Percutaneous Osteotomy of the Distal Phalanx of the Hallux. Indications and Technique

Juan Manuel Yañez Arauz,[*] Juan Martín Yañez Arauz,[*] Verónica Montiel Terrón,[**] Verónica Machado,[**] Matías Alfonso,[**] Carlos Villas[**]

[*]*Leg, Ankle and Foot Sector, Orthopedics and Traumatology Service, Hospital Universitario Austral (Buenos Aires, Argentina)*

[**]*Department of Orthopedic and Traumatological Surgery, Clínica Universidad de Navarra (Navarra, Spain)*

ABSTRACT

Introduction. There are many techniques to correct the hallux deformity. Most of them include metatarsal and/or phalanx osteotomies. The Akin osteotomy of the proximal phalanx is used to correct the distal articular set angle (DASA), or the interphalangeal angle. However, indications for the distal phalanx osteotomy remain unpublished. The aim of this study is to communicate the technique and indications for percutaneous osteotomy of the distal phalanx of the hallux, and to evaluate the results of a case series. **Materials and Methods.** We reported 14 cases in which distal phalangeal osteotomy was performed. Radiographic measurements were performed on dorsal-plantar view of the foot, to analyze distal articular set angle (DASA), interphalangeal obliquity, and F2-IP angle. The surgical technique was performed by minimally incision surgery. The clinical and functional results were evaluated by the visual analog scale for pain and the AOFAS score. The average follow-up was 52 months. **Results.** The clinical outcomes for all the patients were excellent, pain was relieved and deformities corrected. Pre- and post-operative comparative angles: DASA (p: 0.01), except when isolated from the sample for Akin-type osteotomy (p: 0.33). Angle F2-IP and angle F2-MTP (p: <0.00001). The patients were highly satisfied with both the aesthetic and functional results. Complications were registered. **Conclusion.** In the symptomatic hallux distal phalanx deformity a corrective distal phalanx osteotomy should be considered alone, or associated with the osteotomy of the proximal phalanx. Percutaneous distal phalanx osteotomy is an effective, safe, and fast procedure.

Key words: Phalangeal osteotomy; percutaneous surgery; hallux valgus; hallux deformity; MIS osteotomy.

Level of Evidence: IV

Osteotomía percutánea de la falange distal del hallux. Indicaciones y técnica

RESUMEN

Introducción: Las técnicas para corregir las deformidades del hallux incluyen osteotomías metatarsianas y falángicas. Las osteotomías sobre la falange proximal corrigen el DASA y el ángulo interfalángico. Sin embargo, no se han publicado las indicaciones para la osteotomía de la falange distal. El objetivo de este artículo es comunicar la técnica y las indicaciones de la osteotomía percutánea de la falange distal del hallux, y evaluar los resultados de una serie de casos. **Materiales y Métodos:** Se analizaron 14 pies en los que se realizó una osteotomía de la falange distal del hallux para corregir una deformidad. Se midieron el DASA, la oblicuidad interfalángica y el ángulo falange distal-interfalángico en las radiografías. La técnica quirúrgica fue percutánea con control fluoroscópico. Los resultados se evaluaron mediante la escala analógica visual de dolor y AOFAS. Seguimiento medio: 52 meses. **Resultados:** 13 pies de mujeres y un pie de hombre. Edad promedio: 58 años. Los resultados clínico y estético fueron excelentes, con alivio del dolor. Mejoría de la escala AOFAS: promedio 37 puntos. Análisis comparativo de ángulos preoperatorios y posoperatorios: DASA (p = 0,01), excepto cuando se aisló de la muestra a los pacientes con osteotomía tipo Akin (p = 0,33); ángulos F2-IF y F2-MTF (p <0,00001). Se registraron las complicaciones. **Conclusiones:** En la deformidad en valgo de la falange distal del hallux sintomática, se debe considerar una osteotomía correctora sola o asociada a osteotomía de la falange proximal. La osteotomía percutánea de la falange distal es un método eficaz, seguro y rápido.

Palabras clave: Osteotomía; falange; cirugía percutánea; hallux valgus; deformidad de hallux; osteotomía mínimamente invasiva.

Nivel de Evidencia: IV

Received on April 11th, 2020. Accepted after evaluation on September 20th, 2020 • JUAN MANUEL YAÑEZ ARAUZ, MD • juanyanezarauz@gmail.com https://orcid.org/0000-0001-5739-3130

How to cite this article: Yañez Arauz JM, Yañez Arauz JM, Montiel Terrón V, Machado V, Alfonso M, Villas-Tomé C. Percutaneous Osteotomy of the Distal Phalanx of the Hallux. Indications and Technique. *Rev Asoc Argent Ortop Traumatol* 2021;86(2):139-150. https://doi.org/10.15417/issn.1852-7434.2021.86.1.1097

INTRODUCTION

Within orthopedic pathologies of the first toe, hallux valgus is the most common reason for consultation. This pathology has a multifactorial etiology.[1] Myerson[2] suggested an hallux valgus prevalence of 2-4% of the population. The deformity and its clinical manifestations appear between the third and fifth decade of life in 65% of people suffering from this pathology. It is much more frequent in women.[3,4]

It is agreed upon that pointy-toed, high-heeled shoes contribute to its development, for they modify the static and dynamic bone-muscle-tendon configuration of the foot. [5-10]

Hallux valgus can be classified according to the site of deformity (anatomical location) into metatarsophalangeous HV (MPHV) in most cases; and/or interphalangeous HV (IPHV). In 1935, Daw[11] defined hallux valgus interphalangeous as the lateral deviation of the first toe, affecting the interphalangeal joint. He mentioned a lateral deviation of the distal phalanx greater than 10º, which can be independent or associated to hallux valgus metatarsophalangeous.

Sorto et al.[12] defined the concept of "obliquity" or valgus angle (AF1) as the relation between the F1 diaphysis with its distal articular surface and the "asymmetry" or F2 angle as the angle formed by the perpendicular to the surface of the interphalangeal joint, and the diaphyseal axis of the distal phalanx (Figure 1). Moreover, he proposed that alterations in the growth of the phalangeal condyles, or of the base of the distal phalanx, produce deformities at the interphalangeal level.

Figure 1. Angle measurements on anteroposterior weight-bearing radiographs. **A.** DASA. **B.** F2 angle.

In the medical practice, painful deformities of the first ray of the foot usually receive surgical treatment. The aim of surgical treatment is to correct bone deformities by means of osteotomies, achieving a correct biomechanical alignment and good functionality and thus obtaining a painless, plantigrade foot with good first ray alignment.

When hallux valgus is surgically treated, osteotomy is used in most cases. In 1925, Akin[13] described a procedure for the treatment of hallux valgus which consisted of the resection of the medial exostosis of the first metatarsal, a medial wedge resection osteotomy at the base of the proximal phalanx of the hallux and the lateral release of the abductor tendon. This phalangeal osteotomy was popularized as Akin osteotomy, and it was described at the base of the proximal phalanx of the hallux for the correction of the DASA (distal articular set angle) (Figure 2). As a variation, Akin osteotomy can be performed at the distal level to correct hallux valgus interphalangeous (Figure 3). This is done percutaneously with a minimally invasive technique.

Likewise, there are painful distal deformities of the hallux associated with various pathologies (such as diabetes, inflammatory arthritis), which are not associated with hallux valgus.

Figure 2. Akin osteotomy: corrects DASA.

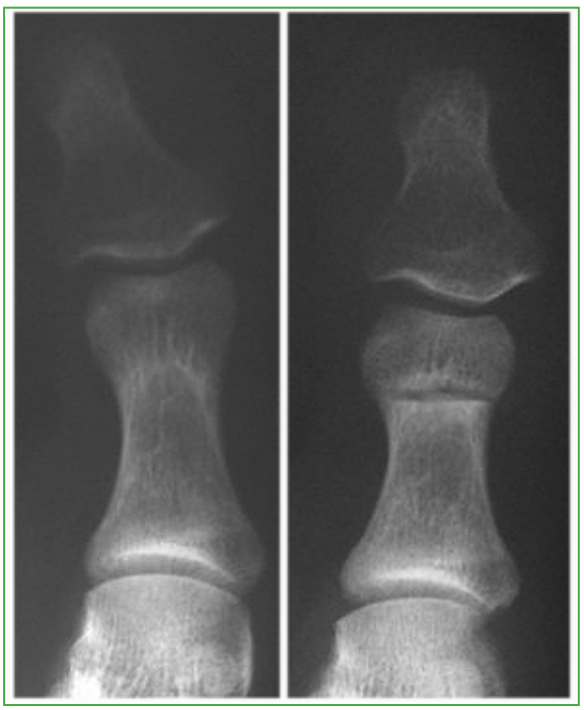

Figure 3. Distal Akin osteotomy: corrects interphalangeal angle.

With these concepts in consideration, the treatment of hallux deformities (hallux valgus with interphalangeous valgus or single distal deformity), should be performed in the main site of bone deformity; that is, the osteotomy could be performed at the metatarsal, proximal, or distal phalanx level (according to the rotation center of the angle of deformity); or it could be combined, depending on the case.

We have not found publications describing a treatment algorithm for hallux deformities comprising percutaneous deviation corrections of the distal phalanx of the hallux.

The aim of this study is to communicate the technique for the percutaneous osteotomy of the distal phalanx of the hallux, its indications and outcomes within a series of cases.

MATERIALS AND METHODS

The study is based on a series of cases where a hallux distal phalanx osteotomy was performed to correct a deformity, associated with hallux valgus surgery or not. 14 feet of 13 patients, where an osteotomy was performed at the base of the distal phalanx of the hallux, were analyzed. In all cases, the osteotomy was conducted percutaneously, with an incomplete medial wedge substraction, without osteosynthesis, for it was self-stable by osteoclast.

Regarding the previous pathology and deformity: in five cases this osteotomy was conducted as part of hallux valgus surgery; 5 cases were digitus valgus with deformity of the distal phalanx (one of them bilateral) with pain and impossibility of wearing shoes; two cases were distal deformities in diabetic patients; one case presented a painful and deforming chronic inflammatory pathology; and the remaining case presented a previous hallux MTP arthrodesis, with painful valgus deformity of the distal phalanx.

The clinical analysis was conducted according to the AOFAS scale of hallux and visual analog scale for pain.[14,15]

Average follow-up was 52 months (39-92 range).

Radiologic Analysis.

Radiographic measurements were performed on anteroposterior radiographs of the foot, taken with the patient standing on both feet, bearing his or her own weight.

The following angles were recorded and analyzed both in the pre-operative and long-term post-operative period (Figure 4):

1. DASA, drawing a tangent to the phalanx's proximal articular facet. Therefrom, the perpendicular to the tangent is drawn, measuring the angle formed by such perpendicular and the line of the proximal phalanx's diaphyseal axis. The normal values are between 0° and 8°.

2. The interphalangeal joint obliquity (IJO)[12], measured by taking the angle where the perpendiculars to the tangent lines of both articular facets (proximal and distal to the first phalanx) intersect.

3. The F2-interphalangeal obliquity (F2-IP)[12], measured by the angle formed between the distal phalanx axis and the perpendicular to the tangent of the proximal phalanx condyles.

4. The distal phalanx-MTP joint angle (F2-MTP): taking the resultant of the intersection of the tangent to the first phalanx's base and the longitudinal axis of the distal phalanx.

Angle alterations taking place more than 38 months after surgery were considered to be due to other causes and not to the surgical technique itself (for example, osteoarthrosis, tarsometatarsal instability, hallux valgus, etc.).

All images were digital, and measurements were conducted with computer software (MB Rouler® version 4.0)

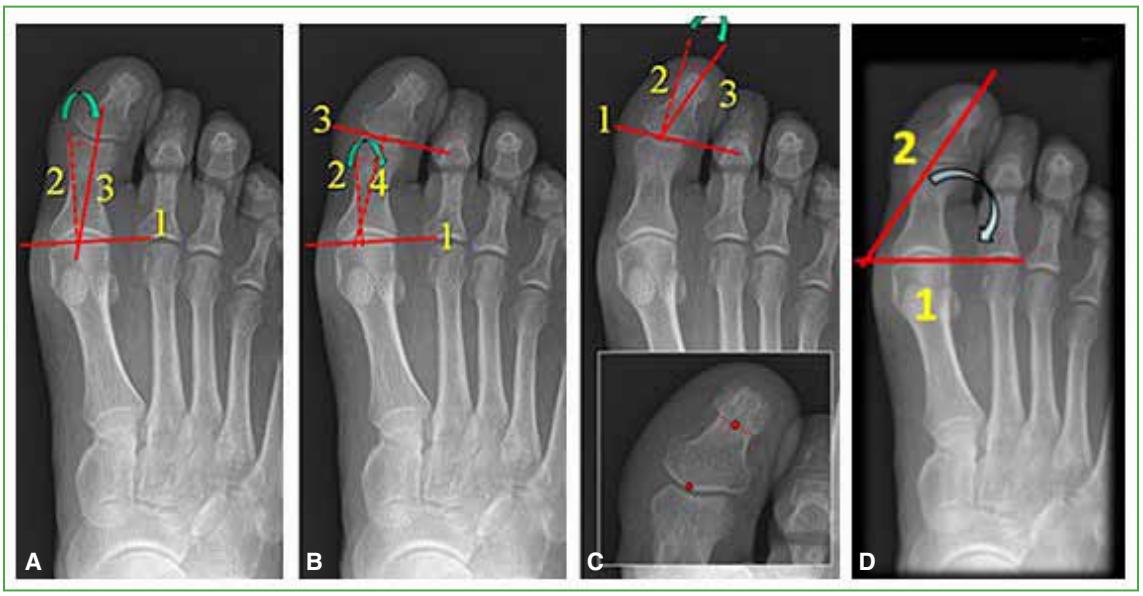

Figure 4. Radiographic measurements. **A.** DASA measurement. **B.** Interphalangeal obliquity. **C.** F2-IP obliquity. **D.** Metatarsophalangeal-distal phalanx angle.

Statistical Analysis

For the analysis of differences in the distribution of a variable between the pre-operative and post-operative period, a paired samples t-test was used. A value p:<0.05 was considered statistically significant.

Two cases are described as examples:

CASE 1

A 67-year-old woman consulted for valgus deviation of the distal phalanx of the first left toe and pain in the interphalangeal joint, associated with limited extension of the second toe, causing a claw-type deformity.

Pre-operative AP radiographs of the left foot showed a DASA of 3º, an IJO of 5º, an F2-IP angle of 3.5º, and an F2-MTP angle of 78º. After considering all possible surgical options and their complications, a surgical correction was performed. It included a percutaneous osteotomy of the distal phalanx of the varus hallux, associated with an interphalangeal arthrodesis of the second left toe. The surgery and post-operative period were conducted according to the specifications below (Figure 5). The values 9 months post-surgery were: DASA 1.5º, IJO 3º, F2-IP angle -4º, and F2-MTP angle 112º. The patient's evolution was satisfactory, with pain relief and satisfaction.

Figure 5. Case 1. Distal hallux deformity with ungual pain and deformity, and pain on the second toe. A. Preoperative image. **B.** Preoperative radiograph.

CASE 2

The second case was a 42-year-old woman with valgus deformity in the distal phalanx of the first right toe, with ungual pain and irruption into the second toe, causing painful hammer-type deformity which made wearing shoes difficult (Figure 6A) due to lack of space for the second toe. Pre-operative right foot radiographs showed a DASA of 5º, interphalangeal obliquity of 12º, F2 interphalangeal angle of 10º and F2 metatarsophalangeal angle of 60º (Figure 6B). Surgical correction was performed by a percutaneous closure osteotomy at the base of the third phalanx of the hallux, associated to minimally invasive treatment of the second hammer toe with base osteotomy of the first phalanx and tenotomy of the extensor of the second toe (Figures 6C and 6D). Post-operative values were: DASA 6º, interphalangeal obliquity 4º, F2 interphalangeal angle 6º and F2 metatarsophalangeal angle 88º. The patient's evolution was satisfactory, with pain relief and the possibility of wearing shoes.

Figure 6. Case 2. Distal hallux deformity with ungual pain and deformity, and pain on the second toe. **A.** Preoperative image. B. Preoperative radiograph. **C.** 2-month postoperative image. **D.** 6-week postoperative radiograph.

Percutaneous surgical technique of osteotomy of the hallux's distal phalanx

The main steps are described: the patient is placed in a dorsal decubitus position with truncal anesthesia in the affected hallux. A medial portal is performed in the base of the distal phalanx, 5 mm distal to the articulation, with a Beaver 64 surgical blade, under fluoroscopic control, up to the bone. It is necessary to take the beginning of the nail matrix as a reference and proceeding with care to prevent any damage, since it is immediately distal to the osteotomy site.

Afterwards, a short Shannon burr at low speed is used to perform an incomplete medial base osteotomy parallel to the articular surface, so as to avoid damaging the matrix, whose base will be greater or lesser depending on the angle of the target deformity. Control fluoroscopy is performed. The lateral wall of the distal phalanx and its periosteum are kept intact. This allows for a self-supporting osteotomy (Figure 7).

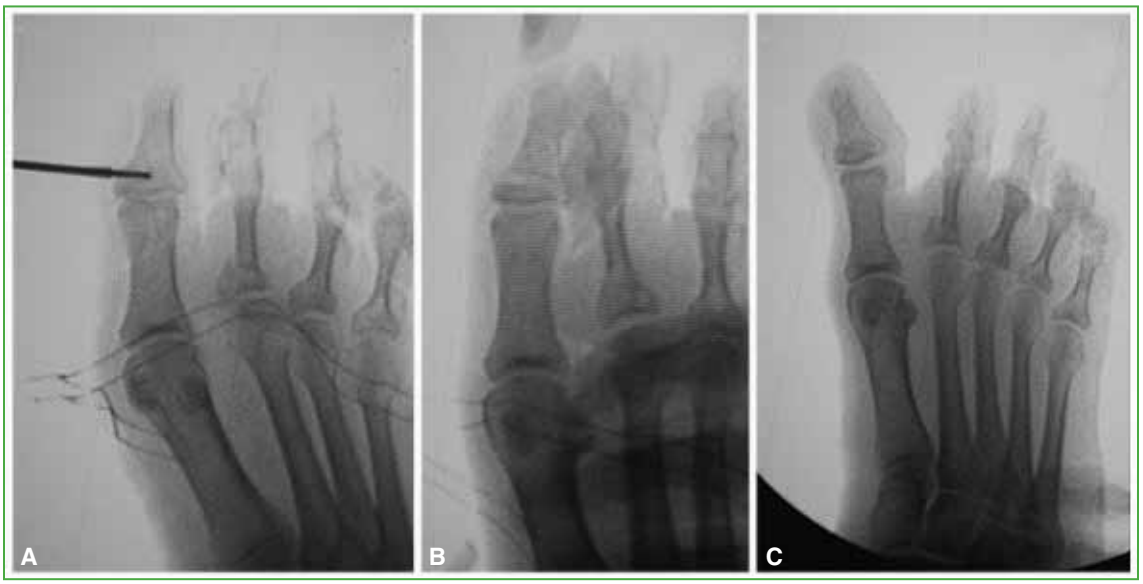

Figure 7. A. Incomplete percutaneous osteotomy technique at the base of the distal phalanx using a short Shannon burr. **B.** Medial base osteotomy. **C.** Osteoclasty with correction of the deformity.

Finally, the osteoclasis is performed and the deformity is corrected. Control fluoroscopy. Closure with a single 4.0 Nylon stitch (Figure 8). Corrective bandage during three weeks, preserving the achieved results, to enable the bone healing in the desired position. Post-operative shoe with immediate weight-bearing. A month after surgery, the progressive use of normal footwear is allowed, depending on tolerance.

Note: If the osteotomy becomes unstable after a complete bone cutting, it may be temporarily stabilized with a Kirschner wire for three weeks to avoid inappropriate bendings. This is unlikely with minimally invasive surgery.

Figure 8. Immediate postoperative image.

RESULTS

Of the 14 operated feet, 13 belonged to women (one case was bilateral) and one to a man. Average age of patients was 58 years (40-74 range).

The clinical and aesthetic outcome was excellent for all patients, with pain relief and good subjective cosmetic results. In all cases, the previous deformity of the distal hallux phalanx was corrected.

Regarding the AOFAS scale, an average improvement of 37 points was observed, with a pre-operative average of 50.7 (35-65 range) points and post-operative average of 87.5 (75-100 range) points (Table 1).

In regards to pain, pre-operative pain averaged 4.64 (2-7 range) and post-operative pain averaged 1 (0-2 range); with $p < 0.0001$ (Table 1).

Table 1. AOFAS and visual analog scale results.

	AOFAS				Reference values
	PreOP	**PostOP**	**Improvement**	**p value**	0 to 100
Average	50.7	87.5	36.8	p: < 0.0001	0: negative outcome.
					100: excellent outcome.
	Visual Analog Scale (0 to 10)				Reference values
	PreOP	**PostOP**	**Improvement**	**p value**	0: no pain.
Average	4.64	1	3.64	p: < 0.0001	10: intolerable pain.

The values of radiographic measurements of the angles in the preoperative and in the long-term postoperative period are shown in Table 2 in a comparative way.

In 5 cases a percutaneous Akin osteotomy of the first phalanx was added (cases 3, 8, 9, 11 and 12). In these cases an improvement of the DASA angle was observed in the post-operative measurements, which leads to the conclusion that Akin osteotomy is good at correcting the DASA angle.

Table 2. Radiographic measurements of preoperative and postoperative angle values.

Case	Preoperative and postoperative measurements of the measured angles								Comments
	DASA		OIP		F2-IP		F2-MTP		
Reference values	**0° to 8°**		**0° to 10°**		**0° to 5°**		**87° to 95°**		
	PreOP	**PostOP**	**PreOP**	**PostOP**	**PreOP**	**PostOP**	**PreOP**	**PostOP**	
1	3	1,5	5	3	3,5	-4	78	102	
2	4	4	11	15	3	1,5	71	85	
3	12	1	2	6	16	2	55	85	F1 osteotomy was added
4	7	7	14	13	12	4	67	86	
5	5	6	12	4	10	6	60	88	
6	15	9	5	5	15	7	70	91	
7	2	2	3	3	17	4	72	86	
8	16	3	12	8	5	2	86	95	F1 osteotomy was added
9	10	1	6	0	12	3	73	88	F1 osteotomy was added
10	3	3	18	18	16	-2	67	90	
11	14	7	17	12	4	0	82	90	F1 osteotomy was added
12	17	4	12	5	16	5	65	85	F1 osteotomy was added
13	9	9	5	5	15	2	68	88	
14	8	8	8	10	19	3	63	86	

DASA = distal articular set angle, OIF = oblicuidad de la articulación interfalángica, F2-IP = F2-interphalangeal obliquity angle, F2-MTP = distal phalanx-Metatarsophalangeal joint angle.

The comparative analysis of angle values between the pre-operative and post-operative period of the distal phalanx osteotomy yielded the following results:

a) the DASA showed a significant difference (p: 0.01) when all values were taken together. If we isolate the patients who underwent an Akin osteotomy of the proximal phalanx, the difference is not statistically significant (p: 0.33); this means pure distal phalanx osteotomy does not alter the DASA.

b) The IJO angle did not present a significant difference (p: 0.13).

c) The measurement of the F2-IP angle presented a significant difference (p: 0.00001) (Table 3)

d) The analysis of the F2-MTP angle also presented a statistically significant difference (p: 0.000001). (Table 3)

e) These last two items evidence the correction power of F2 (or distal phalanx) osteotomy for F2-IP and F2-MTP angles.

We have not observed intraoperative complications, whereas during the post-operative period we observed an asymptomatic alteration of ungual growth in one patient.

Table 3. Average preoperative and postoperative angles, and statistical significance of the correction.

Average F2-IP angle measurement (0° to 5°)			Average F2-MTP angle measurement (87° to 95°)		
PreOP	PostOP	p value	PreOP	PostOP	p value
11.67°	2.36°	p: < 0.0001	69.8°	88.9°	p: < 0.0001

F2-IP = F2-interphalangeal obliquity angle, F2-MTP = distal phalanx-Metatarsophalangeal joint angle.

DISCUSSION

Different treatment algorithms have been proposed for hallux valgus and IP valgus deformities, by means of surgical techniques, including bone alignment in different planes, associated with other surgical steps such as recutting the medial prominence of the metatarsal head and intervening upon soft tissue.[16]

In spite of its relevance, there are no clear data on the prevalence of IP hallux valgus. Neither is there clear consensus on the normal IP angle (IPA) or the causes which may lead to its deformity. Barnett[17] suggested an average angle of 5º as normal; Bryant,[18] an average of 5º in patients with hallux valgus and of 15º in those with hallux rigidus.

Sorto et al.[12] introduced the possible influence of the MTP and IP joints' stability, and an inverse relationship between the presence of MTP hallux valgus and IP hallux valgus.

Coughlin and Shurnas[19] studied 127 feet affected by hallux rigidus and observed an augmented IP angle (18º on average), concluding that rigidity due to MTP osteoarthritis was the cause for increased IP angles and instability.

In coincidence with these authors, Sorto et al.[12, 20] mentions that the rigidity of the MTP joint is a triggering factor determining the instability of the IP joint. This explains the relation between IP hallux valgus and distal phalanx valgus in patients with MTP arthrodesis.

Fitzgerald[21] conducted a long-term study of 69 patients with MTP arthrodesis, finding an increase in the IP angle as arthritic changes developed in that joint after the surgery. In our series, we had a patient with MTP arthrodesis and a painful secondary valgus deviation of the distal phalanx, treated with the technique described.

Barnett[22] established that asymmetry and obliquity are the factors causing deformity in IP hallux valgus.

Shimizu et al.[23] published a case of IP hallux valgus developed after a wound in the epiphysis which was caused by articular osteochondral trauma in a young patient.

In light of these reasons, there are multiple procedures to treat hallux deformities.

In some cases, there occur hypo or hypercorrections, or even relapsed deformities, after using the appropriate surgical technique. In other cases, the problem stems from inadequate assessments of the deformity and incorrect technique choices. Therein, the hallux's distal phalanx, undervalued within the first radius, may cause discomfort in some cases, owing to a residual deformity consisting of a deviation of the nail and the distal phalanx towards the fibular side after surgery, with the concomitant pain and deformity of the second toe.

In the literature, we only found the description of an open lateral osteotomy of the distal phalanx, with an external approach, published by Carnevale[24] and previously described by doctors José María del Sel and Scaramuzza during the first OTS Congress in Mar del Plata, Argentina, in 1956.Considering the IP articular deformity, the intrinsic deformity of the proximal phalanx, and the deformity of the distal phalanx, we believe that the solution to the surgical treatment could be aimed at the proximal phalanx, the distal phalanx or both.

In some other cases, the functional limitation is the result of a painful deformity of the second toe, caused by the lateral deviation of the hallux's distal phalanx, without altering the MTP joint. This kind of distal deviation tends not to affect the toe's mobility, but it may cause mechanical trouble due to friction with the second toe and to "lack of space" while using inadequate footwear, which will in turn cause a greater deformity. Given that the nail bed seems to follow the direction of the distal phalanx, [25] these deformities may cause trophic disorders, such as onychocryptosis.

The higher growth of the distal phalanx's tibial side, observed in some cases, determines its longer size in comparison with the fibular side and may be the cause of deformity in the distal valgus, or simply cause the growth of the exostosis[26] as a result of inhibiting the lateral physis or stimulating a relatively larger medial epiphysis.

Barouk et al.[27] mention that the valgus deformities in the IP joint are treated with techniques involving the proximal phalanx, such as the osteotomy described by Akin.[18] But this would not be enough to correct the asymmetry related to the deformity of the distal phalanx.

Vander Griend[28] assessed 33 feet treated with a distal osteotomy of the first phalanx in patients with IP hallux valgus; he concluded that this is a good technique to correct this problem since it is safe, presents few complications, yields good clinical results and is satisfactory for patients. However, his study does not mention the cases, albeit few, in which the deformity affects the hallux's distal phalanx. Therefore, if we intend to act upon the center of rotation of the deformity's angle and to correct the distal deformity and the IP valgus, we should resort to an osteotomy of the distal phalanx, as proposed in this study. This is because the osteotomy of the proximal phalanx will not correct the distal deformity, as described by Sorto et al.[12]

In 1957, Burry[29] devised a concise method to quantify the degree of valgus deviation in the joint, by means of the angular relationship between the longitudinal bisections of the hallux's distal and proximal phalanges (IP angle). Using this method to evaluate 346 feet, Barnett[17] calculated an average valgus deviation of between 13° and 13.58°. Sorto et al.[12] reinforced this finding, determining the average angle to be 13.48° in 432 assessed feet.

A cadaveric study mentions some complications in distal phalanx osteotomy, like the potential damage to the nail bed and wounding the hallux's extensor longus.[30] We believe that a refined knowledge of normal anatomy and a precise performance of the surgical technique would reduce these potential damages to a minimum. In our series, we observed only a single patient with mild, totally asymptomatic trophic disorders in nail growth. We have detected no wounds in the hallux's extensor.

The authors believe that the distal phalanx's deformity would not cause any problems if treated in small angles between the phalanges, but it may cause discomfort in moderate or severe deformities, especially with >20º IP or F2-IP angles.

There is a lack of clear consensus on which is the ideal normal angle of the distal phalanx; as a result, the question arises of whether we should seek to compensate. However, according to the cited studies, the symptomatic >20º F2-IP angles should be treated by means of a distal phalanx osteotomy.

Another case is the pure deformity of the distal phalanx, along with pain and deformity of the second toe due to compression and an eventual painful nail alteration in the hallux. In these situations, a corrective osteotomy should be performed on the distal phalanx.

Finally, we should mention the cases of IP hypocorrection after a hallux valgus surgery, with distal lateral deviation and residual pain focalized in the IP joint's tibial side with local keratosis. In such cases, distal phalanx surgery may be indicated.

Some of this study's strengths are the statistical analysis, its originality and its novelty within the literature, as well as more than three years of follow-up in all cases. Among its weaknesses, we may mention the number of cases presented, but we should consider that these symptomatic deformities are infrequent.

CONCLUSIONS

In patients presenting a symptomatic valgus deviation of the distal hallux phalanx greater than 20°, a percutaneous corrective osteotomy of said phalanx should be considered, on its own or associated to proximal phalanx osteotomy. The same can be applied to cases of distal deviation with symptomatic compromise of the second toe.

In spite of the small case sample, we believe percutaneous osteotomy of the distal hallux phalanx allows good clinical and radiological correction of distal deformities of the hallux. Percutaneous osteotomy of the distal hallux phalanx seems to be an efficient, safe and fast method.

Conflict of interests: The authors declare they do not have any conflict of interests.

J. M. Yañez Arauz ORCID ID: https://orcid.org/0000-0003-3321-3726
V. Montiel Terrón ORCID ID: https://orcid.org/0000-0002-2140-427X
V. Machado ORCID ID: https://orcid.org/0000-0002-0162-9383
M. Alfonso ORCID ID: https://orcid.org/0000-0001-5824-0857
C. Villas-Tomé ORCID ID: https://orcid.org/0000-0002-7364-6967

REFERENCES

1. Mann RA, Coughlin MJ. Hallux valgus-etiology, anatomy, treatment and surgical considerations. *Clin Orthop Relat Res* 1981;(157):31-41. PMID:7249460
2. Myerson MS. Hallux valgus. En: Myerson MS (ed.). *Foot and ankle disorders*. Philadelphia: Saunders; 2000.
3. Coughlin MJ, Thompson FM. The high price of high-fashion footwear. *Instr Course Lect* 1995;44:371-7. PMID: 7797875
4. Coughlin MJ. Hallux valgus in men: Effect of the distal metatarsal articular angle on hallux valgus correction. *Foot Ankle Int* 1997;18(8):463-70. https://doi.org/10.1177/107110079701800802
5. Haines RW. Shoe design and toe deformation. *Lancet* 1954; 267(6852):1308-11. https://doi.org/10.1016/s0140-6736(54)90712-6
6. Lelievre J. Shoes and our foot. III. The physiological shoe. *Concours Med* 1961;83:1081-4. PMID: 13760672
7. Frey C, Thompson F, Smith J. Update on women's footwear. *Foot Ankle Int* 1995;16(6):328-31. https://doi.org/10.1177/107110079501600603
8. Craigmile DA. Incidence, origin, and prevention of certain foot defects. *Br Med J* 1953;2(4839):749-52. https://doi.org/10.1136/bmj.2.4839.749
9. Coughlin MJ. Women's shoe wear and foot disorders. *West J Med* 1995;163(6):569-70. https://doi.org/10.1177/107110079501600603
10. Coughlin MJ. Roger A. Mann Award. Juvenile hallux valgus: etiology and treatment. *Foot Ankle Int* 1995;16(11): 682-97. https://doi.org/10.1177/107110079501601104
11. Daw SW. An unusual type of hallus valgus (two cases). *BMJ* 1935; 2:580-2.
12. Sorto Jr LA, Balding MG, Weil LS, Smith SD. Hallux abductus interphalangeus. Etiology, X-ray evaluation and treatment. 1975. *J Am Podiatr Med Assoc* 1992;82(2):85-97. https://doi.org/10.7547/87507315-82-2-85
13. Akin OF. The treatment of hallux valgus-a new operative procedure and its results. *Medical Sentinel* 1925;33:678.
14. Hayes MHS, Patterson DG. Experimental development of the graphic rating method. *Psychological Bulletin* 1921;18:98-99.
15. Zealley AK, Aitken RCB. A growing edge of measurement of feelings [Abridged]: Measurement of mood. *Proc R Soc Med* 1969;62(10):993-6. PMID: 5346176
16. Mann R, Coughlin M. Hallux valgus y sus complicaciones. En: *Cirugía del pie*, 5ª ed. Buenos Aires: Editorial Médica Panamericana; 1986.
17. Barnett CH. Valgus deviation of the distal phalanx of the great toe. *J Anat* 1962;96(Pt 2):171-7. PMID: 13865114
18. Bryant JA. A comparison of radiographic foot measurements taken in two different positions. *J Am Podiatr Med Assoc* 2001;91(5):234-9. https://doi.org/10.7547/87507315-91-5-234

19. Coughlin MJ, Shurnas PS. Hallux rigidus: demographics, etiology, and radiographic assessment. *Foot Ankle Int* 2003;24(10):731-43. https://doi.org/10.1177/107110070302401002
20. Sorto LA, Balding MG, Weil LS, Smith SD. Hallux abductus interphalangeus: etiology, x-ray evaluation and treatment. *J Am Podiatry Assoc* 1976;66(6):384-96. https://doi.org/10.7547/87507315-66-6-384
21. Fitzgerald JA. A review of long-term results of arthrodesis of the first metatarso-phalangeal joint. *J Bone Joint Surg Br* 1969;51(3):488-93. PMID: 5820792
22. Barnett CH. The normal orientation of the human hallux and the effect of footwear. *J Anat* 1962;96(Pt 4):489-94. PMID: 13969386
23. Shimizu A, Watanabe S, Kamada K, Tsuboi I, Yamamoto H. Hallux valgus interphalangeus following osteochondral fracture of the proximal phalanx: a case report. *Foot Ankle Int* 2005;26(11):994-6. https://doi.org/10.1177/107110070502601116
24. Carnevale V. Phalanx valga of the great toe ("phalanx valga hallucis") or clinodactyly of the great toe. *Prensa Médica Argentina* 1959;46:761-3.
25. Parrinello JF, Japour CJ, Dykyj D. Incurvated nail. Does the phalanx determine nail plate shape? *J Am Podiatr Med Assoc* 1995;85:696-8. https://doi.org/10.7547/87507315-85-11-696
26. Villas C, Del Rio J, Valenti A, Alfonso M. Symptomatic medial exostosis of the great toe distal phalanx: a complication due to over-correction following Akin osteotomy for hallux valgus repair. *J Foot Ankle Surg* 2009;48(1):47-51. https://doi.org/10.1053/j.jfas.2008.08.011
27. Barouk LS, Barouk P, Baudet B, Toullec E. The great toe proximal phalanx osteotomy: the final step of the bunionectomy. *Foot Ankle Clin* 2005;10(1):141-55. https://doi.org/10.1016/j.fcl.2004.09.006
28. Vander Griend R. Correction of hallux valgus interphalangeus with an osteotomy of the distal end of the proximal phalanx (distal Akin osteotomy). *Foot Ankle Int* 2017;38(2),153-8. https://doi.org/10.1177/1071100716670389
29. Burry HAS. The effect of shoes on hallux valgus: a significant study. Research Report 147: British Boot, Shoe and Allied Trades Research Association.
30. Valentí A, Montiel V, Alfonso M, Villas C. Feasibility of open and percutaneous corrective osteotomies of the second phalanx of the great toe. An approach on a cadaveric model. *Foot (Edinb)* 2019;38:39-42. https://doi.org/10.1016/j.foot.2018.12.001