Scarf Osteotomy for Treatment of Hallux Valgus Deformity

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Abstract: Background: the scarf osteotomy has been a widely practiced bunion operation, but relatively limited prospective data on its outcomes have been reported. The purpose of this investigation was to prospectively evaluate the clinical and radiographic results of treatment of adult primary hallux valgus using the scarf osteotomy of the first metatarsal. **Aim of the Work:** evaluation of scarf osteotomy for treatment of moderate to severe hallux valgus deformity by diaphyseal stable osteotomy. **Patients and methods:** hallux valgus corrections were performed on 10 patients (10 feet), who were followed for at least 6 months with an average follow-up of 12 months. Mean age at the time of surgery was 41 years, and subjects included three male and seven female patients. Prospective clinical data collected included the American Orthopaedic Foot & Ankle Society (AOFAS) hallux-interphalangeal scale score, and the visual analogue scale (VAS) for pain. Data were collected preoperatively and postoperatively. Prospective radiologic data were also collected including hallux valgus angle (HVA), first-second intermetatarsal angle (IMA), and distal metatarsal articular angle (DMAA). Clinical data were collected on complications. **Results:** mean AOFAS hallux-interphalangeal score increased from 49 preoperatively to 94 postoperatively. The mean pain sub score improved from 18 points before operation to 37 postoperatively. The mean function sub score from 31 points to 44 postoperatively and the mean alignment sub score from 1.8 point to 14 postoperatively. Whereas mean VAS pain scores decreased from 5.8 preoperatively to 1.1 postoperatively. All the changes in clinical outcomes were statistically significant. Mean preoperative HVA decreased from 34.4 degrees preoperatively to 10.7 degrees postoperatively. The mean preoperative IMA decreased from 20 degrees preoperatively to 8.6 degrees postoperatively. The mean preoperative DMAA decreased from14 to 11 postoperatively. All radiographic changes were statistically significant except DMAA changes. The overall complication rate was 10% (1/10), attributable to fracture of the first metatarsal bone intra operatively but this healed satisfactory without compromising the outcome. **Conclusion:** Scarf osteotomy was a reliable technique for correction of moderate to severe hallux valgus and had low rates of complication or recurrence.

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1. Introduction

The corrective osteotomy of the first metatarsal bone to reduce an increased intermetatarsal angle is performed using a Z step cut. SCARF is the carpentry term of this Z step osteotomy and osteosynthesis technique. Since the first description of SCARF osteotomy,[1] this procedure has been used with great success for correction of moderate to severe hallux valgus deformities.[2]

Meyer was the first who described the principle of this osteotomy technique in search for greater stability of the corrective first metatarsal osteotomies.[1]

At this time, the use of this operative technique was limited, probably because of the lack of sophisticated osteotomy tools. Approximately 70 years later, micro oscillating saws allowed angulated osteotomy cuts in bone. Early weight bearing due to great inherent stability and rare postoperative complications have contributed to its frequent application.[2,3,4]For correction of up to 5° of intermetatarsal angles in mild hallux valgus deformities, distal metatarsal osteotomies have obtained a high degree of success.[5]The proximal osteotomy along with a soft tissue procedure[6]or the proximal chevron osteotomy with their high corrective potential[7]are excellent procedures in the treatment of moderate to severe hallux valgus deformities. However, sagittal plane instability frequently leads to prolonged osseous healing and first metatarsal dorsiflexion malposition.[8]

Therefore, midshaft osteotomies may fill the gap between the limitation of distal osteotomies and the instability of proximal osteotomies.

An increased intermetatarsal (IM) angle, a normal or increased distal metatarsal articulation angle (DMAA), adequate bone stock, and symptomatic hallux valgus (HV) deformity have been established as major indications for the SCARF osteotomy.[2]To date only a few reports exist in the literature describing midterm results of SCARF osteotomy in larger populations. The literature concerning the SCARF osteotomy includes technical

notes,[2,3]but indications and contraindications have not been well defined.

Aim of the Work

Evaluation of scarf osteotomy for treatment of moderate to severe hallux valgus deformity by diaphyseal stable osteotomy. Evaluate post operative AOFAS score, radiological parameters, and patient satisfaction.

2. Patients and Methods

A prospective cohort study was used in 10 patients with moderate to severe hallux valgus deformities in Luxor International hospital and Azhar university hospitals.

A moderate deformity was classified as one with an IMA of 13 to 20° and HVA less than 40° on X-rays taken in a standing position.

Selection of patients:

A) Inclusion criteria:

1- Moderate to severe hallux valgus deformity

2- 18 to 60 years old patients

3- Significant foot pain that limit patient activities

4- Failure of non operative treatment **(**using accommodating shoes, orthoses and non steroidal anti inflammatory drugs)

b) Exclusion criteria:

1- Patient with mild hallux valgus deformity

2- Osteoporotic bone

3- Elderly diabetic patients

4- Hallux rigidus

5- Open epiphyseal plates

6- Absent pedal pulses

7- Local infection or systemic active infection

Seven females and three male patients, ages 18 to 60, were assessed (age mean 41 years).

The AOFAS Hallux Meta tarsophalangeal Interphalangeal Scale, visual analog pain scale and patient satisfaction were monitored prior to surgery, as well as three and 6 months postoperative. All patients filled out their own AOFAS forefoot questionnaire, visual analog scale and satisfaction rating.

Patient satisfaction was assessed for overall satisfaction, function, appearance, whether they would have the surgery again and if they would recommend it to a friend. Visual analog pain scale was used at the same three time intervals.

Weight bearing AP and lateral radiographs were obtained prior to surgery, and at the three and 6 month follow up visits. Measurements included the intermetatarsal angle, hallux valgus angle and DMAA.

Statistical Analysis

Preoperative and postoperative values for clinical outcome scores and for radiographic measurements were compared using the paired Student t test. Statistical significance was assigned to *P* values of less than. 05%.

Surgical Technique[9]

The patient was placed in a supine position with a thigh tourniquet. Anesthetic of choice was given. The lower extremity was sterilely prepped and draped. A prophylactic antibiotics were given and the tourniquet inflated to 250 mmHg after gravity exsanguinations. A median incision was done under tourniquet control from the mid shaft level of the proximal phalanx distally to the base of the first metatarsal proximally, The plantar blood supply was taken care of during the procedure. The capsule and periosteal structures were elevated from the metatarsal head and neck. The thin septum joining the abductor muscle to the medial border of the first metatarsal was Divided, Thus the first metatarsal medial border and its medial plantar surface were clearly visible. The dorsal synovial fold attached just proximal to the first metatarsal articular cartilage is carefully preserved. With the medial aspect of the first metatarsal exposed, The exposed medial eminence is removed. Kirschner wires are inserted at corner point of planned osteotomy, A three cut Z shaped osteotomy are made. The longitudinal cut is begun at the level of the metatarsal head, 5 mm from the joint at the junction between the dorsal third and the plantar two thirds of the metatarsal and depending on the severity of the deformity to be corrected, this cut is made longer or shorter, but generally the proximal part of the diaphysis reached.[9]

In the frontal plane, this cut is made parallel to the weight bearing plane or slightly oblique from dorso medial to plantar lateral to bring the metatarsal head more plantar if required. The first transverse cut is made distally and dorsally, perpendicular to the long axis of the second metatarsal if the length of the first metatarsal has to remain equal. The transverse cut usually runs parallel to the cartilage line of the metatarsal head. [9] To lengthen the metatarsal, the transverse (short) cut is done in the horizontal plane from medial proximal to distal lateral at an angle that will allow distal translation. If shortening of the first metatarsal is desired, the transverse cut is done from medial distal to lateral proximal in the horizontal plane; the more oblique the cut and the larger the lateral shift, the more shortening will occur. Alternatively, the metatarsal is shortened by removing a segment of bone of the amount of desired shortening by making a second cut just proximal to the first one. This is a more predictable method of obtaining shortening.[19]The second transverse cut is made strictly, Take care to avoid making this cut convergent to the first one because this would prevent the shifting of the head fragment (locking effect).[9] The plantar distal portion is laterally translated to close the

intermetatarsal gap. If necessary, rotation can be done to correct any pathological distal metatarsal angle. If the required distal metatarsal articular angle correction is important, the proximal lateral corner of the head fragment can impinge on the second metatarsal, preventing full correction; in this situation, this corner is resected. A Kirschner wire is Inserted from the proximal fragment distally into the distal fragment, taking care to not place it where the distal screw will be placed for definitive fixation.[9] The use of a wire instead of a clamp prevents stripping of the soft tissues beneath the distal fragment, better preserving its vascularity. A simulated loading test is performed on the forefoot. The hallux should be reduced or nearly reduced on the metatarsal head, and the metatarsal head should be reduced over the sesamoids. If this is not the case, an additional lateral soft tissue release with tenotomy of the adductor tendon is done, depending on the cause of the residual subluxation. These samoid reduction is Checked either clinically or radiographically with a mini C-arm.[9] Two mini fragment screws (2.0 or 2.7 mm) are used to secure the osteotomy.[9] The dorsalmedial metatarsal shaft is removed. If any hallux valgus deformity remains, the cause of this residual deformity should be treated before closing the capsule medially, because the capsule will not be able to hold the correction over time if the hallux valgus deformity is not adequately corrected by osteotomy and soft tissue release.[9]

The medial joint capsule are Repaired, the tourniquet is deflated, Haemostasis is obtained, and the incisions are closed in routine fashion.

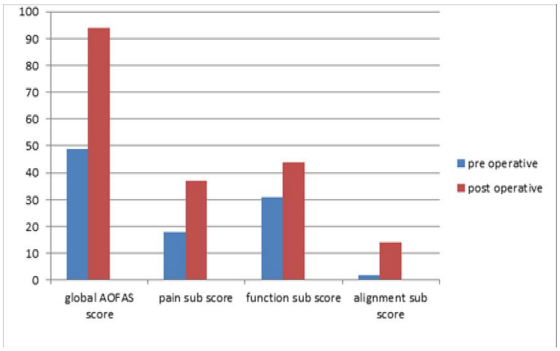

Fig. (1): Graph of clinical changes, Preoperative, postoperative data are shown for glbal AOFAS score, pain, function and alignment.

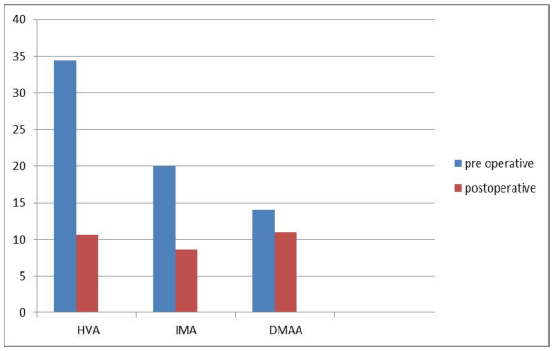

Fig. (2): Graph of radiological changes. Preoperative, postoperative data are shown for hallux valgus angle (HVA), intermetatarsal angle (IMA), distal metatarsal articular angle{DMAA).

3. Results

Table (1): Mean of the clinical evaluation

Clinical changes Evaluation	Pre-operative	Pre-operative	p value
AOFAS score Global	49	94	<0.001
Sub score Pain	18	37	<0.001
Sub score Function	31	44	<0.001
Sub score Alignment	1.8	14	<0.001
VAS pain score	5.8	1.1	<0.001

Table (2): Mean of radiological evaluation

Radiographic angles evaluation	Pre-operative	Pre-operative	p value
HVA	34.4	10.7	<0.001
IMA	20	8.6	<0.001
DMAA	14	11	<0.18

4. Discussion

Although it is accepted that no single operative procedure can address the wide range of deformity of hallux valgus, the Scarf osteotomy has become widely used because of its great versatility. It allows lateral displacement of the plantar bone fragment thus reducing the IMA, medial displacement of the capital fragment in cases of hallux varus, plantar displacement to increase the load of the first ray and *vice versa*, elongation in cases of a short first metatarsal, and shortening in cases of a long first metatarsal.[10,11] In addition, it avoids the complication of metatarsus elevatus associated with other proximal metatarsal osteotomies.[12]

Short term follow up study (mean 6 months) of 10cases showed a mean improvement of the IMA of 11.4° (from20 to 8.6°) and of the HVA of 23.7° (from 34.4° to 10.7°). Complications included one metatarsal fractures at the level of the distal screw.

In comparable with other study (fig.1,2), Valentin[3] reported in a five year follow up of 56 cases with average improvement of the hallux valgus angle of 38.5° to 19°, the IM angle of 16.6° to 11.3°. Fifteen cases of hallux limitus were observed as postoperative complications. Rippstein[13] reported in a two year follow up of 52 cases an average improvement of the hallux valgus angle from 32° to 10°, and the IM angle from 14° to 6°. One metatarsal head necrosis and one painful overcorrection were reported.

Besse[14]reported in a one year follow up of 50 cases an average improvement of the hallux valgus angle from 32° to13.4°, the IM angle from 13.8° to 7.8°. Two patients developed reflex sympathetic dystrophy and two fractures of the first metatarsal were seen.

The correction of DMAA malalignment by SCARF osteotomy was not significant. Therefore, DMAA malalignment should be treated using a modified, shorter SCARF[15,16] or using distal osteotomies. Back to work data was influenced by many social factors, which are not always comparable in different countries. People with sedentary work were able to be back after 14 days.

People carrying out heavy manual or standing work had to wait for six weeks to return to work. Patients were back at their usual level of recreational sports activity, which was mainly hiking, after 8.4 weeks.[17]

A comparable result is reported following a group of competitive athletes treated with first metatarsal osteotomy being back at sports after 8.9 weeks.[18]

The authors are aware of the possible complications in patients with neuropathy and angiopathy. However, after careful neurovascular examination and patient selection in the “high-risk” groups, they did not find a significant higher rate of complications in this group. It must be added in comparing these groups, that the vascular “high-risk” group included younger and more active patients. Patients with sonographic proven peripheral angiopathy were not accepted for surgery.

Cadaver studies analyzing different osteotomies and osteosynthesis of the first metatarsal under bending load conditions categorized the SCARF osteotomy to have double the stability of a distal Chevron osteotomy, or the proximal crescentic osteotomy.[18]

A finite element analysis showed areas of high stress within the first metatarsal at the following locations:

1. Plantar proximal to the metatarsal head.
2. Dorsomedial 2 cm distal to the base of the first metatarsal, which is the metatar so cuneiform joint area.[19] The area plantar proximal to the metatarsal head can be avoided using the SCARF osteotomy cut but the osteotomy cut reaches the area dorsomedial 2cm distal to the base. This may explain postoperative fractures in the proximal part of the dorsal cortex as described in the literature.[2]Therefore, it is necessary to angle the osteotomy cut as mentioned above. The soft tissue technique with a lateral capsular release and medial capsular repositioning through a transosseous trimming suture is as important as the osseous correction of the first metatarsal deformity.

The radiologic results were equal but not better than those for a modified Austin or chevron procedure including a soft tissue procedure.[20]The SCARF osteotomy is technically difficult, but the authors believe that the SCARF is indicated in hallux valgus cases with an IM angle of 14° to 18°.

This procedure is then indicated to fill the gap between the limited corrective possibility of the distal chevron and the more unstable proximal osteotomies with the need for stronger immobilization. The experimentally proven greater stability of the SCARF osteotomy[18,19]favors its use. We routinely used a two screw fixation technique. [2,4,13,14,21]The experimental proven stability encouraged us to believe there was sufficient stability with the SCARF osteotomy.

The correction of the IM angle was 7° to 8° with the SCARF technique and could be increased to 12° in severe cases needing a maximal displacement.

There is no strict age limitation; however, patients older than70 years with a large hallux valgus deformity and arthritis of the MP I joint are at risk of inferior results.

The authors set the lower limit for the SCARF osteotomy at 14° of IM angle because lesser deformities can be treated using a distal chevron osteotomy.

Reported complications include infection, transfer metatarsalgia, osteonecrosis of the first metatarsal head, fracture of the first metatarsal, prominent screw causing irritation, screw backout, postoperative neuralgia and reflex sympathetic dystrophy. [4, 11, 22] In our series the rate of complication was low, We conclude however, that in the short term, the Scarf osteotomy appear to be safe and effective for the treatment of hallux valgus.

Conclusion

Although technical demanding, the Scarf osteotomy provides satiafactory clinical and

radiographic results in hallux valgus deformities at the midterm follow up. Scarf osteotomy is a powerful and versatile procedure to correct hallux valgus deformity, it allow displacement in several planes. As the osteotomy is inherently stable this allows the patient to ambulate post operatively early, and return to work at an earlier date as compared to other procedures. Bilateral procedures are also possible. Scarf osteotomy provides a predictable and satisfying result and had an acceptable rate of complications and a low incidence of recurrence at intermediate follow up.

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