

Increased intermetatarsal angle of the proximal fragment after modified scarf osteotomy: a radiographic study

Aumento do ângulo Intermetatársico do fragmento proximal após osteotomia de SCARF modificada: um estudo radiográfico

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ABSTRACT

Objective: Hypermobility of the first ray can explain the correlation between the instability of this joint and the progression and recurrence of hallux valgus. The modified Scarf osteotomy allows rotation of the distal fragment, in addition to medial traction of the proximal fragment. We believe that if the deformity is corrected by maximizing the instability of the metatarsal-cuneiform joint so that medial inclination of the first metatarsal is no longer possible, then the risk of recurrence in the long term may be lower.

Methods: The pre- and postoperative radiographs of 32 modified Scarf osteotomy cases were analysed. We compared already established angles for the radiographic analysis of the deformity, in addition to the creation of two new parameters for the evaluation of the varisation capacity of the osteotomy proximal stump.

Results: There was correction of hallux valgus and the intermetatarsal angle, in addition to correction of the first metatarsal head in relation to the sesamoids. We found an increase of the medial inclination of the osteotomy proximal fragment, measured using the parameters proposed by the authors.

Conclusion: The modified Scarf osteotomy corrects the conventional hallux valgus parameters, is able to increase the varisation of the proximal fragment of the first metatarsal, and may lead to greater instability in the first metatarsal-cuneiform joint, which, in our opinion, would lead to less chance of recurrence in the medium and long term.

Level of Evidence IV; Diagnostic Studies.

Keywords: Hallux valgus; Osteotomy; Metatarsal bones; Joint instability; Sesamoid bones.

RESUMO

Objetivo: A hiper mobilidade do primeiro raio pode explicar a correlação entre a instabilidade dessa articulação, a progressão e a recorrência do hálux valgo. A osteotomia modificada de SCARF permite uma rotação do fragmento distal, além de uma tração medial do fragmento proximal. Acreditamos que, caso seja feita a correção da deformidade, aumentando ao máximo a instabilidade da articulação metatarso-cuneiforme, de modo que não seja mais possível a inclinação medial do primeiro metatarso, o risco de recidiva no longo prazo poderá ser menor.

Métodos: Foram analisadas 32 radiografias pré e pós-operatória de osteotomia modificada de SCARF. Comparamos ângulos para análise radiográfica da deformidade já consagrados, além da criação de dois novos parâmetros para avaliação da capacidade de variação do coto proximal da osteotomia.

Work performed at the Hospital Felício Rocho, Belo Horizonte, MG, Brazil.

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Resultados: Houve correção do ângulo do hálux valgo e intermetatársico, além da correção da cabeça em relação aos sesamóideos. Encontramos um aumento da inclinação medial do fragmento proximal da osteotomia, mensurado com os parâmetros propostos pelos autores.

Conclusão: A osteotomia de SCARF modificada corrige os parâmetros convencionais de valgismo do hálux e é capaz de aumentar o varismo do fragmento proximal do primeiro metatarso, podendo gerar uma maior instabilidade na 1ª articulação metatarso-cuneiforme, o que, na nossa opinião, levaria a uma menor chance de recorrência a médio e longo prazo.

Nível de Evidência IV; Estudos Diagnósticos.

Descritores: Hálux Valgo; Osteotomia; Ossos do metatarso; Instabilidade articular; Ossos sesamoides.

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INTRODUCTION

Hallux valgus is a complex deformity, often seen in the offices of foot and ankle surgeons⁽¹⁾. It consists of a triplanar deformity that is associated with the pronation and varisation of the first metatarsal, the degree of valgus of the proximal phalanx, and the deviation of the first metatarsal head in relation to the sesamoids⁽²⁾. Conventional surgical treatment of hallux valgus involves an osteotomy of the first metatarsal, associated with other bone and soft tissue procedures⁽³⁻⁶⁾. An important factor to consider in regard to pathophysiology is the mobility of the metatarsal-cuneiform joint of the first ray⁽⁷⁾. Hypermobility of the first ray is one of the components involved in foot diseases, such as hallux valgus, in addition to its direct relation with gravity⁽⁸⁾. It is believed that hypermobility increases deformity, especially when associated with external factors, such as insufficiency of the first metatarsal-cuneiform joint ligaments and muscular imbalance⁽⁹⁾. Clinically, these concepts may explain the correlation between the instability of this joint and the progression and recurrence of hallux valgus⁽¹⁰⁾.

The Scarf osteotomy is extremely versatile because it allows extensive manipulation of the osteotomy fragments and can be used for milder degrees even in more complex deformities. The first metatarsal osteotomy may be only one of the procedures necessary for the correction of the deformity, depending on its specific alterations⁽¹¹⁾. The modified Scarf osteotomy involves a change in the way the bone fragments are handled, from a simple lateral transfer to a lateral rotation of the distal fragment over the axis of the base fragment⁽¹²⁾. With this modification, it is possible to achieve a greater correction of the intermetatarsal angle (IMA) and greater stability by offering better contact between bone fragments⁽¹³⁾. In our study, we used the modified Scarf technique; however, in addition to performing the rotation of the distal fragment, we also performed the

atest possible varisation of the proximal osteotomy fragment. We believe that if the deformity is corrected by maximizing the instability of the metatarsal-cuneiform joint so that medial inclination of the first metatarsal is no longer possible, then the risk of recurrence in the long term may be lower. The aim of this study is to evaluate whether the modified Scarf osteotomy is able to increase the varus position of the proximal fragment of the first metatarsal osteotomy, thus generating maximum amplitude of the metatarsal-cuneiform joint.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 83057417.6.0000.5125.

This is a case series that presents the pre and postoperative radiological comparison of 32 cases of hallux valgus operated between January 2015 and December 2017. The 28 patients in this study had symptomatic hallux valgus, refractory to the expectant treatment. All surgeries were performed by the same surgeon, using the rotational Scarf osteotomy associated or not with other procedures. After the collection of demographic and epidemiological data from the patients' files, radiographs were used to compare the anteroposterior (AP) incidence of the foot with support in the preoperative period and at 8 weeks after surgery. The comparison of the radiographs was performed by a researcher different from the main surgeon using Carestream Vue Motion[®] software. The hallux valgus angle (HVA), interphalangeal angle (IPA), IMA, and subluxation of the first metatarsal in relation to the lateral sesamoid were measured. To evaluate the increase of the medial inclination (varus) of the proximal fragment after the osteotomy, we developed two radiographic measurements: the intermetatarsal angle of the proximal fragment (IAPF), which is drawn between

the axis of the second metatarsal and the axis of the osteotomy proximal fragment by the Scarf technique (Figure 1), and the distance between a point 3 cm distal from the base of the second metatarsal and a point located at the same height for the first metatarsal base (3 cm 1-2) (Figure 2). All variables except the IAPF, which only exists after the osteo-

my, were compared between the pre- and postoperative periods. The IAPF was compared with the preoperative IMA because this allowed quantifying the ability to increase the inclination of the first metatarsal after the osteotomy. All measurements were performed using a virtual ruler with a 0.1 mm scale on real magnification digital radiographs.

Surgical technique

With the patient in a supine position, conventional medial access was performed to the first metatarsal and the first metatarsophalangeal joint. After the release of the lateral capsule and the sesamoid suspensory ligament by the same route, the modified Scarf osteotomy was performed. In the angulation of the fragments during surgery, the greatest possible variation of the proximal fragment was aimed at in order to place the metatarsal-cuneiform joint in a position of greater instability (medial traction of the fragment) (Figure 3). Rotation of the distal fragment was also performed to correct the rotational deformity in metatarsal pronation (Figure 4). After provisional fixation, a good deformity correction was considered when the lateral sesamoid was covered by the distal fragment and pronation was corrected. Fixation was performed using two conventional self-compressing titanium screws. The Akin osteotomy⁽³⁾ was used concomitantly when the IPA

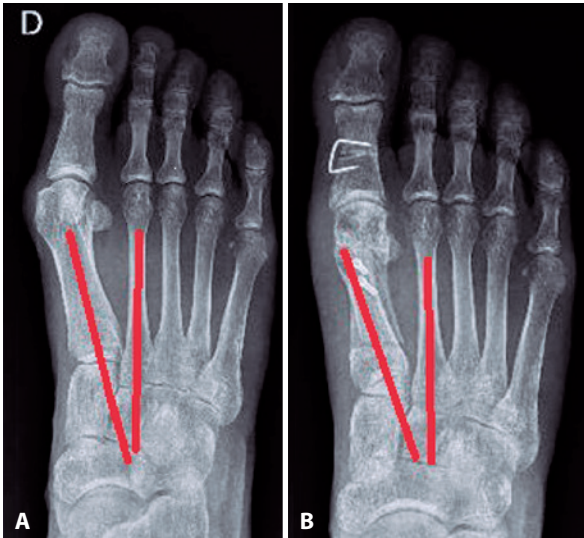


Figure 1. A. Intermetatarsal angle before surgery. We observed the dislocation of the head in relation to the sesamoids. B. Intermetatarsal angle of the proximal fragment. We observed a varus position of the first metatarsal in relation to the preoperative period and a reduction of the head in relation to the sesamoids.

Source: Author's personal archive

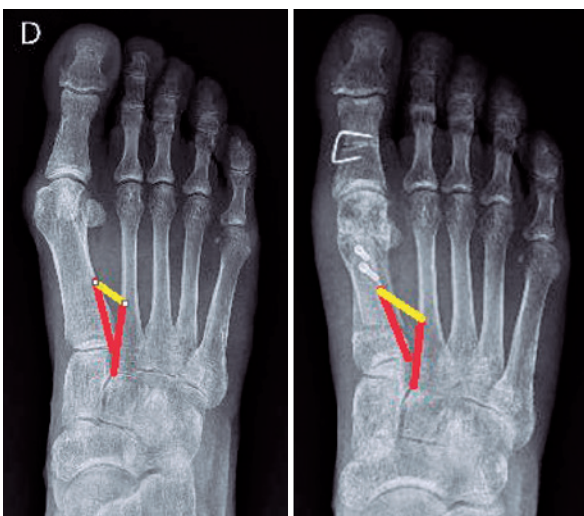


Figure 2. Red line - points 3 cm from the base of the first or second metatarsal. Yellow line - distance between these two points (3 cm 1-2). We observed a distance increase in the postoperative period, representing a variation of the first ray base.

Source: Author's personal archive.

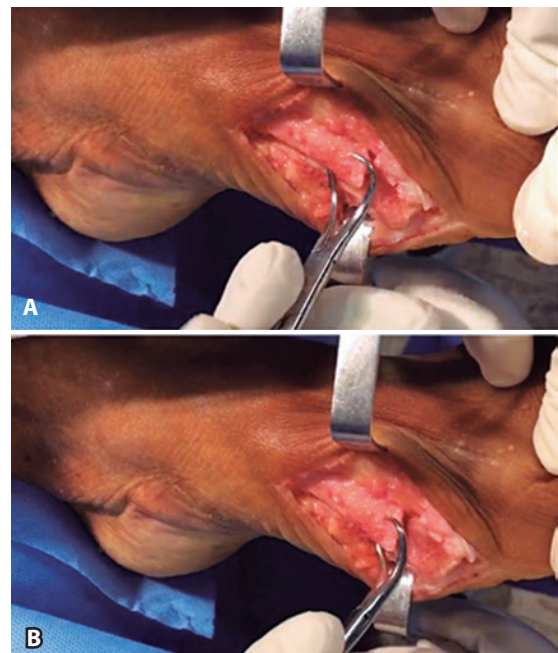


Figure 3. A. intraoperative picture showing the normal position of the proximal fragment. B. Medial traction with forceps, generating a variation of the proximal fragment of the osteotomy.

Source: Author's personal archive.

was increased. Then, a medial capsulorrhaphy and suture of subcutaneous tissue and skin were performed. The support was released with the use of Barouk shoes during the first 4 weeks, followed by the use of rigid footwear until the 8th week. After that period, patients were allowed to walk with conventional footwear.

Statistical analysis

Statistical analysis was performed with GRETL software (2017c). Student's t-test was used to compare continuous variables of pre- and postoperative data. For the categorical variables, containment tables were used. In this study, a 99% confidence interval ($p < 0.001$) was adopted for the significant differences.

RESULTS

The study included 32 feet in 28 patients, and 56% were the left side. The mean age was 45 years, ranging from 19 to 71 years. There was only one male participant. In 22 feet, the following other procedures were performed: 14 Akin osteotomies, 4 Chevron osteotomies of the fifth metatarsal for bunionette correction, and 4 Weil osteotomies with repair of the lateral ray plantar plate. Table 1 shows the values of the radiographic evaluations in the pre- and postoperative periods. The mean HVA was corrected from 27.2° to 6.7° and the mean IMA from 14.9° to 5.2°, evidencing the correction of the metatarsal position. There was a 3.8° increase of the IPA after the surgical procedure. The IAPF increased by 2.9° in relation to the preoperative IMA,

evidencing a possible increase in the instability of the first metatarsal-cuneiform joint due to greater variation of the proximal portion of the first metatarsal. In relation to 3 cm 1-2, a greater distance was observed between the second metatarsal and the proximal fragment of the osteotomy, ranging from 13.7 mm in the preoperative period to 16.0 mm in the postoperative period. All of the above differences were significant ($p < 0.001$).

Figure 5 shows the improvement of the sesamoid position in the postoperative radiographs. Thirteen individuals who were in the 50-75% group changed to the <50% group in the postoperative period, and 12 individuals changed from the >75% group to the <50% group after surgery, with significant values.

DISCUSSION

The aim of the surgical treatment of hallux valgus is to correct the complex triplanar deformity, with the lowest recurrence rate of the disease. Different recurrence factors

Table 1. Pre- and postoperative radiographic measurements

	Preoperative Period mean	Postoperative Period mean	Difference	p-value
HVA	27.2 °	6.8 °	-20.4 °	$p < 0.001$
IMA	14.9 °	5.2 °	-9.7 °	$p < 0.001$
IPA	5.5 °	9.3 °	3.8 °	$p < 0.001$
IAPF	14.9 °	17.8 °	2.9 °	$p < 0.001$
3 cm 1-2 (mm)	13.7	16	2.3	$p < 0.001$

HVA - hallux valgus angle, IMA - intermetatarsal angle, IPA - interphalangeal angle, IAPF - interphalangeal angle of the proximal fragment, 3 cm 1-2 - distance between a point 3 cm distal from the second metatarsal base and a point located at the same height for the first metatarsal base.

Source: Prepared by the author based on the study results

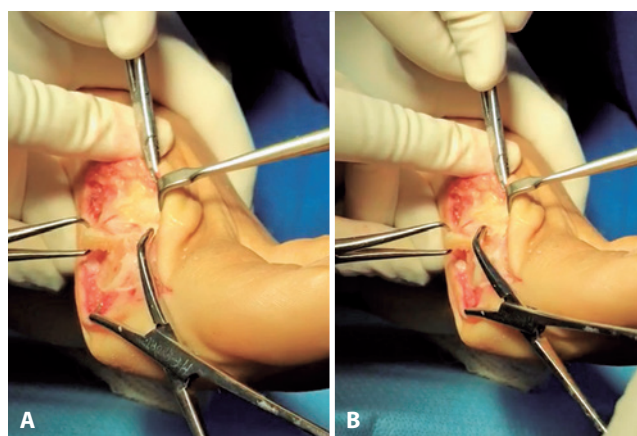
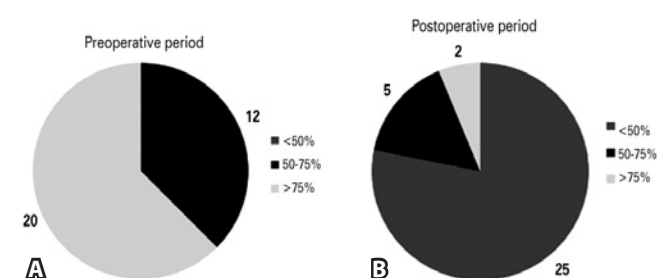


Figure 4. A. Intraoperative picture showing rotational deformity of the metatarsal (pronation). B. Correction of the metatarsal rotational deviation by head rotation.

Source: Author's personal archive.



Graph showing the position of the metatarsal in relation to the lateral sesamoid. A. Preoperative; we observed that the majority of patients presented >75% dislocation. B. Postoperative; we observed correction of the metatarsal head in relation to the sesamoid. Most patients presented <50% dislocation.

Figure 5. Pre- and postoperative position of the sesamoids.

Source: Prepared by the author based on the study results

for the disease are described in the literature, including instability of the metatarsal-cuneiform joint and the position of the head of the first metatarsal in relation to the sesamoids⁽¹⁴⁻¹⁶⁾.

During the procedure, we tried to achieve maximum medial traction of the proximal fragment of the osteotomy because we believe that by reaching this maximum varisation, we will reach the greatest instability possible. When the correction is performed in this way, we believe that the medium and long term medial deviation of the fragment is no longer possible, which could decrease the recurrence rate of the deformity^(17,18).

In our surgical technique, we also sought to correct the position of the first metatarsal head in relation to the sesamoids. Poor head reduction is recognized as a risk factor for recurrence of the deformity, in addition to being a cause of postoperative metatarsalgia⁽¹⁹⁻²¹⁾. We considered it to be an important step of the procedure, and thus, we performed it under fluoroscopy to guarantee the positioning before the final fixation.

The modified Scarf osteotomy can achieve a geometric correction, based on a rotational centre of its fragments,

and is a procedure capable of correcting different degrees of the disease. We chose this technique because we were able to achieve our main objective, which was to increase the varus position of the metatarsal-cuneiform joint and correct the metatarsal pronation in its position in relation to the sesamoids^(22,23).

In the AP radiograph of the foot, when there is ray pronation, the value of the IPA is underestimated. As we correct this pronation, the hallux becomes more perceptible in the radiographic incidence, and therefore, there is an increase in its value.

CONCLUSION

We conclude that the modified Scarf osteotomy corrects the conventional hallux valgus parameters and is able to increase the varisation of the proximal fragment of the first metatarsal, generating greater instability in the first metatarsal-cuneiform joint and leading to a lower chance of recurrence in the immediate postoperative period. The study presents a limitation in relation to the follow-up time in the postoperative period; however, new studies will be carried out in order to increase this follow-up period.

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