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Preliminary Experience With a Minimally Invasive Technique for Hallux Valgus Correction With No Fixation

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Abstract

Background: Percutaneous operative techniques for hallux valgus (HV) correction are less damaging to soft tissues and the first metatarsophalangeal joint, and they carry a lower risk of wound complications. We report our preliminary results using a percutaneous technique that allowed correction of the deformity without internal fixation.

Methods: One hundred ninety-five consecutive patients with isolated symptomatic HV were surgically treated using a percutaneous technique without any form of internal fixation, with a mean follow-up of 34.6 months. The American Orthopaedic Foot & Ankle Society (AOFAS) hallux-metatarsophalangeal-interphalangeal scale score was used for clinical assessment. Radiographic evaluation included pre- and postoperative assessment of the hallux valgus angle (HVA), intermetatarsal angle (IMA), distal metatarsal articular angle (DMAA), and sesamoid position in weightbearing radiographs.

Results: According to the AOFAS score, the patients improved from a preoperative median of 54.7 to 89.6 at 2 years' follow-up ($P = .002$). Patients were satisfied or very satisfied in 94% of cases at the latest follow-up. A mean radiographic correction of the HVA of 15.5 degrees, of the IMA of 5.4 degrees, and of the DMAA of 5.4 degrees was achieved. The AOFAS global score and every individual parameter improved significantly between pretreatment and latest follow-up ($P > .01$). A total of 19 (9.7%) complications were reported.

Conclusion: This percutaneous technique, which did not use any form of internal fixation described, produced durable results for the correction of HV, reliably correcting the deformity and resulting in significant improvement in function and decrease of pain.

Level of Evidence: Level IV, retrospective case series.

Keywords: hallux disorders, forefoot disorders, percutaneous surgery, outcome studies

Hallux valgus (HV) is a common condition with progressive abduction and pronation of the proximal phalanx of the hallux; adduction, pronation, and elevation of the first metatarsal; and lateral capsular contracture of the first metatarsophalangeal joint.[9] In the last decade, there has been a growing interest in the use of minimally invasive surgery for the correction of HV.[3,4] In percutaneous techniques, correction of the deformity can be obtained with different osteotomies, surgical approaches, and fixation devices.[4] There is not much variation in outcome and complication rates among the 5 more widespread minimally invasive techniques to correct HV (Bosch, chevron-Akin, Reverdin-Isham, Endolog, and distal soft tissue release and fixation).[11] The most common complication following minimally invasive foot procedures is recurrence of the deformity.[9] The present study reports the middle-term clinical and radiographic results of a percutaneous technique that allowed correction of the deformity without any fixation.

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Figure 1. A 3.1 × 13–mm Wedge burr is used to shave the bunion.

Methods

Indications

A minimally invasive procedure was used to correct a reducible HV with a hallux valgus angle (HVA) up to 18 degrees and intermetatarsal angle (IMA) up to 9 degrees. Contraindications included severe deformity, with the IMA angle greater than 20 degrees,[11] severe degenerative disease or stiffness of the metatarsophalangeal joint, dorsomedial or dorsal dislocation, severe deformity with dislocation, or hammertoe.[10]

Patients

From May 2008 to July 2012, a total of 195 consecutive patients (18 males [9.3%]; mean age, 51.8 years; and 177 females [90.7%], mean age, 46.9 years) underwent correction of a unilateral painful mild to moderate HV using the without osteosynthesis (WOS) procedure. For the purposes of the present study, we included patients between 20 and 70 years with symptomatic HV. We excluded patients who presented with stiffness of the involved first metatarsophalangeal joint, rheumatoid arthritis, or other inflammatory conditions. We also excluded patients with diabetes, neurological disorders, hypermobility of the first tarsometatarsal joint, previous surgery on the same foot, and previous surgery for contralateral HV. We also excluded patients with bilateral HV, and patients with associated deformities of the lesser toes requiring surgery. We used strict selection criteria to avoid possible confounding factors, ensuring that they were applicable to patients with unilateral isolated HV. All procedures were performed by the same surgeon using a standard operative technique, and all patients underwent the same postoperative protocol. All procedures were performed under ankle block anesthesia[10] using ultrasonography or a nerve stimulator to inject 10 mL of 1.5% mepivacaine hydrochloride (Infomed Fluids srl, Bucharest, Romania). The American Orthopaedic Foot & Ankle Society's (AOFAS) hallux-metatarsophalangeal-interphalangeal scale was used for clinical assessment. All patients were prescribed antithromboembolic prophylaxis for 12 days postoperatively with heparin sodium 4000 UI/day subcutaneously as per institutional protocol. Patients also received 1 g of cefazolin in the preoperative phase and 1 g/day of amoxicillin for the 5 days following the procedure, per institutional protocol.

Operative Technique

With the patient supine with the foot protruding about 20 cm beyond the edge of the operating table (to allow easy access to the image intensifier), the surgeon sat facing the medial aspect of the foot.

- A 3-mm incision was made with the tip of a number 11 scalpel, immediately behind the medial sesamoid. The nick-and-spread technique was used, and the incision was deepened bluntly toward the center of the head of the first metatarsal. This was followed by the insertion of a curette to separate the capsule of the first metatarsophalangeal joint from the underlying bone.

  Employing a "windscreen wiper" action, a 3.1 × 13–mm Wedge burr (cat. 256016; FH Orthopedics SAS, Heimsbrunn, France) was used to shave the bunion (Figure 1). This produced a toothpaste-like mixture of bone debris and blood, which was squeezed out manually through the incision.
- Through the same incision, a 2.0 × 12–mm Shannon burr (cat. 256018, FH Orthopedics SAS) was used to perform an extracapsular subcapital osteotomy of the first metatarsal, perpendicular to its longitudinal axis (Figure 2A and B). The osteotomy could be translated up to 90% of the diameter of the metatarsal shaft, thus recentering the sesamoids and realigning the first ray.
- Using a Beaver 64 scalpel (Rüttgers, Solingen, Germany) through a small dorsal incision, immediately lateral to the metatarsophalangeal joint, we released the lateral soft tissues and the transverse head of the abductor hallucis (Figure 3), to allow translation of the first metatarsal head. Without image intensification, the blade of the Beaver 64 scalpel was inserted parallel to the longitudinal axis of the bone, between the proximal phalanx and the head of the first metatarsal to avoid damaging the dorsal digital nerve. The blade was then turned 90 degrees laterally to cut the tendon and perform a capsulotomy.
- In patients with a high DMAA (10 degrees and above), presenting a curved proximal phalanx, we made a small incision at the base of the proximal

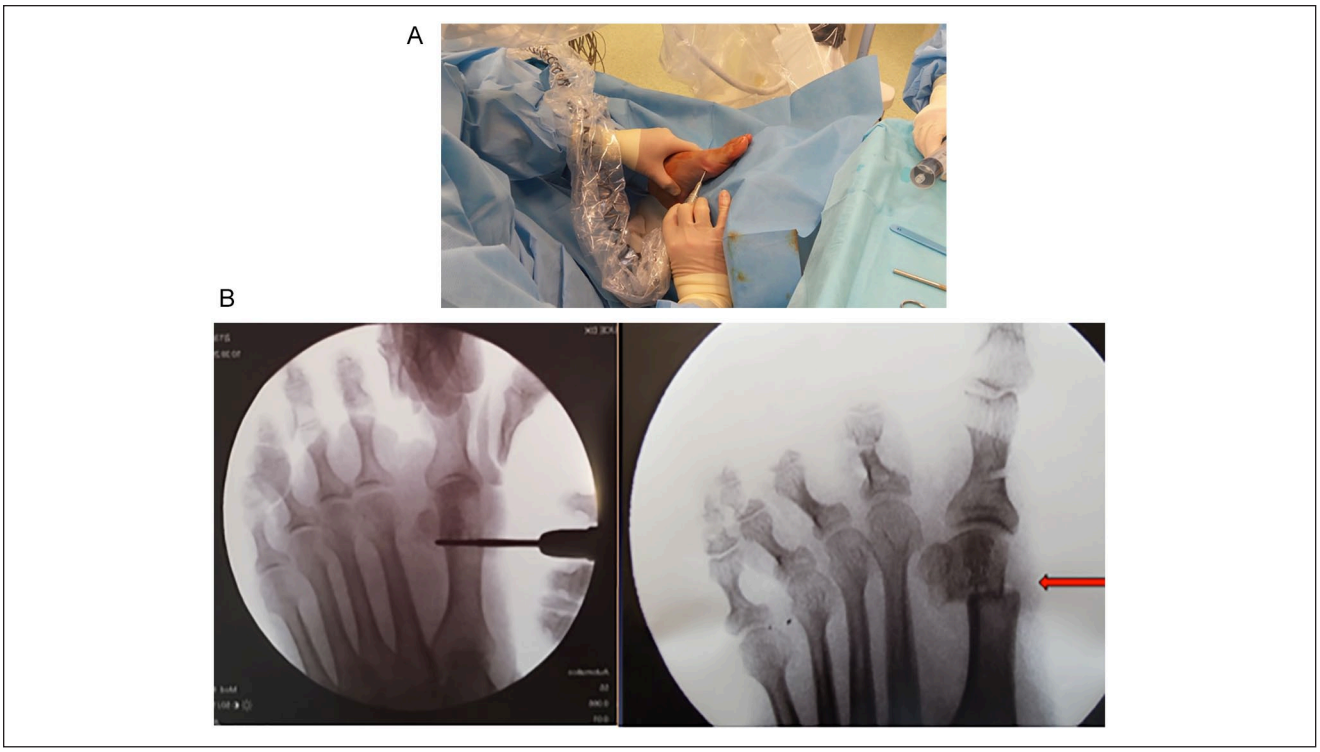

Figure 2. (A) Osteotomy of the first metatarsal using a 2.0 × 12–mm Shannon burr. (B) Radiographic view of the osteotomy of the first metatarsal and translation of the distal fragment (arrow).

Figure 3. Release of the lateral soft tissues and the transverse head of the abductor hallucis with a beaver blade.

Figure 4. Akin osteotomy of the proximal phalanx of the hallux (patient with a DMAA >10 degrees).

phalanx of the hallux and used a 2.0 × 12–mm Shannon burr (FH Orthopedics SAS) to perform an Akin osteotomy (Figure 4).

If a valgus deformity of the distal phalanx was present, we made a small incision, slightly more distal (very close to the distal interphalangeal joint), to correct the valgus of the distal phalanx to better correct the deformity. When performing this osteotomy, we kept the lateral cortex intact to achieve a hinge effect, so that the osteotomy was stable when we performed the definitive correction of the whole first ray. A double osteotomy of the phalanx was not performed.

- After obtaining the desired correction, an appropriate dressing was applied. The dressing consisted of taping made of cotton lint, universal tape, and bandage. The dressing circled the hallux, which was positioned correctly, avoiding hypercorrection. The dressing was replaced 2 weeks after the index procedure and was kept in place for a total of 6 weeks, or until complete bony union (Figure 5). Patients were allowed to walk immediately after the procedure in a shoe with a flat, stiff sole.
- A radiograph was obtained 1 month after the operation. Another radiograph was taken at 3 months, and a third one at 6 months after the index procedure.

Figure 5. Dressing placement.

All patients were reviewed in an ad hoc clinic at a mean of 34.6 months postoperatively (range, 22-51 months), undertaking a clinical and radiographic assessment. For the clinical and radiographic assessment, we used the AOFAS hallux-metatarsophalangeal-interphalangeal score. The radiographic evaluation was completed calculating the HVA,[5] IMA,[12] distal metatarsal articular angle (DMAA),[13] and the sesamoid position in weightbearing anteroposterior radiographs and lateral weightbearing anteroposterior radiographs. All radiographic measurements were performed by the same individual (O.C.), who was not involved in the management of the patients and was unaware of their clinical outcome. All measurements were performed using a commercially available program (AGFA CR 25.0). Measurements were performed twice, 2 to 4 weeks apart, and the mean of the 2 measurements was used for statistical analysis.

Statistics

Descriptive statistics were calculated. The Student *t* test was used for analytical statistics. Quantitative variables were expressed as medians. Qualitative variables were expressed as figures and percentages. Significance was set at $P \leq .01$.

Results

According to the AOFAS score, the patients improved from 54.7 preoperatively to 89.6 at the latest follow-up ($P = .002$). Patients were satisfied or very satisfied in 94% of cases at the latest follow-up appointment. A mean radiographic correction of the IMA of 5.4 degrees (the largest IMA correction grade reached was 18 degrees), a mean HVA correction of 15.5 degrees, and a mean correction of the DMAA of 5.4 degrees were achieved. The AOFAS global score and every individual parameter improved significantly between pretreatment and latest follow-up ($P > .01$). The sesamoid position decreased from 2.9 to 1.

A total of 19 (9.7%) complications were reported:

- Two patients developed a local infection, which was treated with antibiotics for 2 to 6 weeks. In both

Figure 6. Tilt of the first metatarsal head 30 months postoperatively.

instances, the infection resolved uneventfully, and the AOFAS score was excellent.

- One patient developed a deep vein thrombosis on the operated limb. This patient had decided to stop the prescribed prophylaxis. Routine management of the deep vein thrombosis was instituted, with satisfactory outcome.
- Five patients presented delayed bone union (6 months postoperatively) with persistent pain and swelling around the first metatarsophalangeal joint. They were managed using pulsed electromagnetic fields with the IGEA Biostim (Carpi, Modena, Italy) for 2 months. The duration of the daily treatment with BIOSTIM therapy was at least 6 to 8 hours and was performed during the day (the treatment can be divided into 4 sessions of 2 hours) or during the night hours. At the 12-month follow-up, in 3 of these 5 patients the osteotomy had healed and the pain had disappeared. The other 2 patients developed a pseudarthrosis: in one patient the pain was no longer present by the 12-month follow-up and she did not wish any further intervention; the other patient was reoperated elsewhere and did not attend for follow-up.
- Two patients developed transfer metatarsalgia. In one, the symptoms resolved using a custom-made orthotic. In the other, a percutaneous osteotomy of the second to fourth metatarsal neck was performed[2] with resolution of symptoms.
- Two patients developed medial tilting of the metatarsal head; this resulted in pain from rubbing against the footwear. A 3.1 × 13–mm Wedge burr (FH Orthopedics SAS) was used to percutaneously remove the bone. Both patients reported resolution of symptoms 2 weeks after this second procedure (Figure 6).
- In 7 patients, the HV recurred, but the HVA was lower than the value before treatment. These 7 patients were dissatisfied because of the cosmetic result, but only 2 underwent a further procedure.

Of note, 23% of our patients were smokers. This could have been a contributing factor in the complication rate. None of our patients developed hallux varus or osteonecrosis of the head of the first metatarsal by the latest follow-up. No neurovascular complications were found.

Discussion

The most important finding of the present investigation is that the WOS technique produced reliable and durable results, consistent with other open, minimally invasive, and percutaneous techniques for HV correction.[10,11] The WOS technique was developed following our 10-year experience with the percutaneous technique of Reverdin-Isham.[6] We noticed that when the percutaneous osteotomy of the first ray to correct the DMAA angle was also accompanied by a lateral translation of the head of the first metatarsal, as

described by Bosch,[3] better angular correction of the deformity (IMA and DMAA) was achieved, and the results were more likely to persist over time. We therefore hypothesized that the translation of the head of the first metatarsal, with no stabilization by internal fixation, would allow further corrective opportunities. The results of the present investigation seem to confirm our hypothesis. No neurovascular complications were found. As we have specified, however, the senior surgeon (G.L.) was experienced in minimally invasive HV surgery, and this may account for such findings. Probably, however, the main reason is related to the shape of the burr used for the osteotomy. The peculiar structure of its microblades allows the burr to only affect the bone, sparing the surrounding soft tissues.

The results of the present study are encouraging. Other outcome studies on minimally invasive HV correction techniques have reported an unacceptably high rate of complications. For example, Kadakia et al[8] reported a 69% rate of dorsal malunion, and 39% of their patients experienced recurrence of the deformity. It should be noted, however, that these authors did not place their osteotomy, as recommended, in a subcapital location, but more proximally in the shaft of the first metatarsal, and used 1.6 mm instead of the recommended 2-mm Kirschner wires. The use of burrs to produce the osteotomy has been criticized, as it may shorten the first ray. Usually, in expert hands, this shortening is in the order of 2 mm. Jung et al,[7] in a cadaveric study, showed that shortening of 5 to 10 mm is necessary to produce changes in plantar pressure. Kadakia et al[8] were not able to obtain a suitable plantar displacement of the head of the first metatarsal, and their patients developed an unacceptably high rate of dorsal displacement of the head of the first metatarsal. However, the location of their osteotomy was not the prescribed one (ie, subcapital), but markedly more proximal in the diaphyseal portion of the first metatarsal, and made the correction achieved inevitably less stable. We found that with the use of gentle manipulation of the metatarsal head and a well-placed postoperative bandage, this complication was prevented. Stiffness of the hallux may well be inevitable, given the detritus of bone produced by the procedure, and this is the reason we try to evacuate the "toothpaste" produced by trimming the bunion.[1] Our rate of recurrence of the deformity is consistent with that in the literature with other surgical techniques.

The operative technique reported in the present investigation has several strengths. First, the WOS procedure did not include the placement of a Kirschner wire for fixation and required little operative time. The technique was effective, being able to correct the various components of HV, with a high rate of durable excellent and good results. Finally, this technique was cost-effective, as no special instruments were needed and no internal fixation was used.

We are aware of the limitations of this study. First, we had a nonhomogeneous series due to the wide age range and the different grade of the deformities. However, we only reported on patients with unilateral HV in whom no lesser toe deformities requiring surgery were present. In this way, no confounding factors influenced the outcome of HV correction. The presence of associated lesser toe deformities could have affected the final results, particularly the clinical parameters such as pain and limitation in activities of daily living and shoewear.

Conclusion

This operative technique was reliable and effective. The correction obtained and the clinical outcome were satisfactory in the vast majority of patients. We advocate the use of this percutaneous technique for the correction of unilateral isolated HV, but we caution against the indiscriminate use of these techniques without appropriate training and supervision.

Declaration of Conflicting Interests

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