TECHNICAL NOTE

Scarf osteotomy without internal fixation to correct hallux valgus

T. Leemrijse a, M. Maestro b, K. Tribak c, V. Gombault a, B. Devos Bevernage a,d, P.-A. Deleu a,e,

a Foot & Ankle Institute, clinique du Parc-Léopold, 38, rue Froissart, 1040 Brussels, Belgium
b IM2S, 11, avenue d’Ostende, 98000 Monaco, France
c Orthopaedic Department, cliniques universitaires Saint-Luc, 10, avenue Hippocrate, 1200 Brussels, Belgium
d Orthopaedic Department, UZ Gent, 185 De Pintelaan, 9000 Gent, Belgium
e Division of Podiatry, Institut d’enseignement supérieur Parnasse-Deux-Alice, 84, avenue E.-Mounier, 1200 Brussels, Belgium

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KEYWORDS
Scarf osteotomy
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Metatarsal osteotomy;
Hallux valgus;
Forefoot surgery

Summary Scarf osteotomy of the first metatarsal bone to correct hallux valgus deformity has benefited from a number of improvements over the past two decades, most notably regarding the internal fixation method. Internal fixation was deemed mandatory by the authors of early case-series studies. Maestro suggested eliminating the proximal screw by locking the two fragments distally: a notch was created via a medial extension of the cephalic part of the osteotomy, the plantar fragment was displaced laterally, and the distal end of the proximal fragment was then fit into the notch (secondary cut and interlocking joint technique). To further develop this concept and to increase the potential range of translation, we developed an original technique involving distal locking without shortening and proximal stabilisation by impaction of a cortical-cancellous bone graft taken from the medial overhanging edge of the proximal fragment. This original technical variant has not been reported previously.

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Introduction

Scarf osteotomy of the first metatarsal bone followed by internal fixation to correct hallux valgus deformity has been the focus of many technical improvements over the past two decades. In 1996, Maestro modified the technique, increasing the slope of the medial cortex osteotomy in the sagittal plane in order to increase stability and stiffness, thereby diminishing the risk of basal fracture [1]. Lateral translation is the main displacement. However, scarf osteotomy also allows many other displacements, most notably medial rotation of the head and supination to eliminate residual pronation, which is among the causes of recurrence [2]. Internal fixation was deemed mandatory by the authors of early case-series studies [1,3]. Maestro advocated eliminat-
Figure 1  First longitudinal cut on the medial aspect of the first metatarsal. A. Sagittal view and representation of section plane B. The first longitudinal cut allows positioning of the saw according to the desired dorsoplantar slope.

Figure 2  A. Cephalic cut directed upwards. B. During translation, temporary lengthening occurs. C. After interlocking of the fragments, the metatarsal recovers its initial length.

Figure 3  A. A stepped notch is fashioned (blue arrow). B. Translation of the lower and plantar part of the metatarsal into the stepped notch.
Description of the technique

This technical note discusses only the various steps that pertain directly to scarf osteotomy without internal fixation. However, the sesamoid suspensory ligament must be released carefully, phalangeal osteotomy may be required, and capsule tension must be restored.

The metatarsal osteotomy must be placed with great accuracy, and the longitudinal section surface must be perfectly flat to ensure optimal primary stability during translation. The first cut is made along the medial aspect of the metatarsal, in an oblique direction from the upper third of the cephalic region towards the plantar aspect at the proximal part of the metatarsal. Then, the saw is gradually tilted to facilitate engagement of the largest blade surface area, thereby avoiding wobbling of the blade (Fig. 1A). The degree of dorsoplantar slope is chosen to obtain the desired amount of lowering. The medial longitudinal cut will serve as

Figure 4  Creation of a dovetailed notch at the proximal part of the plantar fragment to allow interlocking of the proximal plantar part of the osteotomy.

Figure 5  A. The distal and superior part of the fragment exposed by the plantar translation is cut off. B. The fragment is preserved and turned over. C and D. The fragment is then impacted intramedullarily in the plantar and proximal region. E. Visualisation of the cortex-on-cortex contact zone that precludes conventional screw fixation. F. Visualisation of the impacted bone fragment (area surrounded by the dotted line) by intraoperative fluoroscopy; the fragment stabilises the translation.
Figure 6  Suture travelling through a transosseous tunnel and lying against the superior part of the osteotomy. A. Diagram of the medial view. B. Intraoperative medial view.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Outcomes in our case series of 15 feet (in 12 patients) after a mean follow-up of 7.7 years.</th>
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<td>Age (years)</td>
<td>55</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
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<tr>
<td>Male</td>
<td>2</td>
</tr>
<tr>
<td>Female</td>
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Radiographic outcomes

<table>
<thead>
<tr>
<th>M1P1 Angle (°)</th>
<th>Pre-operative</th>
<th>Post-operative 2004</th>
<th>Last follow-up 2011</th>
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<tr>
<td>Mean</td>
<td>38.5</td>
<td>9.5</td>
<td>10.6</td>
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<tr>
<td>Minimum</td>
<td>34.0</td>
<td>2.0</td>
<td>2.0</td>
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<tr>
<td>Maximum</td>
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<td>15.0</td>
<td>16.0</td>
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<th>Post-operative 2004</th>
<th>Last follow-up 2011</th>
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<tr>
<td>Mean</td>
<td>15.1</td>
<td>6.1</td>
<td>8.7</td>
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<tr>
<td>Minimum</td>
<td>13.0</td>
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<tr>
<td>Maximum</td>
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<td>11.0</td>
<td>12.0</td>
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<th>DMAA (°)</th>
<th>Pre-operative</th>
<th>Post-operative 2004</th>
<th>Last follow-up 2011</th>
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<td>Mean</td>
<td>15.4</td>
<td>5.4</td>
<td>5.4</td>
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<tr>
<td>Minimum</td>
<td>11.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>22.0</td>
<td>7.0</td>
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<table>
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<th>AOFAS Score (/100 patient)</th>
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<th>Post-operative 2004</th>
<th>Last follow-up 2011</th>
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<tbody>
<tr>
<td>Mean</td>
<td>51</td>
<td>91</td>
<td>84.8</td>
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<td>Minimum</td>
<td>57</td>
<td>65</td>
<td>73.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>49</td>
<td>95</td>
<td>95.0</td>
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</table>

Subjective patient evaluation (%)

| Very satisfied | 54.5 | 58.3 |
| Satisfied | 45.5 | 41.7 |
| Dissatisfied | 0 | 0 |

M1P1 angle: angle of the first metatarsophalangeal joint; M1M2 angle: angle between the first and second metatarsals; DMAA: distal metatarsal articular angle.

If the distal transverse cut is perpendicular to the axis of the second metatarsal, pure translation is achieved and stabilisation is required, either via a screw or via interlocking of the two fragments after a secondary cut, which shortens the first metatarsal bone.

To avoid shortening of the first metatarsal, the cephalic cut is angled at 60° relative to the longitudinal cut, in the

a guide for cutting the opposite cortex of the first metatarsal bone (Fig. 1B). The longitudinal cut must be at least 2 cm long to eliminate all risk of secondary displacement. The proximal transverse cut is then performed, at an angle of 60° relative to the longitudinal cut and perpendicularly to the axis of the second metatarsal bone. We will now discuss the distal cephalic cut.
direction of the distal end of the metatarsal bone (Fig. 2A). The result is temporary lengthening during the translation (Fig. 2B). Once the fragments are interlocked, the metatarsal recovers its initial length (Fig. 2C). The proximal cut is already perpendicular to the second metatarsal bone, which ensures that the translation is perfectly isometric.

At the cephalic end, and depending on the desired extent of translation, a stepped notch of variable size is fashioned (Fig. 3A). The size of the notch is in inverse proportion to the desired range of translation. An osteotome is placed in the osteotomy and the periosteum is then released, as well as a few fibres of the attachment of the lateral collateral ligament of the metatarsophalangeal joint, which often prevents or limits translation. The release must be carefully controlled, to avoid injuring the intermetatarsal blood vessels.

The lower plantar fragment of the metatarsal bone can then be readily translated until the stepped notch is reached (Fig. 3B). The metatarsophalangeal joint is then dorsiflexed gradually to impact the fragments in their cancellous bone. The result is immediate strong stability, which must not be modified subsequently. A dovetail notch can be fashioned in the proximal part of the plantar fragment (Fig. 4) to re-impact the proximal and plantar part of the osteotomy, at the cost of a slight decrease in length. This method is chiefly used to obtain pure translation without correction of the distal metatarsal articular angle (DMAA). When the DMAA must be corrected, a shorter osteotomy with a greater rotational effect is made and the proximal part of the cut is not impacted, to ensure marked proximal translation.

After the translation and once impaction is achieved by dorsiflexion of the metatarsophalangeal joint, a secondary cut is made in the distal and superior part of the fragment left uncovered by the plantar translation. This fragment is preserved, turned upside down, and impacted into the proximal plantar medullary canal, thus ensuring perfect stability (Fig. 5).

To avoid distal disimpaction, a 1.5-mm drill is used to create a tunnel in the cephalic region for passage of a transosseous suture resting against the upper part of the osteotomy (Vicryl® 1.0 on a 36-mm semi-circular needle) (Fig. 6). An oscillating bone saw is used to create a small notch 3 mm before the end of the osteotomy to preclude distal displacement of the suture. Tension should be moderate, to avoid cancellous bone damage by the sutures. Primary stability must be compatible with 100° mobility of the first metatarsophalangeal joint, to optimise the likelihood of achieving a good postoperative range of motion.

The postoperative care is the same as after standard techniques, with a stiff shoe or heel-weight-bearing boot for 3 to 4 weeks.

**Results**

Table 1 reports the outcomes of our first continuous series of scarf osteotomies without internal fixation. Mean follow-up
was 7.7 years. Of the 12 patients (15 feet), seven (58.3%) were very satisfied and five (41.7%) were satisfied at last follow-up. The mean overall postoperative AOFAS score was 84.8 (range: 73–95). Reoperation was required for two feet. In one case, iatrogenic hallux varus required revision with construction of an abutment and reverse transfer of the abductor hallucis tendon; [4] the postoperative AOFAS score was 73. In the other case, revision was required because of secondary displacement of the scarf montage after 4 weeks. Plate-screw fixation was used. The final AOFAS score was 80.

At present, 90% of the scarf procedures performed at our institution are done without internal fixation. Internal fixation is reserved for the few cases with limited metatarsus varus.

Discussion

Modern foot surgery must allow rapid functional recovery, which requires strong primary stability of the osteotomy. In our opinion, a versatile and reliable technique with a potential for three-dimensional correction that can be adapted to moderate-to-severe hallux valgus is crucial. Chevron osteotomies, basal osteotomies, and Lapidus-type arthrodesis are associated with inadequate outcomes and complications [5]. Efforts made to improve surgical techniques led to the development of scarf osteotomy, which allows a wide range of translation and can be adapted to also allow rotation and supination. Scarf osteotomy is a complex and technically challenging procedure whose considerable potential lies in its ability to provide three-dimensional correction [1]. The main correction is achieved via translation, a fact that is insufficiently highlighted or even ignored [6,7].

The interlocking effect introduced by Maestro as a corrective technique allows preservation of the lateral collateral ligament, thereby allowing shortening in patients with global forefoot alignment disorders. The interlocking effect both improves stability and increases range of motion. This variant was chiefly considered in combination with surgical shortening of the lateral metatarsal bones or in patients with limited hallux valgus mobility.

A diverging cut that is perpendicular to the axis of the second metatarsal proximally and directed towards the distal part of the metatarsal, followed by re-impaction, avoids shortening while also obviating the need for internal fixation.

Criticism of the diaphyseal overlap (shingle effect) stems from a technical flaw related to poor comprehension of the osteotomy method [8]. The distal end of the cut must extend to the cephalic part of the metatarsal. This crucial technical point avoids translation into a diaphyseal zone lacking in cancellous bone. In addition, the metaphyseal-cephalic part of the metatarsal is wider, which allows a wide range (or even “extreme”) translation (Fig. 7).
The scarf osteotomy without internal fixation is a diaphyseal-metaphyseal osteotomy with an oblique longitudinal cut that allows a very wide range of lateral translation without limitations related to screw placement. The wide range of translation ensures better correction of the metatarsus varus in feet with moderate-to-severe hallux valgus. It also allows sufficient medial rotation to correct the DMAA if needed, thereby ensuring long-term maintenance of the correction, provided adequate metatarsophalangeal congruence is preserved. Another advantage is elimination of the many complications related to internal fixation in osteoporotic bone.

There is no need to remove the internal fixation material, a step that has a negative impact on the surgery. The revision procedure is often difficult to accept by the patient, can result in iatrogenic injury, and carries a risk of motion range limitation. Furthermore, the second hospital stay and the additional time on sick leave if the patient is still working entail substantial costs in countries with public health insurance and worker’s compensation programs [6,9–11].

Finally, when no internal fixation is used, high-quality remodelling occurs at the osteotomy site, without stress shielding (Fig. 8).

The learning curve for scarf osteotomy is long. Strict compliance with the various technical devices is crucial when performing this economical, reliable and physiological procedure.

Conclusion

Scarf osteotomy without internal fixation allows the correction of moderate-to-severe deformities. The principles of the technique must be followed scrupulously. The distal cuts must diverge to avoid excessive or inappropriate shortening of the first metatarsal bone. The absence of screws allows a wider range of lateral translation and, therefore, the reduction of marked preoperative metatarsus varus. Finally, stability is ensured by distal interlocking and, if needed, proximal impaction.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References