in another patient, salvage surgery was attempted but failed. Two patients ($-16°$ and $-24°$) were dissatisfied, one ($-16°$) primarily because of limited motion of the MTP joint and the other ($-24°$) because of the appearance. The patients with postoperative hallux varus had greater correction of the intermetatarsal angle; the follow-up intermetatarsal angle in feet with and without varus deformity averaged 3.1° (range, $-4°$ to 8°) and 8.3° (range, 5–23°), respectively.

In two patients, a Keller-Brandes procedure[8] had been performed 11 and 12 years after the primary surgery because of increased painful arthritis in the first MTP joint. One foot required revision surgery for recurrent hallux valgus deformity.

Inadequate correction of the intermetatarsal angle ($>15°$) was measured in three feet. The preoperative intermetatarsal angles measured 15°, 17°, and 20°. The postoperative angles measured 16°, 16°, and 18°, respectively. One patient had an increased deformity, one had minimal correction, and one had a 2° correction.

DISCUSSION

There is no other study with >7 years follow-up[4] for basal closing wedge osteotomy. With an average fol-

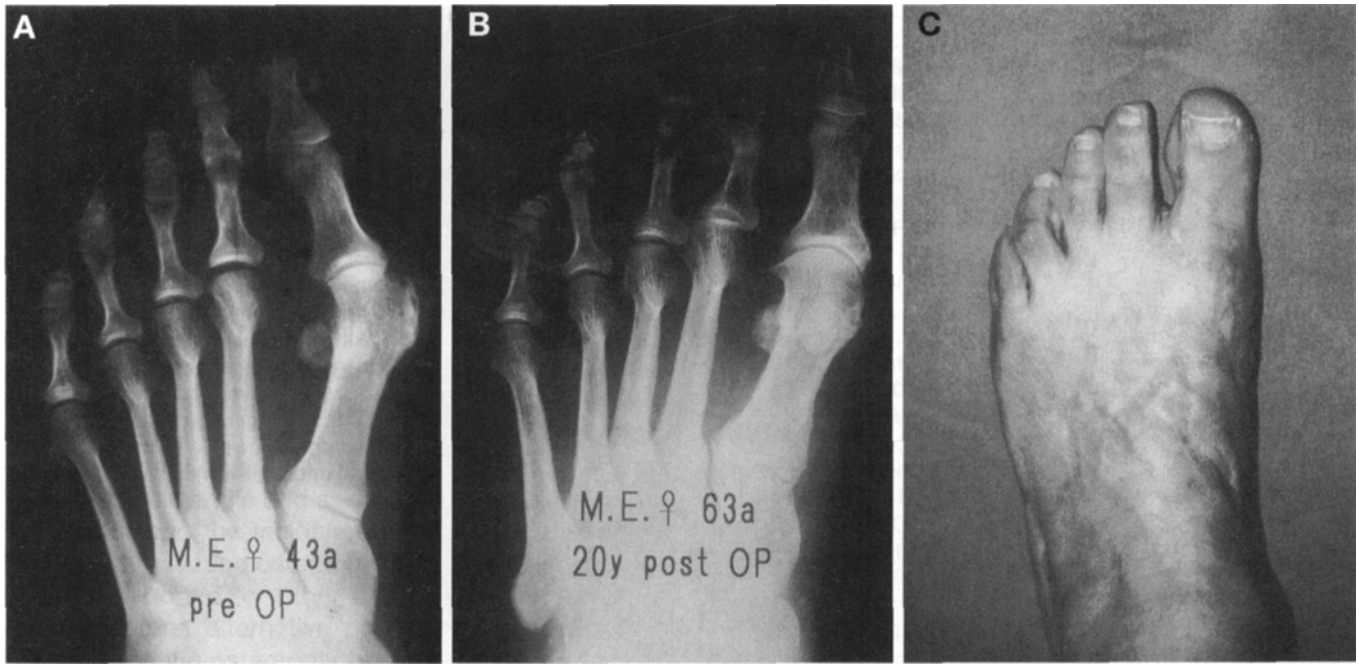

Fig. 4. This 24-year-old woman underwent basal closing wedge osteotomy with bunionectomy. *A*, Preoperative roentgenogram showed a 42° angle between the phalanx and the metatarsal bone of the great toe and a 19° angle between the first and second metatarsals. *B*, Radiograph at 20 years after osteotomy showed a hallux valgus angle of 11° and an intermetatarsal angle of 10°. *C*, Clinical photograph at 20-year follow-up.

low-up of 194 months, the long-term risks and the benefits of this technique can be accurately determined.

The average reduction of the intermetatarsal angle from 16.1°, preoperatively, to 6.7° at final follow-up represents the good correction of the metatarsus primus varus deformity achieved (Table 1). Furthermore, the correction of the sesamoid position from 2.9 before surgery to 0.9 at long-term follow-up reflects the excellent correction of metatarsus primus varus and hallux valgus with this combination of procedures (Fig. 3). However, good correction of the intermetatarsal angle and the sesamoid position are not the only key points for the long-term success of correction for hallux valgus and metatarsus primus varus.

A major problem that is related to the principle of a closing wedge osteotomy is the shortening of the first metatarsal. Even with the use of a formula, it is difficult to accurately determine the amount of shortening. The closing wedge osteotomy entails loss of the length caused by the wedge and by the loss of bone substance (at least in the amount equal to the width of the oscillating sawblade). Some loss of length may be also attributed to the method of fixation.[16] In the current study group, shortening averaged 5 mm. This amount is identical to that found by Krismer and Eichenauer[10] and similar to that of Wanivenhaus and Feldner-Busztin,[23] who measured 3.7 mm of shortening. After a proximal metatarsal chevron osteotomy, Sammarco et al.[15] measured a metatarsal shortening of approximately 2 mm. We found no correlation between shortening and patient satisfaction. However, the patient with the most shortening (26 mm) was dissatisfied with the procedure and presented severe transfer metatarsalgia underneath the second, third, and fourth metatarsal heads.

Dorsal angulation is considered a key point in the evaluation of the basal closing wedge osteotomy. Jahss et al.[7] pointed out that shortening of the first ray along its axis necessarily entailed dorsal displacement of the first MTP joint. Therefore, they recommended plantar placement of the osteotomy in all cases. Schuberth et al.[16] were unable to determine how much of the observed dorsal displacement was produced intraoperatively and how much occurred as a result of postoperative migration.

The incidence of dorsal angulation in the current series was 25%, which was less than that of Mann et al.,[11] who measured 28% in a series of 109 proximal crescentic osteotomies. Mann et al.[11] pointed out that dorsiflexion of the first metatarsal did not influence the presence of transfer lesions. Sammarco et al.[15] tried to avoid metatarsalgia in a series of 51 proximal metatarsal chevron osteotomies by slight plantar displacement; they noticed no transfer lesions at final follow-up.

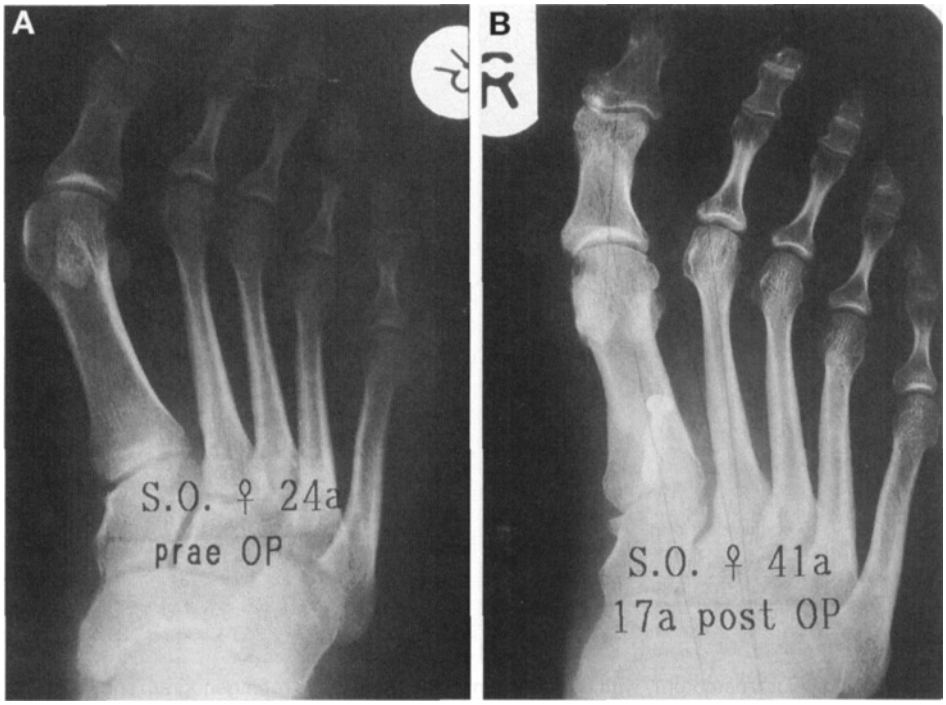

Fig. 5. This 24-year-old woman underwent basal closing wedge osteotomy with bunionectomy. *A*, Preoperative roentgenogram showed a 42° angle between the phalanx and the metatarsal bone of the great toe and a 17° angle between the first and second metatarsals. *B*, Roentgenogram at 17 years after osteotomy showed a hallux valgus angle of 14° and an intermetatarsal angle of 5°.

In the current study, the cases of dorsal angulation differed from the results presented by Mann et al.[11] Of the current 15 cases of dorsal malalignment, 6 cases (40%) had metatarsalgia. All four feet with severe dorsal malalignment had metatarsalgia. Of the 27 cases without measurable dorsal malalignment, 8 cases (30%) had metatarsalgia. Patients retrospectively reported that the onset of metatarsalgia occurred several years after the surgery. The authors believe that if metatarsalgia is present, it is a late complication of the primary hallux valgus surgery.

Transfer metatarsalgia was a significant problem in the current series, affecting 20 feet (25%), which is similar to the results of Wanivenhaus and Feldner-Busztin,[23] who reported 27%. Analyzing the results for causes of metatarsalgia other than dorsal malangulation, shortening in patients with metatarsalgia measured 5 mm on average, identical to that of the asymptomatic group. This is similar to the results of Mitchell et al.,[12] who found no correlation between first metatarsal shortening and second metatarsalgia in a review of 100 distal metatarsal osteotomies. But one cannot assume that all changes encountered at the final follow-up were caused by the surgery. The forefoot spreads with time, patient weight increases, and certain types of shoes may also contribute to foot changes after 10 years. Therefore, the authors did not grade as failures the results of two patients who underwent Helal osteotomies for the treatment of metatarsalgia.

Sixteen patients had a hallux varus deformity. Analysis related the deformity to excessive resection of the medial eminence, overcorrection of the intermetatarsal angle (secondary to removal of an oversized wedge), and excessive capsulorrhaphy. Earlier, Mann et al.[11] had reported that a mild degree of varus angulation did not seem to bother the patient; we were able to confirm this statement. Only two patients with severe deformities (16° and 24°) were dissatisfied.[21]

There is no question that a basal osteotomy should be the standard treatment for severe metatarsus primus varus. The current study is the first to document long-term clinical outcome after basal closing wedge osteotomy.

The closing wedge osteotomy does have disadvantages. It is technically demanding because it is often difficult to determine the exact dimensions of the osteotomy from preoperative radiographs and because reproduction of the planned osteotomy is frequently difficult in vivo. It also entails the risk of shortening, dorsal malalignment, and metatarsalgia.

Comparison of the clinical outcome and, especially, patient satisfaction, in this series, to that of other series using proximal osteotomies for the correction of hallux valgus and metatarsus primus varus is possible only for mid-term and short-term results. In the current series, 68% of patients were very satisfied, but 13% were dissatisfied. These results were less favorable than the results reported in other series. Cedell and Anström,[2] noted 78% excellent results at 19 months;

Wanivenhaus and Feldner-Busztin[23] achieved excellent results in 22 of 26 patients at 34 months, and Resch et al.[13] achieved excellent results in 22 of 25 patients at 37 months.

In 1992, Mann et al.[11] published a retrospective review of 75 patients (109 feet) who underwent proximal crescentic osteotomy and distal soft tissue release. After a mean follow-up of 34 months, excellent results were achieved in 93%. More recently, Dreeben and Mann[3] presented the long-term follow-up of this procedure, with 85% excellent results. Russo-Alesi and Sammarco[14] reported 83% excellent results at a mean follow-up of 39 months after proximal chevron osteotomy.

In the current study, despite good correction of the intermetatarsal angle and sesamoid position, the clinical results and the incidence of complications after basal closing wedge osteotomy were not as favorable as those reported for other procedures in the literature. Therefore, alternative procedures, such as the basal crescentic osteotomy or the basal chevron osteotomy, should be used.

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June 8–11, 1996

56th Annual Meeting of Scientific Sessions of the American Diabetes Association. The deadline for abstracts was January 5, 1996. Original data may be accepted for exhibition in abstract, poster, and/or oral presentations. Abstract applications and meeting information may be obtained by contacting: Jill Thompson, American Diabetes Association, 1600 Duke St., Alexandria, VA 22314, Tel: 1-800-232-3472, ext. 212, Fax 703-683-1839.

June 13–15, 1996

The Foot and Ankle in Elite Athletic Competition, Atlanta, GA. Chairmen: Pierce Scranton, M.D., and Donald Baxter, M.D. For more information, contact the American Orthopaedic Foot and Ankle Society, 1-800-235-4855.

June 26–29, 1996

Summer Meeting, American Foot and Ankle Society, Hilton Head, SC.

July 5–6, 1996

21st Annual Meeting of the Japanese Society for Surgery of the Foot, Tokyo, Japan. For more information, contact Haruyasu Yamamoto, M.D., Department of Orthopaedics, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo-ku, Tokyo 113, Japan, Tel: 3-5803-5272, Fax: 3-5803-0142.

April 24–27, 1997

Third Congress of the European Federation of National Associations of Orthopaedics and Traumatology (EFORT), Barcelona, Spain. Organizer: Prof. A. Navarro, Hospital Vail d'Hebron, Orthopaedics Surgery and Traumatology Department. Organizing Secretary: Grupo Geyseco, Muntaner 77, Barcelona 08011, Spain, Tel: 34 3 453 92 89, Fax: 34 3 453 24 94.

ERRATA

In the Roger A. Mann Award article "Juvenile Hallux Valgus: Etiology and Treatment" by M. J. Coughlin (**16:**682-697, 1995, November issue), the artist has misrepresented the hallux valgus angle in Figure 1. The hallux valgus angle is the acute angle formed by the longitudinal axes of the first metatarsal and of the proximal phalanx. The artist is representing the hallux valgus angle as the solid obtuse angle of 140, as measured.

In the Author Index of December 1995 issue (**16:**819-824, 1995), the second entry under D. R. Bohay's name is incorrect. It should read:

Bohay, D. R.
Manoli, A., II: Foot Fellow's Review: Subtalar Joint Dislocations, 16:803

Sanders, Marcus, and Swanson did not contribute to this article.

In the article "Foot Function in Diabetic Patients after Partial Amputation" by Garbalosa et al. (**17:**43-48, 1996, January issue), co-author James H. Campbell's academic degrees and honors were listed incorrectly. The correct listing is: MBAPO.HDip.PO.

We deeply regret these errors and any inconvenience they may have caused.