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Original article

First metatarsal extracapsular osteotomy to treat moderate hallux valgus deformity: the modified Wilson-SERI techinique

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Abstract. From February 2017 to December 2018, 20 patients (a total of 20 feet) had undergone the proposed modified Wilson-SERI osteotomy technique, for moderate hallux valgus. The mean age of patients was 58,25 years (range 19 to 78). The hallux valgus angle (HVA), the intermetatarsal angle between first and second metatarsal bone (IMA) and the distal metatarsal articular angle (D.M.A.A) were measured. The feet were assessed based on the scoring system used by Broughton and Winson and by the American Orthopedic Foot and Ankle Society (AOFAS) hallux-metatarsophalangeal-interphalangeal scale. All twenty one patients were followed up postoperatively for a minimum of 12 months. No patient was lost at follow-up. The mean HVA angle decreased significantly from 31,1° before surgery (range 22.9°-40°SD 5.0) at 11,2° (range 2.5° to 22.0°SD 5.3) at twelve months follow up. The mean IMA angle decreased significantly from 12,5° (range 8.0°-18.6°SD 3.8) before surgery at 7,4° (range 3.4°-14.0°SD 2.5) at twelve months follow up. The mean DMMA angle decreased significantly from 15.1° (range 5.3° to 20.0°SD 4.4) before surgery at 7,4 °(1.5° - 10.7°SD 2.5) at twelve months follow up. The mean score according to the AOFAS forefoot was increased from 22,1 (range 13-30 SD 5.0) to 88,2 (Range 77-96 SD 5.2) ($p<0.0001$). No complications, like dislocations, avascular necrosis of the first metatarsal and deep venous thrombosis, were observed in the postoperative period. We consider the Wilson-Seri procedure as a low cost minimal invasive and stable technique that could be a valid alternative to the various metatarsal osteotomies in the treatment of moderate hallux valgus deformity. Short term results at twelve months after surgery are quite satisfactory but further studies are necessary, to better comprehend an overall outcome of such approach in the long run.

Key words: hallux valgus; metatarsal osteotomy; foot surgery, minimally invasive

Introduction

The first description of a surgical technique for the treatment of hallux valgus dates back to 1871; since then, many approaches have been proposed, as alternative therapeutic methods (1). This evolution reflects a better understanding of the anatomy and biomechanics of the foot over years, as well as a development of new technologies and surgical devices to be used (2). In this context, multiple surgical approaches have been suggested for the treatmentof moderate hallux valgus. Distal osteotomy of the first metatarsal bone is one of the most popular procedures for surgical correction of this kind of deformity (3,4). During the last decade, there has been a growing interest in minimally invasive surgery (MIS) and percutaneous techniques. These

procedures are characterized by skin incisions, smaller than 1 cm, an excellent preservation of the soft tissues and the use of very specialized equipment (5,6). Some of the advantages of MIS surgery match perfectly with the current demands of modern healthcare: reduction of morbidity, good surgical times, low infection frequency and fast recovery (7).

Wilson's technique, for instance, consists of an oblique distal extra-articular osteotomy of the first metatarsal bone, combined with remodeling of the medial exostosis (8).

Following the trend of the growing popularity of minimally invasive surgery, Giannini and collaborators proposed a technique called SERI, acronym for Simply Effective Rapid Inexpensive. The application of this technique has not been limited to proposing surgeons and over the years had wide diffusion and validation (9-13). Here, we first describe a novel minimally invasive first metatarsal extracapsular osteotomy that combines features of both the aforementioned procedures, which the authors subsequently called "modified Wilson-SERI". We conclude presenting the preliminary mid-term outcomeof this method.

Materials and Methods

Ethical Considerations: the patients, after consult with the surgeon, signed an informed consent to undergo a surgical procedure consisting of a combination of two safe and widely validated techniques, and to allow divulgation of anonymous images, video, radiographs and data for scientific purposes.

From February 2017 to December 2018, 20 patients (for a total of 20 feet) underwent the proposed modified Wilson-SERI osteotomy technique, for moderate hallux valgus, by a single surgeon (the first author of this manuscript).

Patients with concomitant other pathologies of foot or previous second transfer metatarsalgia were excluded.

The mean age of patients was 58,25 years (range 19 to 78 years, SD 17.37), 18 women and 2men were retrospectively evaluated.

Indications for surgery included:skin irritation, bunion, difficulty with wearing shoes, functional disability because of pain located at the first metatarsophalangeal joint (14,15). The radiographic images of all eligible subjects were obtained from the Picture Archiving and Communication System (PACS) of our Institution and examined in 2 standard X-rays projections (dorsoplantar and lateral projections of the foot in a weight-bearing position). All patients underwent radiographs for preoperative evaluation (usually 1 month before surgery), secondly at the end of the surgery and finally during follow-up at 30 days, 6 months and 12 months. Follow-up visits were scheduled at 7 and 14 days in postoperativetime, so as to check the surgical incision, then approximately 30 days after surgery and at 3, 6 and 12 months.

We measured the hallux valgus angle (HVA), the intermetatarsal angle between first and second metatarsal bone (IMA) and the distal metatarsal articular angle (D.M.A.A).

Hallux valgus was classified as: mild (HVA ≤19°), moderate (HVA 20°-40°), and severe (HVA >40°). Only cases with moderate hallux valgus deformity were includedin our study (HVA, 20°-40°; IMA 11°-20°). Angle measurements were made using the DICOM visualization software (Syngo Studio Imaging VB36C, Siemens Healthcare, Erlargen, Germany) in use at our institution (San Carlo Borromeo Hospital, Milan, Italy).

Statistical analysis was undertaken using"R" for Windows version 3.6.1 (2019-07-05) (R Core Team 2019, R Foundation for Statistical Computing, Vienna, Austria. (https://www.R-project.org/). Measurements were carried out by three of the authors who did not perform the surgical procedure: the head of our department, a resident surgeon and a surgeon with experience in foot surgery; pre-operative x-rays, and follow-up x-rays at 30 days and 12 months were object of these measurements. The authors have followed the American Orthopaedic Foot and Ankle Society (AOFAS) guidelines published in 2002 (16).

Feets were assessed based on the scoring system used by Broughton and Winson (17). Results were classified as "excellent" when the patient achieved Grade 1 in all categories, "good" when the patient had no more than two Grade 2's and no Grade 3's, and "poor" in any other case. Patients were asked to fill in the questionnaires, unassisted, while attending

a pre-admission clinic and while attending the 12 months follow-up consultations. For evaluation of the development of second transfer metatarsalgia, callosity or tenderness beneath the second metatarsal head was investigated at the 12 months follow up. The two-sample t-test with equal variances was used to compare preoperative and follow-up AOFAS scores. A p value of <0.05 wasconsidered statistically significant.

Surgical technique

All patients received as antibiotic prophylaxis 2 grams of cephazoline 30 minutes prior to skin incision. They were positioned supine without a pneumatic tourniquet. A blade number 11 was used for a 1.5 - 2cm longitudinal skin incision and then forced towards the medial site of the first metatarsal bone just proximal to the bunion, and, by using electrocauterization, it could reach the cortex. By using a Shannon 2.1x12mm (Shannon long burr / MIS, FH Orthopedics, Heimsbrunn, France) a fail-safehole was created as a starting point, from which the dorsal and plantar osteotomy cuts could proceed. The fail-safe hole was drilled and reached from the medial to the lateral cortex at a 90° angle to the long axis of the second metatarsal bone. Small and curved Klemmer forceps were used to separate the capsule from the medial eminence of the first metatarsal head. Using the same Shannon burr, we were able to start the osteotomy from the fail-safe hole and subsequently carry it out, keeping the angle at 45° from the proximal and lateral site to the distal and medial one.

The Shannon burr was then inserted into the fail-safe hole to produce the plantar arm of the osteotomy. The osteotomy plane was about 70° to 90° to the supporting surface and proximal to the sesamoid bones. A V-shaped osteotomy of a 115° to 135° angle was created (Figure 1, Figure 2). With the Shannon burr

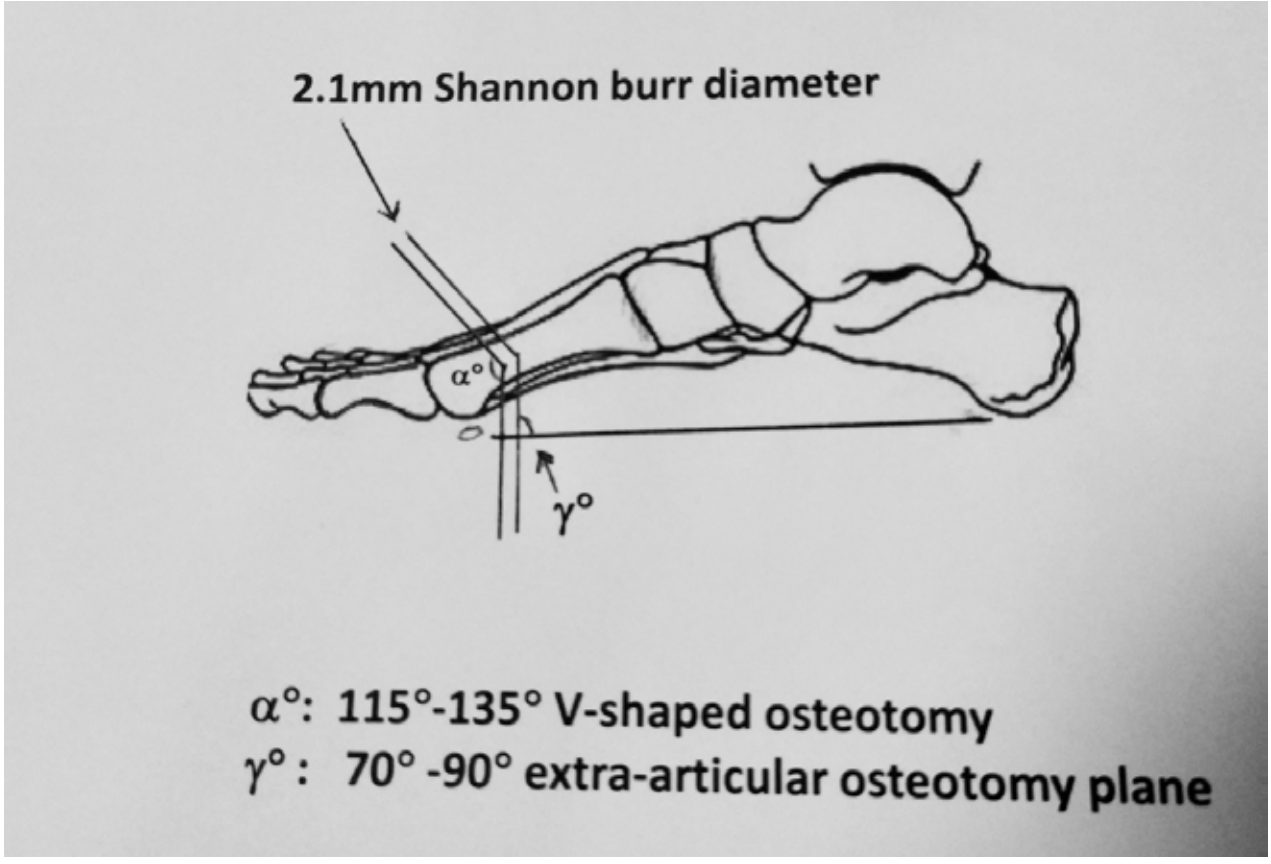

Figure 1. Osteotomy level of the first metatarsal bone by the Shannon burr.

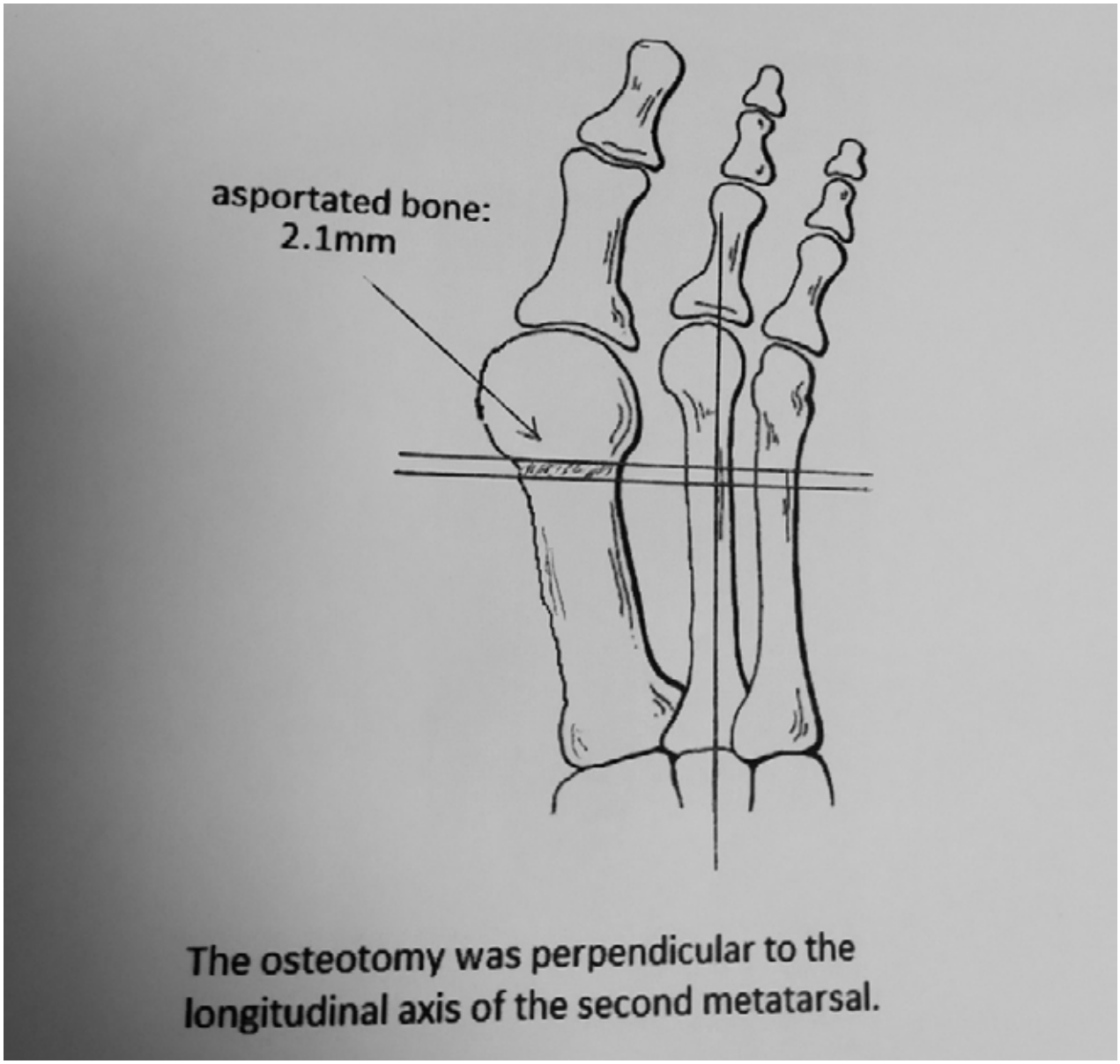

Figure 2. Osteotomy level of the first metatarsal bone by the Shannon burr.

approximately 21 mm of bone was removed, a restrained shortening of the first metatarsal was achieved. The distal fragment was then distracted, pushed down on plantar direction and displaced laterally. A large Klemmer was used to displace the osteotomy. Washout of bone debris was performed using a 10ml syringe filled with physiological saline solution. According to Giannini, a 2-mm Kirschner wire was inserted to stabilize the osteotomy (12). It was first inserted in the distal direction through an incision onto the soft tissues, under the capsule and adjacent to the bone, along the longitudinal axis of the great toe, coming out near to the nail of hallux. Then, the wire was withdrawn from the tip of the toe, until its proximal end reached the osteotomy line. The Kirschner wire was inserted in a retrograde manner through the osteotomy site into the diaphyseal medullary cavity of the first metatarsal bone up to the base of it (Figure 3, Figure 4, Figure 5).

Figure 3. Preoperative X-ray image showing bilateral hallux valgus deformity.

When the proximal stump of the osteotomy was medially prominent, the excessive bone had to be removed, using a Wedge burr 3.1x13mm (Wedge burr / MIS, FH Orthopedics, Heimsbrunn, France). The incision was closed using a 3-0 Safilquick®absorbable suture (BBraun, Melsungen, Germay).

Postoperative rehabilitation

A functional bandage and TD (Podartis, Crocetta del Montello, Italy) or PodaLight (DJO, Lewisville, TX, USA) heel bearing shoes were used for 30 days with immediate full weight bearing allowed. The sutures were removed 14 days in post-operative time. Patients were followed up at 7,14 30 days and 3, 6,12 months.

Results

All 20 patients were followed up postoperatively for a minimum of 12 months. No patient was lost

Figure 4. Dorsoplantar and lateral projection post surgery radiographs of the left foot.

Figure 5. Radiogram at 18 months after surgery at the left foot. The right foot was not included in our study because of short follow-up (6 months). Combined modified Wilson-SERI osteotomy was used in both sides.

at follow-up. The mean HVA angle decreased significantly from 31,1° before surgery (range 22.9°-40°; SD 5.0) at 11,2° (range 2.5° to 22.0°; SD 5.3) at 12 months follow up. The mean IMA angle decreased consistently from 12,5° (range 8.0°-18.6°; SD 3.8) before surgery at 7,4° (range 3.4°-14.0°; SD 2.5) at 12 months follow up. The mean DMMA angle decreased significantly from 15.1° (range 5.3° to 20.0°; SD 4.4) before surgery at 7,4° (range 1.5° - 10.7°; SD 2.5)at 12 months follow up.

The mean score according to the AOFAS forefoot increased from 22,1 (range 13-30; SD 5.0) to 88,2 (Range 77-96; SD 5.2) ($p<0.0001$). Periosteal reaction was evident in all patients by 4 weeks after surgery. A good callus formation was well appreciated at 6months follow up after surgery in all patients.

Pre-operatively, 15 patients were classified as grade 3 and5 patients presentedgrade 2 according to the Broughton and Winson's scoring system. At 12months follow up, 18 patients had grade 1 and 2 patients had grade 2.

There was one case of transfer metatarsalgia at rays 3 and 4 treated successfully conservatively with metatarsal pad.

No complications, like dislocations, avascular necrosis of the first metatarsal bone, deep venous thrombosis or osteomyelitis were observed in the postoperative period.

There was one case with superficial wound infection,solved with antibiotic therapy. Moreover, no intra-operative fractures, vascular or nerves lesions occurred. Finally, there was not any delayed consolidation or a non-union case at the osteotomy site.

Discussion and Conclusion

Several types of distal metatarsal osteotomy approaches have been reported with a high rate of good to excellent clinical and radiographic outcomes. Chevron technique became popular thanks to simplicity, rapid learning curve and excellent results, despite deformity recurrences in the long term (18,19). The Italian SERI technique proposed by Giannini has been used during the last years in differenthospitals with excellent results (9-13). Some other techniques has been used in the past and then abandoned because of technological evolution of the hardware on foot surgery.

Distal metatarsal osteotomies as Reverdin's or Mitchell's have provided benefits and good results in some severe cases. Proximal osteotomies help to achieve correction of a large IMA. Techniques as Endolog that provide stable fixation can reduce the risk of recurrences, but the disadvantage of the hardware that remains in place especially in young patients should not be underestimated (20).

In the surgical technique proposed, thedistal extra articular osteotomy of the first metatarsal bone is performed with a shannon burr. This is a very useful tool that allows to accurately perform osteotomies with maximum respect for the surrounding tissues and minimizing the size of the skin incision.

Fixation with a Kirschner wire, as previously described, guarantees elasticity and hypertrophic callus formation. The functional bandage protects the wire to prevent migration and confers stability of the

fixation. Compared to a more distal osteotomy, extra-articular distal osteotomy decreases the risk of avascular necrosis of the metatarsal bonehead and favors the decrease of the intermetatarsal angle. Plantarization of the first metatarsal head with a shortening in a safe range of about 2.1mm seems to prevent the transfer ofmetatarsalgia (21-23). The learning curve of the technique proposed is shallow and reproducible by a foot surgeon who is already familiar with percutaneous and mini-invasive surgical instrumentation. The proposed technique shows similarly good outcome as other distal osteotomies of the first metatarsal in documented studies and significant improvement of hallux valgus and intermetatarsal angles.

The main limitations of our study include a relatively small sample size.

Despite that, we consider the Wilson-SERI procedure as a low cost minimal invasive and stable technique that could be a valid alternative to the various metatarsal osteotomies in the treatment of moderate hallux valgus deformity. Midterm results at 12months after surgery are quite satisfactory but further studies are necessary, to better comprehend an overall outcome of such approach in the long run on a wider sample of patients.

Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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