Results of minimally invasive surgery versus scarf osteotomy for correcting moderate and severe hallux valgus

Retrospective observational study

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Abstract

Introduction: Surgery is indicated when the pain associated with the hallux valgus deformity is the main symptom and conventional treatment is not effective. The aim of this study was to evaluate our experience with minimally-invasive techniques and scarf-like osteotomy by the AOFAS scale, X-rays with correction in the intermetatarsal angle and the metatarsophalangeal angle, the Regnauld scale, and the Reynolds criteria.

Materials and Methods: Descriptive observational study of the retrospective cohort type. We included the feet operated on using minimally-invasive techniques and scarf-like osteotomy. We revised clinical data preoperatively and 3 and 6 months after the surgery, considering functionality, imaging findings in three angles, and Reynolds and Regnauld's classifications.

Results: We included 123 patients who were subject to 150 procedures: minimally-invasive surgery (44.7%) and scarf-like osteotomy (55.3%). Median age was 56 years old (IQR= 42-51); 88.6% of the patients were females. There were no differences between both techniques immediately before the surgery and 3 and six 6 afterwards in the intermetatarsal angle; however, the metatarsophalangeal angle was corrected ($p<0.001$) and the AOFAS score was better 3 months after the surgery with the minimally-invasive techniques ($p<0.001$).

Conclusions: Both techniques correct deformities back to normality. With the minimally-invasive technique, correction was greater and the AOFAS score was better. The incidence of acute complications was similar between techniques. More clinical trials on this subject are required to confirm the findings in this study.

Conclusiones: Ambas técnicas corrigen la deformidad a valores normales. Con la técnica mínimamente invasiva, la corrección fue mayor y el puntaje AOFAS resultó mejor. La incidencia de complicaciones agudas fue similar. Se necesitan ensayos clínicos sobre este tema para confirmar los hallazgos de este estudio.

Key words: Hallux valgus; scarf-like osteotomy*;* minmally-invasive surgery; complications; AOFAS.
Level of evidence: III

Resultados de la cirugía mínimamente invasiva y la cirugía abierta tipo scarf para la corrección del hallux valgus moderado y severo. Estudio observacional retrospectivo

Resumen

Introducción: Cuando el dolor asociado a deformidad en hallux valgus es el principal síntoma y el tratamiento conservador no es eficaz, está indicada la cirugía. El objetivo de este artículo fue evaluar nuestra experiencia con la técnica mínimamente invasiva y la osteotomía tipo *scarf*, mediante la escala AOFAS, radiografías con la corrección del ángulo intermetatarsiano, el ángulo metatarsofalángico, la escala Regnauld y los criterios de Reynolds.

Conflict of interests: The authors have reported none.

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Materiales y Métodos: Estudio observacional descriptivo de tipo cohorte retrospectiva. Se incluyeron los pies operados mediante las técnicas mínimamente invasiva y tipo *scarf.* Se revisaron los datos clínicos preoperatorios, y a los 3 y 6 meses de la cirugía, sobre funcionalidad, hallazgos imagenológicos de tres ángulos, y las clasificaciones de Reynolds y Regnauld.
Resultados: Se incluyeron 123 pacientes en quienes se realizaron 150 procedimientos: cirugía mínimamente invasiva (44,7%) y tipo *scarf* (55,3%). La mediana de edad era de 56 años (RIC 42-61), el 88,6% eran mujeres. No hubo diferencias entre el preoperatorio inmediato, y a los 3 y 6 meses para el ángulo intermetatarsiano entre las dos técnicas; sin embargo, el ángulo metatarsofalángico se corrigió (p <0,001) y el puntaje AOFAS fue mejor a los 3 meses con la cirugía mínimamente invasiva (p <0,001).
Conclusiones: Ambas técnicas corrigen la deformidad a valores normales. Con la técnica mínimamente invasiva, la corrección fue mayor y el puntaje AOFAS resultó mejor. La incidencia de complicaciones agudas fue similar. Se necesitan ensayos clínicos sobre este tema para confirmar los hallazgos de este estudio.

Palabras clave: Hallux valgus; osteotomía tipo *scarf;* cirugía mínimamente invasiva; complicaciones; AOFAS.
Nivel de Evidencia: III

Introduction

There are reports on more than 150 surgical procedures for hallux valgus correction, which include the release of soft tissues and osteotomies. Distal osteotomies have been indicated for moderate deformities with >17º intermetatarsal angles and correction of the metatarsal distal articular angle, with adequate results in terms of deformity correction and functional improvement.[1-7]

Since this is a weight-bearing limb, the surgical treatment of this condition implies some impairment time for the patient and, therefore, costs for them and those near them. On top of that, if we add adverse episodes such as infection, re-fracture and complex regional pain syndrome, morbidity will have direct effects on the patient and the health system. [1,2,4,5]

The scarf-like procedure has been effective with good to excellent results in the AOFAS (American Orthopaedic Foot and Ankle Society) scale; however, there are reports on complications such as infection in the surgical area, complex regional pain syndrome, lack of bone healing, deficient bone healing, dorsal impaction of the head of the first metatarsal bone, excessive correction and insufficient correction. [2,3,6-8] This "Z" diaphyseal osteotomy of the first metatarsal bone requires exposition of the whole bone by medial approach, what allows the surgeon to have access to both the diaphysis and the metatarsophalangeal joint and thus correct the metatarsal distal articular angle and lengthen the first short metatarsal bones.[2-5,8]

Minimally-invasive surgery was described by Lamprecht-Kramer-Bosch in 1982 for the first time and it was based on linear subcapital osteotomy in the metatarsal bone. Current techniques consist of modifications of such procedure,[6] and over the past years they have made progress. The advantages of these techniques are decrease in patients' recovery time and rehab, because the deep resection of the soft tissues is less extensive, surgical time can be shorter, and they do not require osteosynthesis material.

There are also reports on complications such as nervous injury, vascular injury and deformity recurrence, among others, and the complications usually associated with conventional surgery.[9-15]

Given the high incidence of hallux valgus deformity and a significant increase in surgical treatments that are carried out for hallux valgus correction, it is worth evaluating clinical and radiographic outcomes in surgical techniques— these procedures have economic impact on the social system, what has to do with using—or not using—osteosynthesis material.

Materials and Methods

This was an observational study of the retrospective cohort type. We selected medical histories from adult patients with moderate and severe hallux valgus evaluated at a hospital between 2009 and 2014, who were operated on using scarf—like or minimally invasive techniques as critically determined by their surgeons. Every surgeon has a surgical technique of choice according to his or her learning curve.

We excluded those patients with surgical history in their hallux or toes, deformity secondary to traumatism or incomplete clinical or radiographic data.

In every patient we documented socio-demographic history, clinical status according to the AOFAS scale, imaging findings with evaluation of intermetatarsal and metatarsophalangeal angles, Regnauld scale and Reynolds status, before the surgery and three and six months afterwards.

Surgical technique

Open scarf-like surgery

We administer every patient regional anesthesia (generally ankle blockade) and we insert a cuff around their ankle. We conduct lateral distal release through a distal approach at the level of the first intermetatarsal space.

We conduct a medial approach at the level of the dorsoplantar interval, working on skin and soft tissues, and conducting longitudinal capsulectomy with exposure of the two distal thirds of the first metatarsal bone. We carry on with osteotomy: the longitudinal cut is carried out on the medial surface, and it is longitudinally oblique, dorsal and distally aimed.[1,2,16] We determine the location of the proximal apex in relationship with the intermetatarsal angle: it will be more proximal if the intermetatarsal angle is greater and the distal limit is 5 mm from the distal cartilage. Transverse cuts are carried out in Chevron-like way at 60° from the longitudinal cut and proximally aimed; first we carry out the proximal transverse cut, and the distal transverse cut is extra-articular, what increases the movement angle at the level of the metatarsophalangeal joint and preserves dorsal blood supply to the metatarsal head. Displacement allows the surgeon to display the fragments in different final positions. Lateral displacement can reach up to two thirds of the diaphysis diameter, what makes it possible to lower the plantar distal fragment without inclining the metatarsal bone head. Bone shortening relaxes the flexor hallucis brevis muscle, generally decompressing the metatarsophalangeal joint. Fixation is carried out with screws (Figure 1). [1,2,17]

Hallux pronation is the key variable for Akin osteotomy; however, when the intermetatarsal angle is >16° or the metatarsophalangeal angle is ≥40º, Akin osteotomy will also be required to complete correction.

Minimally-invasive surgery (percutaneous osteotomy)

The surgical technique we evaluate in our study consists of regional blockade in supine position and elastic cuff around the neck of the foot to release the first intermetatarsal space. We carry out a 12 mm-incision at the level of the first intermetatarsal space to release the adductor muscle tendon, an incision at the level of the metatarsal transverse ligament, lateral capsulotomy up to 45°- varus hallux and release plus reduction of sesamoid bones. We carry on to dorsal bunionectomy at the level of the first metatarsal head, if needed. Then, through a 2 mm-incision at the level of the distal center of the bunion, we individualize the capsule and with a 2.2 mm-Shannon reamer we remove the bone with permanent blood supply, and also bone detritus with the aid of saline solution irrigation. We carry out a new 2 mm-incision on the first metatarsal bone at the level of its dorso-lateral mid-third. With the Shannon reamer we carry out cortex osteotomy, which is completed by hand leaving a medial hinge; this procedure is repeated at the level of the proximal phalanx of the hallux through a medial approach, at the level of the phalanx mid-third.[6] In this moment we take X-rays to confirm correction. The foot is immobilized with soft bandages with medial support and adhesives tape holding correction for four weeks; the first bandage change is carried out two weeks later. The patient is immediately allowed complete weight bearing with the use of a rigid-sole shoe for six weeks (Figure 2).[10]

Statistical analysis

First of all we carried out a descriptive analysis of the information. Qualitative variables were expressed as absolute and relative frequencies. Quantitative variables are described as medians and interquartile ranges (IQR), taking into account their statistic behavior. So as to illustrate the differences between the surgical groups, we used the Wilcoxon test for the quantitative variables and the chi-squared test or the Fisher test for the qualitative variables, as required. We interpreted as significant ones those differences with a p=0.05 value in the two-tailed hypothesis test. Data analysis was carried out using the 13.0 version STATA program.

This study was approved by the Research Ethics Committee at the Fundación Universitaria Sanitas.

Results

We included 123 patients in whom we carried out 150 procedures in five years. Depending on the surgical technique in use, critically determined by the surgeon, patients were divided into two groups: minimally invasive (67 patients, 44.7%) and scarf-like (83, 55.3%).

Median age was 56 years old, and most patients were females (88.6%). Table 1 shows the patients' initial characteristics.

Before the surgery, most patients suffered occasional, mild pain with no limitation in activities of daily living, and they needed comfortable shoes. In physical examination, 98% of the patients showed hallux metatarsophalangeal pain and, in the cases of severe pain, such joint was unstable due to articular incongruity; however, it was possible to passively reduce the joint in some cases. The hallux interphalangeal joint was stable and painless, and 46% had symptomatic bone callus. Table 2 shows the patients' characteristics according to the type of procedure.

We found statistically significant differences between the two groups of patients in pain intensity and functional limitations, which were greater in the scarf-like surgery. In the AOFAS scale the score was slightly higher in the group with minimally-invasive surgery.

Figures 3 and 4 show the changes in the intermetatarsal and metatarsophalangeal angles, before the surgery and three and six months afterwards, in both groups.

Figure 5 shows progress in AOFAS scales depending on the chosen technique. With both procedures we got greater scores, especially six months after the procedure.

As regards the intermetatarsal angle, we found a 2°-difference before the surgery, and although we found statistically significant differences between the two procedures, this difference is not relevant from a clinical point of view.

Figure 1. Preoperative and postoperative follow-up. Scarf-like open surgery.

Table 1. Patients' preoperative characteristics.

Characteristic	n (%)
Age*	56 years old (42-61)
Sex	
Female	109 (88,6%)
Male	14 (11.4%)
IMT angle*	14 (12-16)
MTF angle*	32 (31-38)
Pain	
None	18 (12.0%)
Mild, occasional	117 (78.8%)
Moderate, daily	12 (8.0%)
Intense, almost always present	3 (2.0%)
Activities	
Without limitations	83 (55.3%)
Without limitations in ADL	3 (2.0%)
Limitations in ADL	62 (41.3%)
Significant limitations in ADL	2 (1.3%)
Shoes	
Trendy shoes	9 (6.0%)
Comfortable shoes	136 (90.7%)
Orthopaedic shoes	5 (3.3%)
MTF-IF stability	
Stable	3 (2.0%)
Clearly unstable	147 (98.0%)
Callus	
Absent or asymptomatic	81 (54.0%)
Symptomatic	69 (46.0%)
Reynolds	
1	15 (10.0%)
2	98 (65.3%)
3	37 (24.7%)
Regnauld	
1	144 (96.0%)
2	6 (4.0%)
AOFAS scale*	49 (44-54)
Surgical technique	
Minimally-invasive	67 (44.7%)
Scarf-like	83 (55.3%)

*Median (IQR). MTF = metatarsophalangeal, IMT = intermetatarsal, AVD = activities of daily living

Figure 2. Preoperative and postoperative follow-up. Minimally-invasive surgery.

Table 2. Patients' preoperative characteristics by type of procedure

Characteristic	Scarf osteotomy (n = 83)	Minimally-invasive surgery (n = 67)	p
Age*	59 (42-67)	53 (44-58)	0.005
Sex			
Female	72 (86.7%)	62 (92.5%)	0.253
Male	11 (13.3%)	5 (7.5%)	
IMT angle*	13 (12-16)	15 (13-16)	0.037
MTF angle*	32 (31-39)	32 (31-38)	0.463
Pain			<0.001
None	9 (10.9%)	9 (13.4%)	
Mild, occasional	71 (85.5%)	46 (68.7%)	
Moderate, daily	-	12 (17.9%)	
Intense, almost always present	3 (3.6%)	-	
Activities			<0.001
Without limitations	60 (72.3%)	23 (34.3%)	
With limitations in ADL	3 (3.6%)	-	
Limitations in ADL			
Significant limitations in ADL	20 (24.1%)	42 (62.7%)	
	-	2 (3.9%)	
Shoes			0.043
Trendy shoes	7 (8.4%)	2 (3.0%)	
Comfortable shoes	71 (85.5%)	65 (97.0%)	
Orthopedic shoes	5 (6.1%)	-	
MTF-IF stability			0.254
Stable	3 (3.6%)	-	
Clearly unstable	80 (96.4%)	67 (100%)	
Callus			0.190
Absent or asymptomatic	49 (59,1%)	32 (47.8%)	
Symptomatic	34 (40.9%)	35 (52.2%)	
Reynolds			0.008
1	5 (6.0%)	10 (14.9%)	
2	63 (75.9%)	35 (52.3%)	
3	15 (18.1%)	22 (32.8%)	
Regnauld			0.089
1	82 (98.8%)	62 (92.5%)	
2	1 (1.2%)	5 (7.5%)	
AOFAS scale*	49 (44-49)	52 (47-57)	<0.001

* Mediana (IQR). MTF = metatarsophalangeal, IMT = intermetatarsal, AVD = activities of daily living.

In the metatarsophalangeal angle there was a 2°-difference favoring minimally-invasive surgery three and six months after the surgery (Figures 4 and 5). This angle was similar in both groups before the surgery (Table 3).

On the other hand, at time of comparing AOFAS scales between both groups, we found significant differences in preoperative evaluations and three months after the surgery in both techniques; it was slightly better in minimally-invasive surgery, although it was not six months after the surgery (Table 4). As regards complications, we identified a superficial infection in each group, which was treated with v.o. antibiotics. Seventeen (20.5%) patients in the scarf-like group reported discomfort in association with the osteosynthesis material (pain); in eight (9.6%) patients, we removed the osteosynthesis material. One patient in the minimally-invasive group suffered osteotomy bone healing delay in the first metatarsal bone in one foot. We did not find osteoarthritis progression, and the correction of the position of the lateral sesamoid bone did not show statistically significant differences.

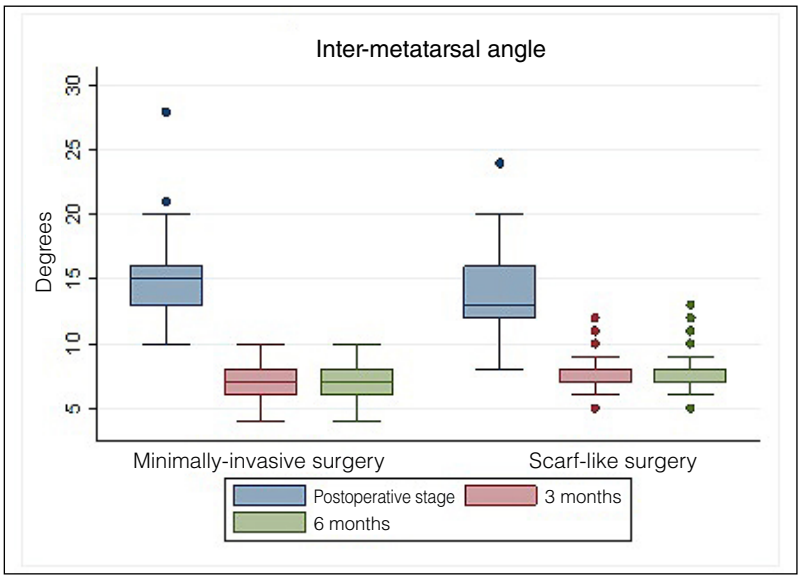

Figure 3. Intermetatarsal angle by type of surgery.

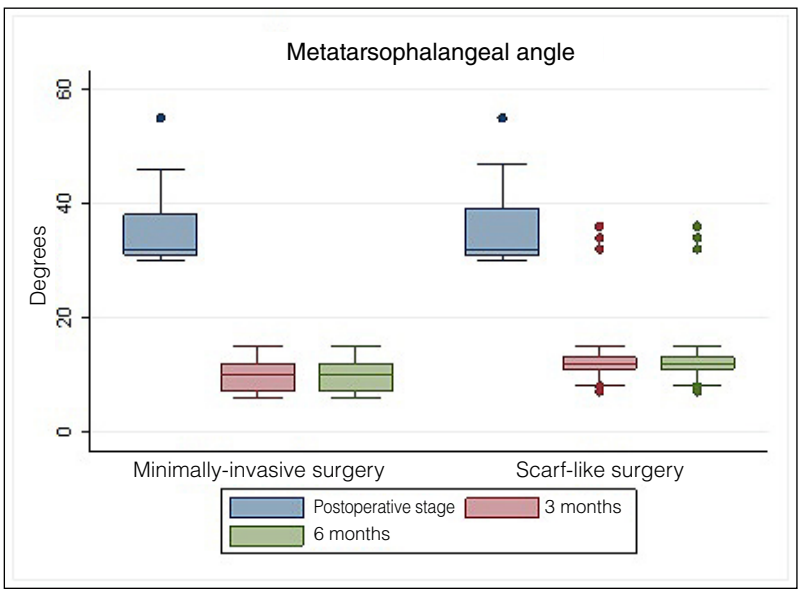

Figure 4. Metatarsophalangeal angle by type of surgery.

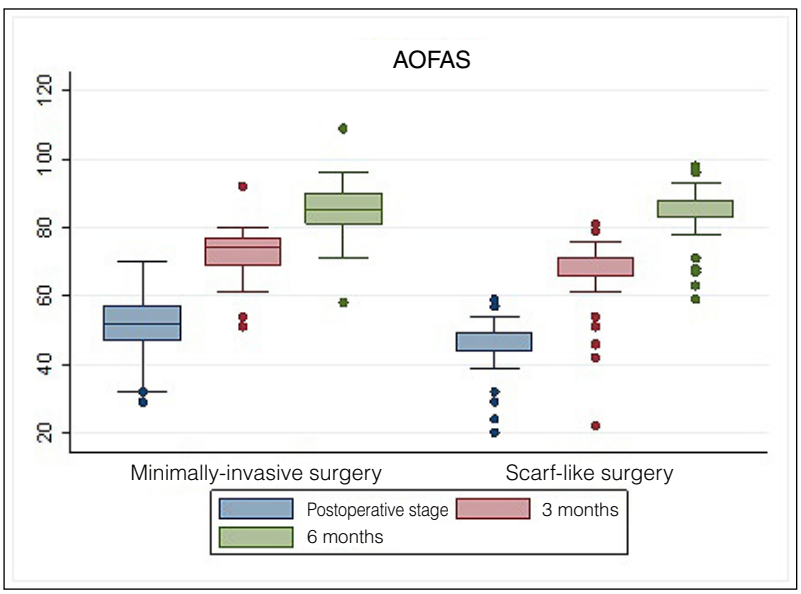

Figure 5. AOFAS scale by type of surgery.

Table 3. Angle by type of procedure

	Intermetatarsal angle			Metatarsophalangeal angle	
	Scarf osteotomy (n = 83)	**Minimally invasive surgery (n = 67)**	**p**	**Scarf osteotomy (n = 83)**	**Minimally invasive surgery (n = 67)**
Preoperative	13 (12-16)	15 (13-16)	0.037	32 (31-39)	32 (31-38)
3 months	7 (7-8)	7 (6-8)	0.023	12 (11-13)	10 (7-12)
6 months	7 (6-8)	7 (7-8)	0.023	12 (11-13)	10 (7-12)

Discussion

Nowadays, there are no prospective randomized comparative studies between non-invasive techniques and open methods, what implies considerable lack of substantial evidence when it comes to the use of these techniques. In the latest systematic revision, Maffulli concludes that we are still to have enough evidence supporting hallux minimally-invasive surgery, due to the heterogeneity of the case series presented, and the lack of reproducibility of the studies, because surgical techniques require an ample learning curve.[18,19]

The scarf-like procedure has been effective and has got good to excellent results in the AOFAS scale. On the other hand, there are reports on complications such as infection in the surgical area, complex regional pain syndrome, lack of bone haling, deficient bone healing, dorsal impaction of the head of the first metatarsal bone, excessive correction and insufficient correction. [1-4,6-8,17]

In both cohorts, we used distal lateral release as an adjuvant technique to correct the deformity. This first step has been described as effective in the reduction of the intermetatarsal and metatarsophalangeal angles. In the Augoyard's study in a cohort of 40 patients, every step decreased the metatarsophalangeal angle from 29.9° to 11.1°. In turn, the 1.70°-intermetatarsal angle added to the medial capsulorrhaphy plus the release of the metatarsosesamoid suspensory ligament resulted in a 3.9°-decrease (21% of the total). On the other hand, the release of the phalangeal insertional band decreased this angle in 5.1° (27%), and the complete resection of the adductor muscle, in 1.5° (8%). Thirty percent of the sesamoid bones are reduced while carrying out the first maneuver, whereas 60% gets reduced after completing the three surgical steps.[20]

There are reports on deformity recurrence as the more worth-noting complication to avoid when it comes to minimally-invasive surgery, but this is not our experience.[6] Weil also describes nervous, vascular and tendon injury—transitory nervous injury represented 12% and permanent nervous injury, 0.5%.[9,19]

De Prado et al. report <1%-infection rates; in other series, infection rates are up to 5%. In all cases there is shortening of the metatarsal bone; in 3% of the cases this is statistically significant. Bone healing delay rates in osteotomy oscillate between 4% and 8%. There are reports on burns due to temperature increase in reamers at the time of carrying out osteotomy; therefore, we used a metallic protector.[20,21]

Table 4. AOFAS by type of procedure

	AOFAS	
	Scarf surgery (n = 83)	**Minimally invasive surgery (n = 67)**
Preoperative	49 (44-49)	52 (47-57)
3 months	71 (66-71)	74 (69-77)
6 months	85 (81-90)	88 (83-88)

Median (IQR).

According to Gianini, this type of non-invasive surgery has been carried out for hallux valgus correction in cases of >20° intermetatarsal angle and >40° hallux valgus angle.[22] Recent studies set out mild or moderate deformities as indications, and severe stages, osteoarthritis in metatarsophalangeal joints, hallux rigidus and joint instability as contraindications.[22]

In this study, we report the application of percutaneous surgery in patients who showed greater angle-deformities and who did well. In Landazabal's study on 104 patients with moderate or severe hallux valgus, patients were subject to a minimally-invasive technique with functional and radiographic improvement.[23]

During follow-up, AOFAS scales showed clinical and functional progression to improvement, what represents patients' statistically significant improvement, with tendencies towards better results in the patients subject to minimally-invasive techniques. The two techniques corrected deformities back to normality; postoperative evaluation was carried out in both groups, and differences were statistically significant in metatarsophalangeal angles three and six months after the surgery. We believe that this is due to the fact that the group with the minimally-invasive technique received Akin osteotomy in the proximal phalanx of the hallux in all cases and, the group of open surgery, only if patients met the previously mentioned criteria.

With respect to the complications inherent in each procedure, 17 patients in the scarf-like surgery group felt discomfort due to osteosynthesis material. In the other group there was a case of osteotomy bone healing delay, which finally healed.

The limitations of this study were its retrospective character, the difficulties to get radiographic images (because many of them were not available in digital format), the lack of data in medical histories so as to contact the patients for follow-up, and the lack of homogeneity in both groups so as to compare them with one another, associated with selection bias at the time of choosing a surgical technique.

Conclusions

We report a combined technique of minimally-invasive surgery with a percutaneous approach, which is safe and effective to correct hallux valgus. On the other hand, our experience with scarf-like open surgery is good in hallux valgus, as reported in specialized literature. We conclude that surgeons should feel assured at the time of implementing any of these techniques in the correction of moderate and severe hallux valgus.

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