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Proximal Oblique Sliding Closing Wedge Osteotomy for Hallux Valgus

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Abstract

Background: The proximal oblique sliding closing wedge osteotomy (POSCOW) technique was developed to address moderate to severe hallux valgus deformity. We present a retrospective multicenter study to analyze the midterm radiological and clinical outcomes of patients treated with this type of proximal osteotomy fixed with plates.

Materials and Methods: One hundred and forty-four patients (187 feet) were operated on between May 2005 and June 2010 in 2 separate centers. Inclusion criteria were symptomatic moderate to severe incongruent hallux valgus deformity, no significant restriction in the first metatarsophalangeal joint movement, none to minimal degenerative changes in the first metatarsophalangeal or the tarsometatarsal joints, and no hypermobility. The median age was 60 years. The preoperative hallux valgus angle (HV) was 35.6 degrees, intermetatarsal angle (IM) was 15.3 degrees, AOFAS score was 53 points. The median follow-up was 35 months (range, 12-73). A POSCOW osteotomy was performed in all patients and fixed with plates. We recorded the satisfaction rate, postoperative clinical and radiological results, and complications.

Results: The patient satisfaction rate was 87%. The mean postoperative HV angle was 12.3 degrees, IM angle 4.8 degrees, AOFAS score 89 points. The mean decrease in the first metatarsal length was 2.2 mm (range, 0-8). Twelve feet (6.4%) with recurrence of the deformity required revision surgeries. Removal of complete or partial hardware was needed in 23 feet (12.3%) for symptomatic hardware. Five feet (2.6%) developed hallux varus but only 2 required surgery. Transfer metatarsalgia was noted in 9 feet (4.8%).

Conclusions: The POSCOW osteotomy was an effective and reliable method for relieving pain and improving function. A learning curve was present, as most of the complications happened in the initial cases. To our knowledge, this is the largest reported series of proximal closing wedge osteotomy for hallux valgus deformities.

Level of Evidence: Level IV, case series.

Keywords: hallux valgus, proximal osteotomies, proximal oblique sliding closing wedge osteotomy

Introduction

Several proximal metatarsal osteotomies[3,7,15,20,21,23,26] have been described in the literature for moderate to severe hallux valgus deformity. Multiple modifications of each technique have also been published with different modes of fixation to reduce the complication rate. To date, none of the techniques has been found superior in all parameters. Proximal oblique sliding closing wedge osteotomy (POSCOW) of the metatarsal with plate fixation[28] has been recently described by Wagner et al[28] and appears to have superior results. The POSCOW technique is a modification of a lateral closing wedge osteotomy with lateral displacement of the distal segment along the inclined plane of the initial osteotomy. Based on its mathematical model,[5] the lateral displacement of the distal segment and the size of the closing wedge can be preoperatively determined in order to correct the deformity. As shortening is one of the most common drawbacks of any proximal osteotomy,[20,23,26] the addition of the oblique sliding component can

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compensate for the shortening caused by the closing wedge. The purpose of this retrospective study was to evaluate the clinical and radiological results of the POSCOW technique on patients with moderate to severe hallux deformity.

Methods

We retrospectively evaluated 144 patients (187 feet) operated on between May 2005 and June 2010 by 3 foot and ankle surgeons in 2 separate centers. Forty-three cases were bilateral. There were 132 women and 12 men. The median age was 60 years (range, 14-81). The median follow-up was 35 months (range, 12-73). Inclusion criteria were symptomatic moderate to severe incongruent hallux valgus deformity, restriction of less than 30 degrees in the first metatarsophalangeal joint movement, none to minimal degenerative changes in the first metatarsophalangeal or the tarsometatarsal joints (TMT) on preoperative radiographs, and no hypermobility, which was determined clinically. Every patient presented an incongruent first metatarsophalangeal joint, which has been described as a differentiating factor between pathological and normal hallux valgus alignment.[22] Patients with inflammatory arthritis, gout, mild deformities, poor skin quality, and poor circulation were excluded. The preoperative information (including range of motion of the first metatarsophalangeal joint and radiographic analysis) used in the study as well as for the AOFAS score were obtained from the patients' medical records. Standard weightbearing AP, oblique, and lateral radiographs were taken of each foot. Measurements were done according to Coughlin.[10] The mean preoperative hallux valgus angle (HV) was 35.6 degrees, and the mean intermetatarsal angle (IM) was 15.3 degrees. Nine of the 144 patients had previous bunion surgery. The median preoperative AOFAS score was 53 points. We recorded the satisfaction rate using the Johnson score,[17] postoperative change in HV and IM angle, first metatarsal length change, and complications after the surgery. Complications included any malunion, nonunion, infection, recurrence (defined as a recurrent hallux valgus deformity noted by the patient irrespective of the metatarsophalangeal angle), hallux varus, and hardware irritation. In addition to the hallux valgus correction with the POSCOW technique, other procedures were also done on some, such as Akin procedures, Weil osteotomies, percutaneous extensor tenotomies, and neurectomies. A distal modified McBride bunionectomy was also part of the standard protocol. The absolute length of the first metatarsal was measured on the AP view. The *t* test statistical method was used for analysis.

Surgical Technique

A medial longitudinal incision was made from the first TMT joint to just proximal to the interphalangeal (IP) joint. An inverted "L" capsulotomy was performed exposing the metatarsophalangeal (MTP) joint and proximal metatarsal. The incision was made just below the accessory extensor hallucis tendon. The first metatarsal was exposed and dissected subperiostically, leaving the lateral and plantar distal area intact to preserve circulation. The dorsal cutaneous nerve of the hallux was identified and protected in the dorsal flap. The MTP joint was inspected with osteophytes excised and drilling was carried out for small denuded cartilage areas. A resection of the medial eminence (medial to the sagittal groove) was performed. A lateral release was always performed, either through the joint or through a separate dorsal incision. The proximal first metatarsal osteotomy was performed 15 mm distal to the metatarsocuneiform joint, taking care to leave enough room for the proximal screw plate fixation. This osteotomy was marked with a fine marking pencil (Figure 1). A mark was also made following the longitudinal axis of the bone in order to make sure that no malrotation of the metatarsal bone was produced after the osteotomy. We then measured the calculated wedge on the lateral side of the bone with a metal ruler and drew the second osteotomy line on the bone. Using a microsagittal saw, the osteotomy was completed; first the distal cut, then the proximal as the latter was better stabilized by the base of the metatarsal. The lateral wedge was closed and the distal segment slid distally and laterally by abducting the proximal metatarsal segment with a small Key periosteal elevator (Figure 2). Fixation was performed with a mini-fragment plate, initially placed on the dorsal side and later in the series on the medial side of the bone. In the past 2 years, either a medial locked plate with or without compression screws were utilized. For this latter technique, 2 different plate models were used, both with locking screws (Figure 3). The temporary 1.6 wires were either removed or the tips bent, cut, and rotated against the bone (in osteoporotic bone situations). A mini bone anchor was utilized in 77 patients of these series, attached to the distal metatarsal to attach the capsule to the bone to prevent capsular slippage.[13] The distal capsulorraphy was "vest over pants" using 0 absorbable suture. Fluoroscopy was used to confirm the reduction of the MTP joint and sesamoids. The subcuticular layer was closed with 4-0 absorbable suture and the skin with 4-0 nylon suture.

Postoperative Course

The patients were placed in a soft bulky dressing with no pressure on or specific splintage of the great toe. A fiberglass cast (which was bivalved in the operating room) was applied over the dressing. The patients are mainly nonweightbearing (if a cast was applied) or weightbearing over the lateral side of the foot (if immediate use of a postoperative stiff sole shoe was indicated). At 2 weeks the sutures were removed and the patients were weightbearing as

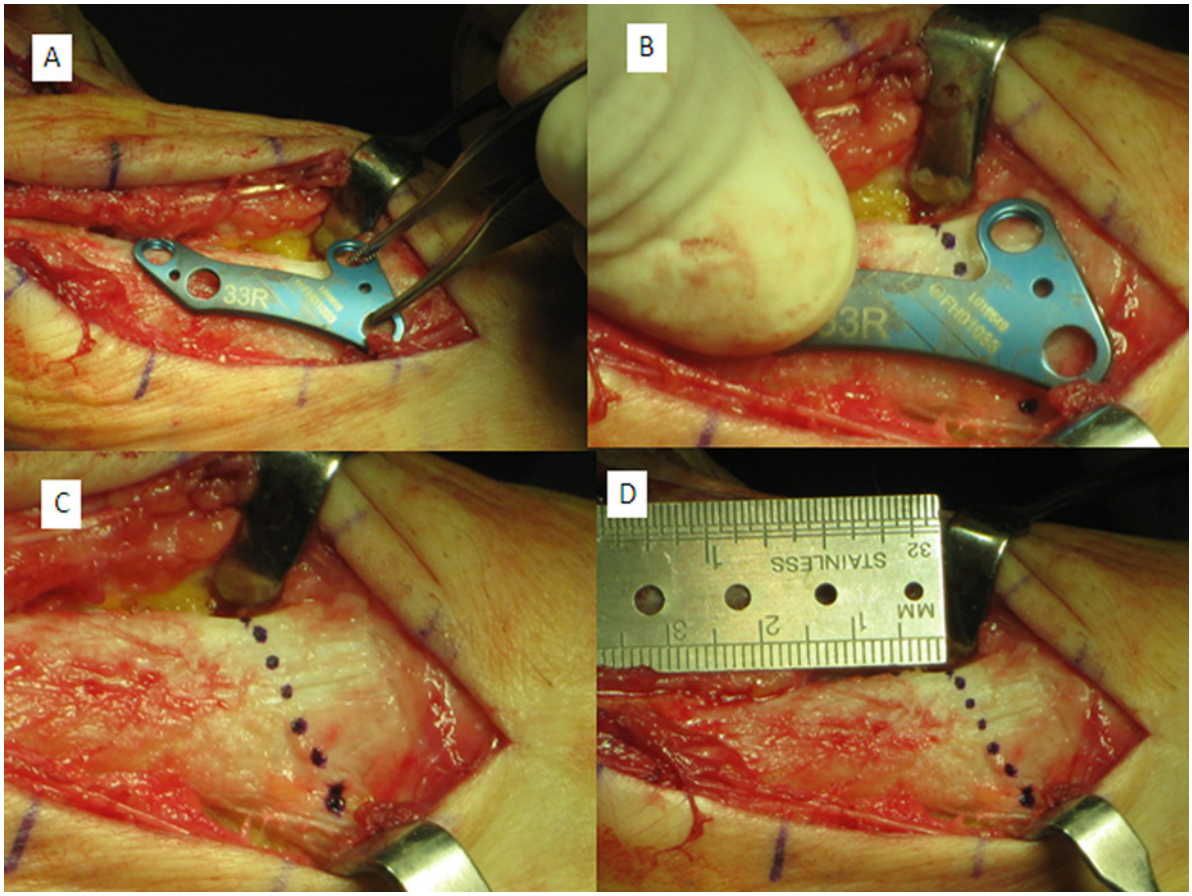

Figure 1. (A) Selecting plate and placement at base of first metatarsal. (B) Proximal osteotomy is cut parallel to and just distal to plate base. (C) Proximal oblique line. (D) Measuring width of wedge base

tolerated in an orthopedic wedge shoe (Barouch) or stiff sole shoe, which was used for weightbearing up to the 6-week interval. At 6 weeks the patient moved on to their own sandals or wide toebox closed shoes. Women were encouraged to delay the wearing of high-heeled shoes until the 9-month interval, at which time they were given no restriction on footwear. Walking exercise was allowed at 6 weeks and sporting activities at 3 months.

Results

The patient satisfaction rate was 87%. The mean postoperative HV angle was 12.3 degrees, with 24 degrees of improvement (range, 0-46) ($P < .05$). The mean postoperative IM angle was 4.8 degrees, with 10.5 degrees of improvement (range, 0-23) ($P < .05$). The mean decrease in the first metatarsal length was 2.2 mm (range, 0-8). The mean postoperative AOFAS score was 86 points (range, 25-100) ($P < .05$). Fifteen feet (8%) developed recurrence of the hallux valgus deformity requiring no treatment and 12 feet (6.4%) with recurrence of the deformity required revision surgeries. Five feet (2.6%) developed hallux varus but only 2 required surgery. Bone healing (diagnosed from plain x-rays) occurred at a median of 10 weeks. Two (1%) of them had nonunion, requiring revision surgery with plate exchange in one of them and surgical debridement for infection in the second one. One (1.2%) had failed fixation. Six (3.2%) patients had delayed union. Two patients developed minor wound dehiscence that healed with local wound care. Removal of complete or partial hardware was needed in 23 feet (12.3%) for hardware irritation. The vast majority of the cases requiring hardware removal corresponded to cases fixed with dorsal plates (91%). There was 1 (1.2%) incidence of broken screw, which was removed. No (0%) evidence of malunions noted. Transfer metatarsalgia was noted in 9 feet (4.8 %). Nineteen patients also had an Akin procedure for additional hallux valgus interphalangeus. Of 187 feet, 142 had additional lesser toe surgery including a combination of hammertoes, Weil osteotomies, percutaneous extensor tenotomies, and neurectomies.

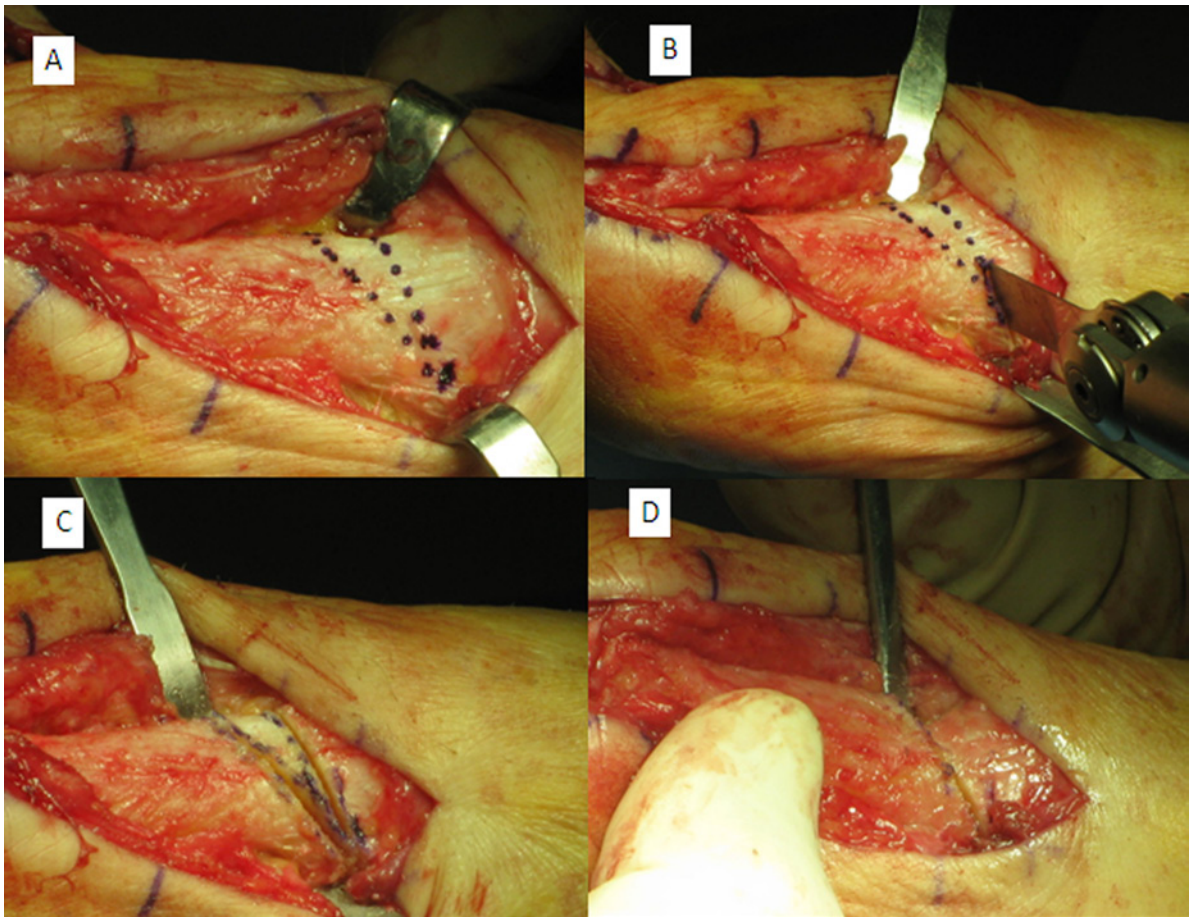

Figure 2. (A) Outlining the wedge. (B) Wedge is cut with microsagittal saw; complete base cut last. (C) 6 mm laterally based wedge. (D) Abducting proximal segment and closing wedge.

Discussion

More than 100 surgeries have been described for hallux valgus deformity correction. It is well accepted that moderate to severe hallux valgus deformity that requires surgical treatment needs to be corrected by a proximal metatarsal osteotomy.[2] A few of the popular proximal metatarsal osteotomies are the proximal crescentic osteotomy, opening wedge osteotomy,[9,24,25] Scarf[1,11,12] osteotomy, Ludloff osteotomy, modified Ludloff [3,7,15,21] osteotomy, lateral closing wedge[20,23,26] osteotomy, and cuneiform osteotomy.[18] Every procedure is unique and no surgery has been shown to be superior in the literature.

The POSCOW technique was developed by Wagner[28] to address moderate to severe hallux valgus deformity correction (Figure 4). The POSCOW corrects the intermetatarsal angle by both lateral translation and rotation of the metatarsal bone, thus achieving a more powerful correction. In this way it lessens the amount of rotation needed to create parallelism of the first and second metatarsals and decreases the likelihood of increasing the distal metatarsal articular angle. Second, the osteotomy tends to shorten the first metatarsal length, which decreases the tension on the first MTP joint, easing the ability to correct the alignment. The oblique osteotomy, however, makes up shortening caused by the lateral closing wedge, thus minimizing the negative effect of a shortening osteotomy (Figure 5).

The major problem associated with any closing wedge[20,23,26] osteotomy is shortening of the first metatarsal. The average shortening achieved by closing wedge osteotomy by studies described by Trnka et al[26] is 5 mm and 3.7 mm in some other studies described by Krismer and Eichenauer[19] and similar to that of Wanivenhaus and Feldner-Busztin.[29] Some loss of length may also be attributed to the method of fixation.[1] In the POSCOW technique,

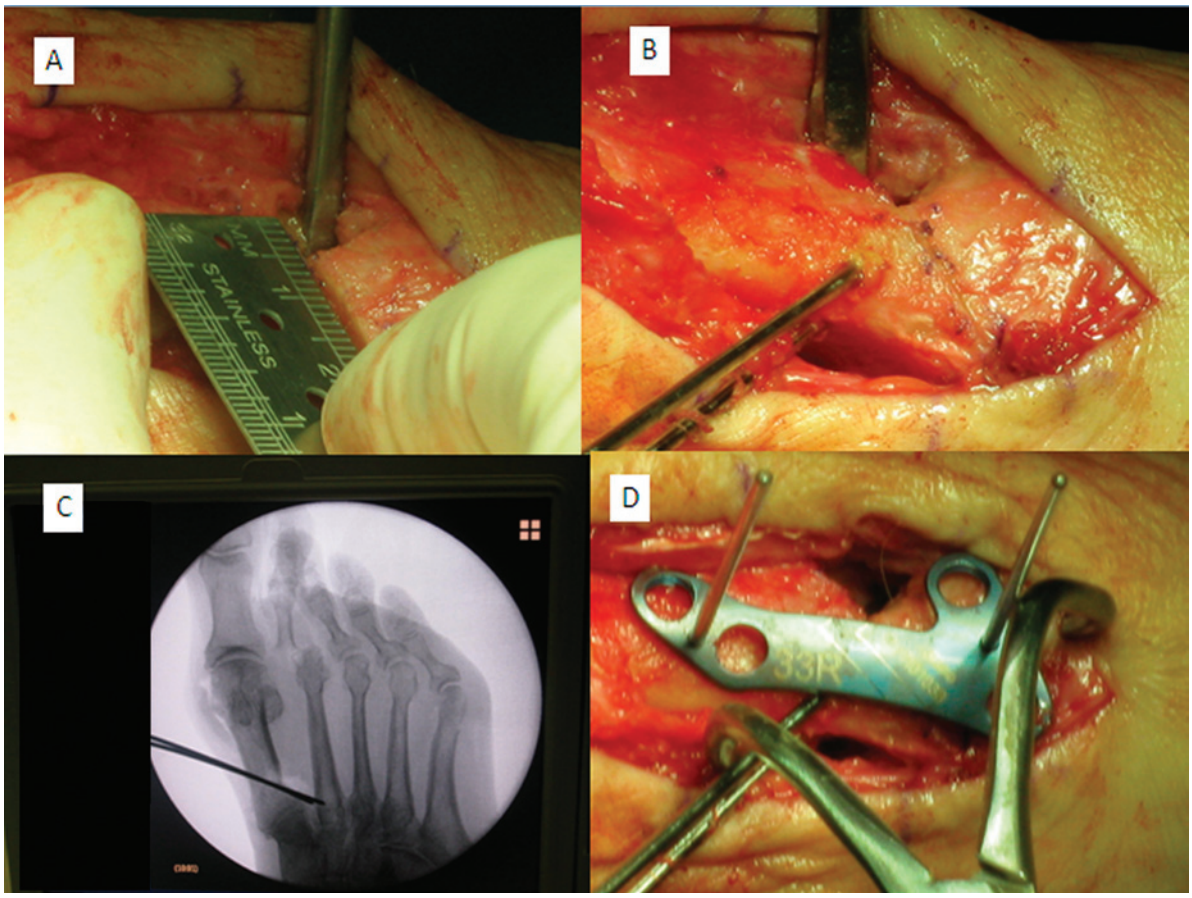

Figure 3. (A) Sliding the distal segment laterally up inclined plane 5 mm. (B) Fixing with 2 parallel 1.6 fixation pins. (C) Checking alignment. (D) Applying compression with tenaculum and applying plate.

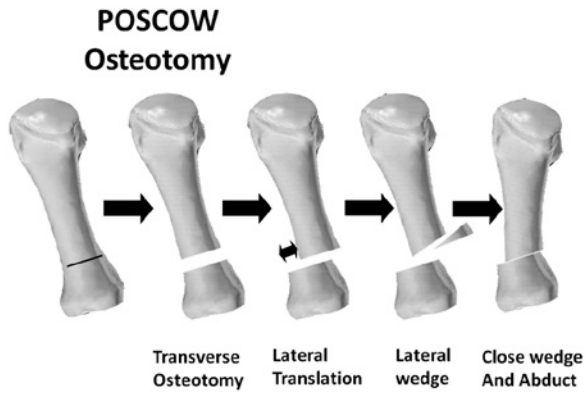

Figure 4. Diagram of proximal oblique sliding closing wedge osteotomy (POSCOW), depicting the transverse osteotomy, its lateral displacement, and removal of lateral closing wedge.

Figure 5. Preoperative and postoperative radiograph of a patient showing correction of hallux valgus deformity after using proximal oblique sliding closing wedge osteotomy (POSCOW) technique. Additional procedures included an Akin osteotomy and a modified Weil osteotomy of the second metatarsal.

Table 1. Improvement of Intermetatarsal (IM) and Hallux Valgus (HV) Angles in Proximal Metatarsal Osteotomies Published in the Literature.

Surgery	Author	No of Feet	Mean Follow-up in Years	Mean IM Improvement in Degrees	Mean HV Improvement in Degrees
Scarf	Crevoisier et al[11]	84	1.8	6	25
Cresentic proximal metatarsal osteotomy	Veri et al[27]	37	12.2	6	13
	Zettl et al[30]	114	2.1	10	26.5
Cresentic proximal metatarsal osteotomy	Buzzi et al[6]	50	5.6	8.6	25.8
Ludloff	Chiodo et al[7]	82	2.5	9	20
Opening wedge		64	1.6	6.4	14.7
Closed wedge	Haapaniemi et al[14]	167	8	10	16
	Nedopil et al[20]	86	4.4	11.1	12.1
Lapidus	Coetzee et al[8]	105	3.7	9.8	21
Proximal oblique sliding closing wedge osteotomy (POSCOW)	**Our study**	**187**	**2.8**	**10.5**	**24**

by the addition of the oblique sliding component, we can compensate for the shortening caused by the closing wedge. Therefore, we had very minimal shortening (average 2.2 mm) of the first ray and a small incidence of transfer metatarsalgia.

Regarding our results, the average correction of hallux valgus angle achieved by this surgery compares favorably with most of the other published series (Table 1).[7,8,14,20,27] The average reduction of the IM angle achieved by this technique is more compared to most of the other series published to date for proximal metatarsal osteotomies[3,7,8,15,19,21,25,27,30] (Table 1). Our study had no incidence of dorsal malunion, which is considered a key point in the evaluation of the basal closing wedge osteotomies.[20,23,26] Jahss et al[16] 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[23] were unable to determine how much of the observed dorsal displacement was produced intraoperatively and how much occurred as a result of postoperative migration. Recurrence is a known complication of any hallux valgus correction surgery. In series published by Buzzi et al[6] using a proximal crescentic osteotomy, the loss of correction was seen in 2 patients in 50 feet (4%) with average follow-up of 5.6 years. In the opening wedge osteotomy by Smith et al,[25] 2 of 64 (3.1%) had recurrence with average follow-up of 20 months. Scarf osteotomy published by Crevoisier et al[11] with an average follow-up of 22 months had 3 of 84 (3.5%) recurrence. The Lapidus procedure published by Bednarz PA et al[4] had 5 of 31 (16%) recurrence. In our series, 12 feet (6.4%) presented a severe recurrence of the deformity requiring revision surgeries. This was probably related to failure of fixation and soft tissue imbalance. After introduction of our current fixation plates, the incidence of complications including recurrence or failure of fixation became very infrequent, emphasizing the fact that achieving stable fixation of the osteotomy was key for a good result, even with early weightbearing. Finally, our complications of delayed union, nonunion, and hardware failure were comparable to other case series of proximal osteotomies.[1,3,11,12,15,21] As our patients presented with moderate to severe hallux valgus deformities, which included most of the time symptoms arising from the lesser toes and metatarsal bones, the correction achieved in the entire forefoot helped us to obtain a high satisfaction rate. Because of the median follow-up of 35 months, all of the complications were treated by that time. We always educated our patients about the risk of developing a complication, and its subsequent treatment, and we believe this helps to increase satisfaction.

The strengths of this study are that to our knowledge it is the largest series published to date using a proximal closing wedge technique for moderate to severe hallux valgus correction. We used a uniform technique for performing the proximal osteotomy, which allowed preoperative planning and all of them were fixed with plates. We believe that using medial plates for fixation helped decrease our complications such as recurrence or failure of fixation. Medial plates constructs are between 1.5 and 2.2 times stiffer than constructs using dorsal plates (unpublished data) and we believe should be preferred when fixing proximal metatarsal osteotomies.

The drawbacks for this study include its retrospective nature and that it is difficult to standardize treatment in hallux valgus surgery as more than 140 feet had additional procedures that might have some influence on the radiological, functional, and satisfaction results of our patients. Nonvalidated scoring methods were used, as they are widely

encountered in foot and ankle literature. The use of associated Akin procedure could influence the functional results of the POSCOW technique, confounding the results of the metatarsal osteotomy. However, the number of patients who received an Akin was low compared to the total study population. Regarding radiographic results, the Akin osteotomy could alter the HV angle, but not the IM angle, which was modified significantly in our patients. We favor the use of the Akin osteotomy in cases where the metatarsophalangeal soft tissue balance is intensely altered, therefore shifting the valgus pull of the flexor and extensor tendons to the medial side of the joint, hopefully avoiding recurrence. The learning curve for this technique is steep, as we observed most of our complications in our first 40 cases. Our follow-up is intermediate term, and a longer follow-up is recommended.

Conclusion

The POSCOW osteotomy was an effective and reliable method for relieving pain and improving function. A learning curve was present, as most of the complications happened in the initial cases. We suggest that this proximal metatarsal osteotomy modification provides a more regular surface with very good bone contact that should assure adequate bone healing and may allow for a faster rehabilitation. This new osteotomy combined rotation and displacement achieving excellent postoperative correction, and it allowed preoperative planning, which we believe allowed us to obtain better and more reliable results in our patients.

Declaration of Conflicting Interests

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