LONG-TERM OUTCOMES AFTER SCARF OSTEOTOMY FOR HALLUX VALGUS: 9 YEARS OF CLINICAL AND RADIOLOGICAL FOLLOW-UP

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Abstract: *The middiaphyseal metatarsal Scarf osteotomy has become increasingly popular over the years because it provides great versatility, high stability and early weight-bearing. Even so, only a few studies exist in the literature with regard to long-term outcomes. In this paper we report the results of our study on 23 patients with a mean follow-up of 9 years. Between January 1998 and December 2003, 31 patients (41 feet) underwent this type of osteotomy. During the follow-up, 8 cases were lost. Clinical evaluation based on the American Orthopaedic Foot and Ankle Society score proved a significant improvement from 52 to 85 points (p – 0.0001). Radiological assessment pointed the reduction of first intermetatarsal angle (IMA) with a mean of 5 degrees (p – 0.0001) and hallux valgus angle with 19 degrees (p-0.0001). These results confirm the reliability of Scarf osteotomy in the treatment of moderate-to-severe hallux valgus deformities.*

INTRODUCTION

The surgical correction of hallux valgus is still a challenge for orthopaedic surgeons. Over the years its treatment has been somewhat controversial. Over 150 different procedures were described in the last century, yet no definite recommendations with regard to operative techniques were given. Many good alternatives are available and are usually selected based upon surgeon preference and availability. The severity of deformity might guide us in choosing the procedure.

In mild and moderate deformities, distal metatarsal osteotomies are recommended with no consensus about carrying out an additional lateral soft tissue release (generally not recommended).(1) In moderate to severe deviations with incongruent first metatarsophalangeal, joint proximal metatarsal osteotomies are needed because of their greater potential to correction. On the other hand instability in sagittal plane requires prolonged healing time and lateral soft tissue release is also mandatory in those cases.(2)

The Z-shaped Scarf osteotomy became popular among specialists for correction of moderate deformities of hallux valgus and has been used with great success, primarily because it provides great stability by the broad contact surface between the bone fragments allowing quick healing with early weight bearing even performed bilaterally. Even so, we found only few studies in literature reporting the long term outcomes after this type of surgery. No univocal indication and contraindications are described. The technique should always be adapted to the particularities of each individual case, combined with other procedure e.g. proximal phalangeal osteotomy, soft tissue lateral release, in order to obtain optimal outcomes and followed by a rigorous postoperative rehabilitation.

PURPOSE

The aim of the present paper was to assess within a prospective clinical study the long-term outcomes after an average of nine-year follow-up in patients who underwent Scarf osteotomy for hallux valgus and eventually, to compare these results with those acquired at the short-medium term appointments.

MATERIALS AND METHODS

Between January 1998 and December 2003, 31 patients (41 feet) with hallux valgus underwent Scarf osteotomy of the first metatarsal bone (M1) in the Clinic of Orthopaedics and Traumatology of Mureş County Hospital. There were 29 female and 2 male patients. All interventions were carried out by the same surgical team and in 10 cases, bilateral correction was required. At the time of final follow-up, eight cases were lost, usually because they could not be traced, other passed away, thus 23 patients (28 feet) remained by this time in the study cohort (22 of them females and one male, with bilateral osteotomy in 5 cases, all females). The average age at the time of surgery was 38 years (from 19 to 53 years old). The mean follow-up was of 9 years.

We proposed to achieve a long-term evaluation based on both clinical and radiological assessment. Charts were also assessed to determine the postoperative rate of satisfaction. Simultaneously, we tried to compare the recent outcomes with our short-medium term results published earlier.(3,4)

A single observer recorded complaints and clinical findings before and after surgery including pain, footwear and gait difficulties, range of motion in the first metatarsophalangeal joint, presence of bunion, signs of skin irritation over or under the metatarsal heads, associated deformities (e.g. hammer toe). At the time of follow-up, we searched for residual or recurrent deformities, presence of some of previous complaints. Patients' opinions about the result of the procedure were also rated, marking them as excellent, good or unsatisfactory. For an objective assessment, the 100-point American Orthopaedic Foot and Ankle Society (AOFAS) score was used before surgery and at follow-up visits.

The surgery was always proposed after the arsenal of

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conservative treatment was exhausted: roomier foot wears, specific orthopaedic devices like hallux valgus night splints, pads, toe spacers and non-steroidal antiinflammatory drugs. Exclusion criteria included: hallux rigidus,open epiphyseal plates, absent pedal pulses, severe osteoporosis and infections.

Radiology

Standard dorsoplantar and lateral radiographs of the weight bearing forefoot were taken before osteotomy and at each postoperative examination, measuring the:

- hallux valgus angle (HVA), completed by the bisection of the first metatarsal bone (M1) and the bisection of the proximal phalanx of the great toe. The normal values are between 10 and 15 degrees.(5)
- intermetatarsal angle (IMA), showing the varus deviation of the M1. This angle is formed by the intersection of the bisection of first and second metatarsal. Normal variation of this angle is from7 to 9 degrees.(6)

Other anatomical conditions were also taken in consideration: translation of sesamoides towards intermetatarsal space, presence MTP joint arthrosis, MTP joint congruency, shortening and internal rotation of M1.

Operative technique

All interventions were performed by them same surgical team with patient in supine position, applying a mid-thigh tourniquet under spinal anaesthesia.

The approach was via the standard longitudinal medial skin incision over the first metatarsophalangeal join, which runs from the proximal half of the proximal phalanx to the middle third of the first metatarsus depending on the length of theosteotomy. To preserve the blood supply to the distal fragment, the dissection of the soft tissues on the plantar aspect of the first metatarsal head was limited. The joint capsule and periosteum were incised longitudinally and the dorsomedial aspect of the metatarsal head was exposed.

The lateral release was performed through a dorsal intermetatarsal incision, which included a longitudinal section of the lateral capsule above the lateral sesamoid. Commonly, this should be enough in mild-to-moderate cases, but in sever deformities, section of adductor tendon with a vertical incision of lateral capsule might be requisite.(7) In addition to preparation of the osteotomy site, the medial eminence of the metatarsal head was resected (bunionectomy) leaving the articular surface intact.

The Z-shaped Scarf osteotomy requires three cuts. The long cut begins at the level of the head about 5mm proximally from the articular surface, runs in the axis of the diaphysis parallel to the inferior cortex reaching to the proximal third. In the frontal plane, the osteotomy runs parallel to the weight bearing surface or slightly oblique (about 20 degrees) if lowering of the metatarsal head is desired (figure no. 1). The distal arm of the Z runs proximally and dorsally, usually at 60 degrees to the long cut and perpendicularly to the axis of the second metatarsal thus the length of the M1 remains equal. The proximal short arm of the Z is parallel to the first short cut running plantarly and distally. Once the osteotomy is completed, the distal, plantar fragment is translated laterally holding in place the proximal, dorsal fragment. In addition to the translation lowering, shortening or lengthening of the MI may be performed to correct other components of the deformity:

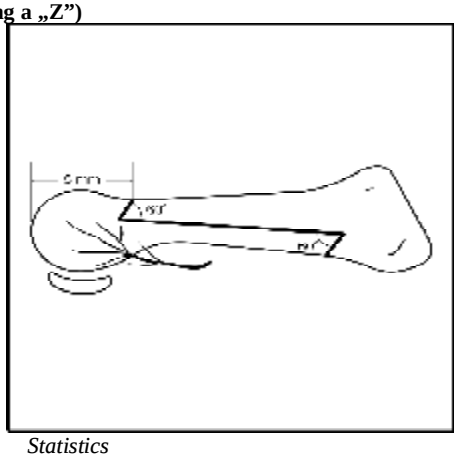
- lowering e.g. in case of high pressure on the second metatarsal head, might be achieved if the longitudinal cut is more oblique (>30°) in the frontal plane,
- shortening is required i.e. sever cases with IMA >18°. The transverse cut should be oblique from medially-distally to laterally-proximally. If additional shortening is needed, small bony fragments at the level of the anterior and posterior cut are resected.
- if lengthening is indicated, the short cut should run from medially-proximally to laterally-distally. More oblique the short cut is, greater longitudinal change is obtained.
- additional rotation is useful in congenital hallux valgus in order to maintain the congruence and the mobility of the first metatarsophalangeal joint.(4)

Akin osteotomy of the proximal phalanx of the hallux should complete the intervention if valgus deviation of the great toe is not entirely reduced, avoiding residual deformity. In more severe forms, the transposition of adductor hallucis tendon to the dorsal aspect of M1 with transosseous fixation is needed.(4)

In our cases, cuts were made by the oscillating saw and the position was secured by two small cannulated bicortical compressive screws. The overhanging edge of the proximal fragment was resected. Capsule was repaired with great toe in adduction and plantar flexed using absorbable sutures and the wound edges were closed. The perioperative care consisted of second-generation intravenous cephalosporin administration (at the induction of anaesthesia, 8 and 16 hours after surgery) thromboembolic prophylaxis with low molecular weight heparin salts for 10-15 days, intravenous and oral pain medication.

All patients were encouraged to stand on heels right the next day after surgery, than to walk with progressive weight bearing on forefoot and in the next three weeks, to wear open-toe sandals.

Figure no. 1. General aspects of Scarf osteotomy (three cuts forming a „Z")



Statistics

Mean values and standard deviations (SD) were measured. We used paired samples Student's t-test and Wilcoxon signed-rank test to evaluate the statistical significance, where p-values<0.01 indicated high statistical significance, p-values<0.05 statistical significance, and p-values>0.05 proved no statistical significance.

RESULTS

Analyzing the AOFAS score, a significant improvement (figure no. 2) was seen from the preoperative mean value of 52 points (Range 18 to 78, SD 15.889) to 85 points at the final follow-up (Range 50 to 100, SD 12.826) which proved to be a statistically high amelioration (p – 0.0001).

Although in some cases, the pain evaluation score showed a slight decreased value of 32.50 points (SD 7.005) comparing to the previous follow-up (namely, 34 points), yet a statistically significant improvement (table no. 1) from the preoperative value of 21.79 points (SD 7.724) was detectible (p - 0.01) .

The mean function score showed also significant

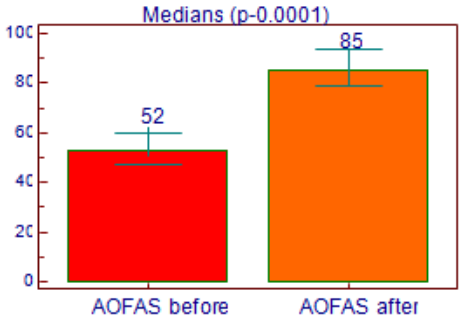
improvement from the preoperative value of 29.36 points (SD 8.270) to 38.75 points (SD 6.022), mildly lower that the short-medium term result of 40 points.

The mean alignment score showed a significant increase (p – 0.0001) from 2 points (Range 0 to 8, SD 3.528) to 15 points (Range 0 to 15, SD 4.023).

Table no. 1. Long term outcomes

AOFAS score (points)	Preoperative mean value ± SD	Mean value at follow-up ± SD	p value
Global	52 ± 15.889	85 ± 12.826	0.0001
Pain	21.79 ± 7.724	32.50 ± 7.005	0.01
Function	29.36 ± 8.270	38.75 ± 6.022	0.0001
Alignment	2 ± 3.528	15 ± 4.023	0.0001
Radiological measurements (°)	**Preooperative mean value ± SD (MIN.-MAX.)**	**Mean value at follow-up ± SD (MIN.-MAX.)**	**p value**
IMA	15.04 ±2.560 (9 -18)	10.07 ±2.448 (4 - 14)	0.0001
HVA	32.29 ±6.241 (21 - 44)	13.26 ±5.487 (6 - 27)	0.0001

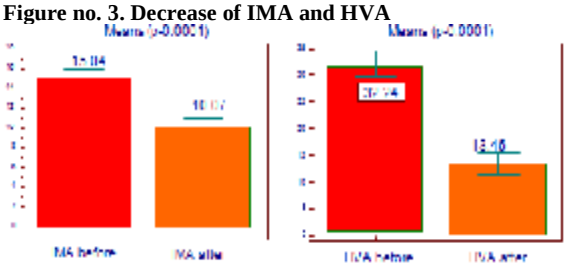
Figure no. 2. Improvement of AOFAS score



The IMA decreased from the preoperative mean value of 15.04 degrees (Range 9 to 18, SD 2.560) to 10.07 degrees (Range 4 to 14, SD 2.448) (p-0.0001). The HVA has also been reduced (figure no. 3) from 32.29 degrees (Range 21 to 44, SD 6.241) to 13.26 degrees (Range 6 to 27, SD 5.487) (p – 0.0001).

Two cases developed recurrence of the deformity, and in one case, the patient complained about residual metatarsalgia. 60.86 % of patients (14 cases) were satisfied with a good clinical result. In 21.73% of cases (5 patients), we found a less beneficial outcome, and in 17.39% of cases (4 patients) the results of surgery were poor.

Figure no. 3. Decrease of IMA and HVA



DISCUSSIONS

"Scarf" is an expression used in carpentry and architectural terminology, which refers to create a joint by cutting and anchoring the ends of two blocks so that to overlap and form one single piece. This configuration proved to be much more stable and provides a broad contact surface between the bone fragments, allowing quick healing with early weight bearing. Our patients were allowed to walk on heels right the next day after surgery and to bear full weight on forefoot after three weeks without any significant complication. Scarf osteotomy is also popular because it allows a multidirectional displacement of the bony blocks after osteotomy e.g. lateral displacement of the distal part to reduce the intermetatarsal angle (IMA), plantar displacement to decrease the load of the other metatarsal heads, shortening, elongation, rotation.(8)

Scarf osteotomy often must be combined with a lateral soft tissue release, excision of the medial bony eminence, medial capsulorrhaphy and occasionally with a proximal phalangeal osteotomy.(8)

This type of osteotomy is commonly indicated in mild to moderate deformities with intermetatarsal angle between 11 and 18 degrees (other studies suggest an IMA of 14 to 24 degrees) (9) without severe joint arthrosis.

However, executing the translation of the distal fragment in a several different ways, the scarf procedure may be used in more complicated cases too. In severe deformities with IMA >24, translation with shortening of the first metatarsal bone may be performed. It offers the correction without tensioning the soft tissues, restores the capsular, muscular and ligamentar balance and preserves the mobility of metatarsophalangeal joint. Lowering of the first metatarsus may be associated with the translation if high pressure and pain occurs on the second metatarsal head. The long arm of the Z cut runs in more oblique direction completing an angle >30º with the horizontal line. Coughlin reported that 71% of feet with hallux valgus deformity had an increased 1st metatarsal length - 2.4 mm longer when compared with the 2nd metatarsal.(10)

The scarf procedure is technically demanding and requires prolonged learning curve to assure suitable short and long term results without significant complications. According to the worldwide studies, frequently reported complications may include intra- and postoperative shaft or proximal fracture, infection, delayed union, malunion (both translation or rotation), nonunion, long or protuberant screws on the plantar side (causing irritation, pain, stiffness, needs to be removed once the osteotomy cut is healed), screw tail-dive, under- or overcorrection, early or even late recurrence of the metatarsal varus deviation, neuralgia, metatarsalgia, osteonecrosis of the metatarsal head, osteoarthritis in the first metatarsophalangeal joint.

In addition to the above, it has to be mentioned the "troughing" phenomenon, subsidence of the cortices into the cancellous bone with elevation of the first ray.(8) This undesirable outcome might be avoided by making the long cut of the osteotomy from the head to the base as long as possible parallelly to the inferior cortex of the shaft and the short arms of the Z 45 degrees to the long one, reaching the metaphysis where bone stock is more consistent. Shortening the depth of the short arms of the Z osteotomy (more vertically) thereby decreasing the amount of metatarsal collapse can also prevent "throughing".(8)

Main contraindication to the scarf osteotomy is the severe osteoporosis, osteoarthritis of the first, metatarsophalangeal joint, arterial occlusive disease or rarely, ligamentous laxity with instability in the first cuneometatarsal joint.

Assessing the clinical outcomes, AOFAS score proved a significant improvement from 52 to 85 points. This scale is widely accepted for functional evaluation of the forefoot. On the other hand, the authors of this paper are not convinced that the

AOFAS score is adequate for the evaluation of long-term outcomes too. For example, despite the significant amelioration of the mean pain score (from 21.79 to 32.5 points), the present finding showed a slight decrease compared to the middle term results (34.19 points).(4) Some patients were evaluated 12-13 years after surgery and the recurrent pain could be explained by some other pathological changes which occurred during the aging process, like joint degeneration. Another variable that can alter the outcome is that the mobility of the first ray is difficult to assess accurately, especially when other pathological conditions of the forefoot are associated.

The mean reduction of IMA was of 5 degrees (from 15° to 10°). HVA proved a mean correction by 19 degrees, from 32° to 13°. Our results correlate with those specified in the literature (11), but most of these studies assess short-to-medium term outcomes and only a few randomized trials were found describing results after a longer follow-up. This means that even if our findings are encouraging, the current data-base regarding the perspective utility of Scarf osteotomy is generally poor and our study cohort size is small. More trials with long-term follow-up would be desirable.(12)

We routinely used a two-screw fixation technique. Fixation with only one screw also proved to allow enough stability in most cases (13,14) and even reports with no internal fixation were found in literature.(15) This latter is a promising solution in advanced osteoporosis were classic Scarf osteotomy is contraindicated.

As a result of the multi-planar nature of the osteotomy, there is a potential risk of producing unintended rotational mal-unions in all three planes, which could explain the poor outcomes in some cases, like the two recurrences in our study, our third case with residual metatarsalgia.

Figure no. 4. Mild hallux valgus, before and after Scarf osteotomy

CONCLUSIONS

IMA between 10° to 20° is an optimal indication for Scarf osteotomy. This procedure restores forefoot function, assures a predictable and durable correction of moderate to severe hallux valgus deformities. The long-term results are satisfactory in more than 60% of cases. Main advantages are: it allows multi-planar correction, excellent sagittal and transverse plane stability, early mobilization of patient, no casting is required. On the other hand, it is a technically precise and challenging procedure. The database concerning the outcome of this intervention is still insufficient.

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