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ORIGINAL ARTICLE

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Reverdin-Isham technique with and without fixation: preliminary results

Técnica de Reverdin-Isham com e sem fixação: resultados preliminares

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ABSTRACT

Objective: This study evaluated the radiographic results of the traditional minimally invasive percutaneous Reverdin-Isham surgical technique for hallux valgus treatment using the American Orthopaedic Foot and Ankle Society (AOFAS) score and compared this result with a proposed modification involving additional osteosynthesis with a cannulated screw.

Methods: We retrospectively assessed 22 feet across 15 patients with mild to moderate hallux valgus. All patients underwent surgical treatment using the Reverdin-Isham technique. Eleven feet were fixed with 2.4- or 2.7-mm cannulated screws. A single orthopaedic surgeon performed these procedures between January 2014 and June 2016. The metatarsophalangeal (MTP) angle and intermetatarsal angle (IMA) were evaluated using radiographs, and the AOFAS score was applied before surgery and 90 days after.

Results: An improvement was found in the parameters evaluated in both groups, with significant differences shown between the pre- and post-procedure follow-up assessment. No significant difference was found between the groups with regard to fixation; however, the scores were slightly higher for the group where osteosynthesis was used.

Conclusion: The Reverdin-Isham procedure is effective and safe for correcting mild to moderate hallux valgus and additional fixation presented with promising results, although without significant difference. Additional studies with larger samples and longer follow-up times are needed to define the role that additional screw fixation plays in the overall scope of treatment.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Hallux valgus/surgery; Minimally invasive surgical procedures; Osteotomy/methods.

RESUMO

Objetivo: O objetivo deste estudo foi avaliar radiograficamente e através do escore AOFAS os resultados da técnica de tratamento para hálux valgo minimamente invasiva percutânea de Reverdin-Isham tradicional comparada à proposta de modificação por osteossíntese adicional com um parafuso canulado.

Métodos: Avaliamos retrospectivamente 22 pés, em 15 pacientes com hálux valgo leve a moderado, pois todos foram submetidos a tratamento cirúrgico conforme técnica de Reverdin-Isham. Em 11 pés foi adicionada fixação com parafuso canulado de 2,4 ou 2,7mm. Os procedimentos foram realizados de janeiro de 2014 a junho de 2016 por um único cirurgião ortopédico. Foram avaliados através de radiografias o ângulo metatarso-falângico e ângulo intermetatársico e aplicado escore da *American Association Orthopaedic Foot and Ankle Society* (AOFAS) antes da cirurgia e com 90 dias após o procedimento.

Resultados: Houve melhora nos parâmetros avaliados em ambos os grupos, com diferenças significativas no seguimento pré e pós procedimento. Não houve diferença estatística entre os grupos em relação à fixação, porém os resultados foram levemente superiores no grupo em que foi empregada osteossíntese.

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Conclusão: O procedimento de Reverdin-Isham é eficaz e seguro para correção de hálux valgo leve a moderado e a fixação adicional apresenta resultados promissores, embora sem diferença estatística. Entretanto são necessários mais estudos, com maior população e seguimento mais longo para definir seu papel no âmbito global do tratamento.

Nível de Evidência IV; Estudos Terapêuticos; Série de Casos.

Descritores: Hallux valgus/cirurgia; Procedimentos cirúrgicos minimamente invasivos; Osteotomia/métodos.

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INTRODUCTION

Although the prevalence of hallux valgus varies widely in the literature, it is considered a common pathology, especially among the elderly and women[1]. This condition is defined as the static subluxation of the first metatarsophalangeal (MTP) joint with the lateral deviation of the hallux and the medial deviation of the first metatarsus. Radiologically, hallux valgus is characterised by an angle greater than 9° between the first and second metatarsals (intermetatarsal angle; IMA); a valgus angle greater than 15° between the first MTP joint and the phalanx of the metatarsophalangeal (MTP) angle and the lateral subluxation of the sesamoids (DS) to varying degrees[2].

In orthopaedic practice, numerous classical procedures cover a wide range of surgical techniques to treat this pathology according to its severity, which include various soft tissue procedures, arthrodeses, and osteotomies. In this context, minimally invasive surgeries have gained popularity because they are faster and associated with early recovery and lower morbidity[3]. Of these techniques, we highlight the osteotomy proposed by Reverdin and revised by Isham, a percutaneous technique that aligns the first ray and corrects the valgus rotation of the first metatarsal head[4] and does not include the use of osteosynthesis material in its original description.

The aim of the current study was to evaluate patients operated on using the original Reverdin-Isham technique, without osteosynthesis, compared with those receiving additional percutaneous fixation with cannulated screws. The maintenance of the correction of radiographic angles and patient satisfaction were analysed during the postoperative follow-up period as well as before and after surgery using the American Orthopaedic Foot and Ankle Score (AOFAS)[5] score.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 60242616.3.0000.5225.

We selected patients with a diagnosis of hallux valgus, ranging from mild to moderate, according to the Coughlin classification[6], who underwent surgical treatment by the same orthopaedic surgeon between January 2014 and June 2016.

The patients were evaluated by the surgeon and surgical team before and 3 months after the surgery. They were evaluated during both operative periods through the application of the AOFAS questionnaire as well as pre- and postoperative radiographs in the anterior-posterior and profile views with weight bearing. The following radiographic angles were measured: MTP (i.e., the HVA), considering normal values lower than 15°, and the IMA, considering normal values below 9°[7,8]. For data collection, medical records, radiographs, and data previously collected by the surgical team were consulted.

The measurement techniques were standardised and described as follows. MTP: the angle formed between the mediodiaphyseal axis of the proximal phalanx of the hallux and the mechanical axis of the first metatarsal. We considered normal values lower than 15º. The IMA angle is formed between the mechanical axis of the first and second metatarsal. We considered values below 9° as normal[2]. The distal metatarsal articular angle (DMAA) was measured between the line that links the two extreme points of the distal articular surface of the first metatarsal and the perpendicular traced relative to the mediodiaphyseal axis of the same metatarsal. We considered values up to 8°[9] as formal.

After data collection, the patients were allocated into two groups according to technique without fixation and with additional fixation with a percutaneous cannulated screw. Thus, 22 feet were considered and divided into two groups of 11. Patients who did not meet the inclusion criteria were excluded from pre-selection. We did not include individuals who had active inflammatory disease or who had undergone any previous surgical treatment for the disease in question.

All patients were followed up for a minimum of 3 months. There was no loss to follow-up.

Following the technique described by Isham[10], a medial longitudinal incision of approximately 0.5 to 1cm, slightly proximal to the medial eminence of the first metatarsal head, was performed, followed by periosteal displacement up to the medial cortical bone of the first metatarsus and the dorsal-medial joint capsule adjacent to the exostosis of the metatarsal head.

First, the dorsomedial eminence of the first metatarsal head (exostosis) was resected using a high-torque burr (percutaneous wedge burr) with the motor operating at a maximum 5,000 revolutions per minute. This procedure was performed under fluoroscopic guidance.

The bone was resected up to the articular surface of the head of the first metatarsus, preserving the sagittal sulcus. This procedure uses fluoroscopy for parametric evaluation. Next, the osteotomy proposed by Reverdin-Isham was performed in the first metatarsal, using as a parameter a straight line in the same access route of the medial approach. For the osteotomy, straight Shannon burrs were used. This osteotomy was performed at the first metatarsal, parallel to the articular surface, forming a medial closing wedge dorsal to the plantar and distal to the proximal direction, just behind the joint space, posterior to the DS, with a caudal inclination of 45° and the preservation of the lateral cortex. The hallux was placed in forced adduction, compressing the osteotomy space with osteoclasy of the cortical and correcting the MTP angle. With this manoeuvre, the modification of the IMA between the first and second metatarsals was also obtained, as was the orientation of the distal metatarsal joint angle.

Next, through a second minimum access route at the level of the lateral region of the MTP joint of the hallux, the ligamentous capsule lateral to the joint was released with the percutaneous tenotomy of the adductor hallucis. In the presence of the interphalangeal hallux valgus, the osteotomy of the first phalanx was also performed (i.e., the Akin procedure[10]) through a third access, dorsomedial (0.5cm) located medially to the extensor hallucis longus tendon. Proximal osteotomy was performed on the phalangeal metaphysis, with a high-torque straight burr, removing a wedge of approximately 1.5mm and preserving the lateral cortex, with correction achieved by closing the osteotomy. No fixation was performed for the Akin osteotomy.

The groups differed at the end of the third stage, when the study group was subjected to fixation in the dorsal-to-plantar, distal-to-proximal, and medial-to-lateral directions using a 1.5-mm guidewire for a 2.4 or 2.7-mm cannulated screw, based on availability (cannulated self-tightening screw with two threads with different pitches, Herbert-type or similar, in both titanium and steel). The procedures of the present study were performed with the patients in dorsal decubitus under spinal anaesthesia.

Dressing and bandaging were maintained in a slight hypercorrection, and the stitches were removed approximately 7 days after surgery. The hypercorrection positioning was maintained, with periodic changes, for another 5 weeks. Weight bearing was allowed according to tolerance beginning on the first postoperative , with the use of an orthosis (i.e., a postoperative sandal with a rigid sole). Starting on the 6th week after surgery, the use of conventional footwear was allowed, and physical therapy was started, as needed. Patients were kept from physical activity for 60 days, were allowed supervised activities at 90 days, and high-impact activities at 6 months after surgery.

Patients were evaluated approximately 7 days, 6 weeks, 2 months, 3 months, and 6 months after surgery. For the purpose of the present study, the AOFAS questionnaire was applied when the patients returned approximately 3 months after surgery. Control X-rays were routinely performed immediately after surgery and at 6 weeks and 3 months postoperatively (Figures 1 to 3).

Statistical analyses

The results are described as means, standard deviations, medians, and minimum, and maximum values. To compare the two surgical techniques (with and without fixation) during the preoperative period and postoperative period and to analyse the differences between the two time periods, Student's t-test for independent samples or the non-parametric Mann-Whitney test were used. Comparisons between the preoperative and postoperative evaluations within each surgical technique were performed using Student's t-test for paired samples or the non-parametric Wilcoxon test. The normality of the variables was evaluated using the Shapiro-Wilks test. We defined p-values <0.05 as indicating significance. The data were analysed using IBM SPSS Statistics v. 20.

RESULTS

The outcomes of the surgeries of 15 patients, all women with a mean age of 51.6 years (22 to 77 years; standard deviation 14 years), were included. The surgeries were bilateral in seven patients and unilateral in eight. Thus, 22 feet underwent the Reverdin-Isham osteotomy, 11 with fixation

Figure 1. Reverdin-Isham (without fixation).
Source: Author's personal archive.

Figure 3. Postoperative radiograph with cannulated screw fixation.
Source: Author's personal archive.

Figure 2. Postoperative clinical aspect of the minimally invasive technique (portals and scar of the fixation access).
Source: Author's personal archive.

and 11 without fixation. Akin osteotomy was performed on eight of these feet, four feet in each group.

In patients with bilateral surgeries, the technique was the same for both feet (three patients with fixation and four without fixation). In patients with unilateral surgeries, five were performed with fixation and three without fixation. For the analysis, the feet of the same patient were considered independent observational units.

The clinical-radiographic classification, according to Coughlin, included mild to moderate cases. A mean MTP angle correction of 25° was observed during the preoperative period, and an angle of 7.78° was observed during the postoperative period, for a mean correction of 17.41°. The mean reduction of the IMA was 5.40°.

All osteotomies showed signs of radiographic consolidation starting at the sixth postoperative week.

Regarding the AOFAS score, a gain in the postoperative score was found for all cases, and the groups with and without fixation had means of 31.1 and 25 points, respectively. Table 1 shows descriptive statistics by group and the p-values of the statistical tests for the groups of feet defined by the use of fixation in relation to the AOFAS results (Table 1).

Figure 4 shows the results within the evaluation (pre and post) and within each of the groups of feet defined by the use of fixation. For cases with fixation, the test results indicated a significant difference between the pre- and postoperative AOFAS score (p=0.003). The same was observed for cases without fixation (p=0.003).

When we evaluated the results of the IMA, mean decreases of 4.2° and 5.6° were found for the groups without and with fixation, respectively. The values shown in Table 2 and represented in Figure 2 indicate a significant difference between the pre- and postoperative evaluation of the IMA in both groups for cases with ($p < 0.001$) and without fixation (p=0.010) (Table 2, Figure 5).

Regarding the MTP angle for the cases with fixation, the results indicated a significant difference between the pre-

Table 1. Statistical comparison of the AOFAS score before and after surgery, with and without fixation

Evaluation	Fixation	AOFAS score						p-value*
		N	Mean	Medium	Minimum	Maximum	Standard deviation	
Pre	Without	11	59.1	62	47	65	4.9	0.562
	With	11	55.3	57	44	65	8.8	
Post	Without	11	84.1	85	75	85	3.0	0.217
	With	11	86.4	85	75	95	6.7	
Difference (Post-Pre)	Without	11	25.0	23	13	38	6.2	0.217
	With	11	31.1	38	10	51	12.9	

* Non-parametric Mann-Whitney test, p<0.05.
Source: Prepared by the author based on the results of this study.

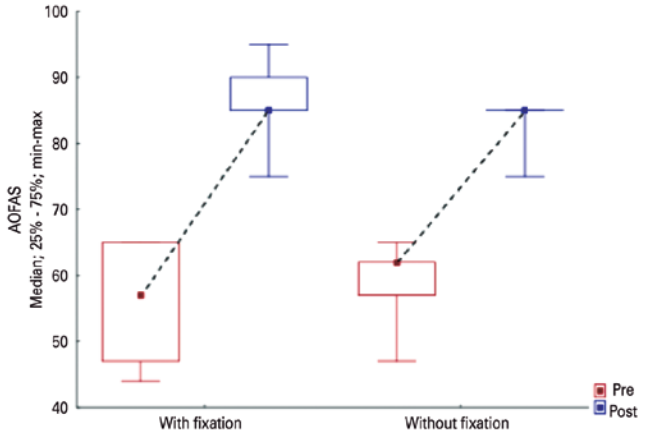
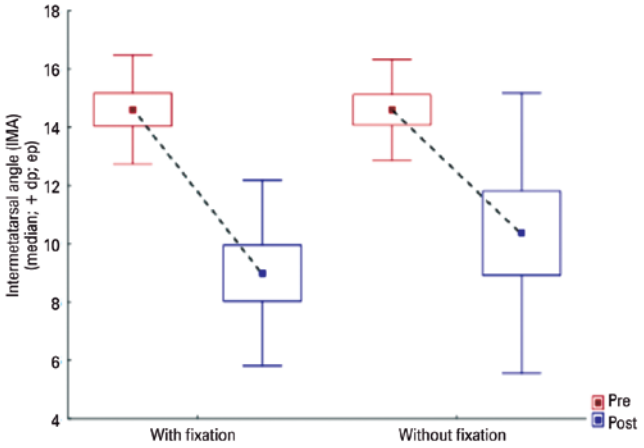


Figure 4. Graphical comparison of the two groups according to the improvement in the AOFAS score.
Source: Prepared by the author based on the results of this study.



sd: standard deviation; se: standard error.
Figure 5. Graphical comparison of the two groups according to changes in the IMA.
Source: Prepared by the author based on the results of this study.

and postoperative evaluation (p<0.001); the same was true for the cases without fixation (p<0.001). Mean corrections of 15.7° and 18.7° were observed for the groups without fixation and with fixation (Table 3, Figure 6).

We found only one case of postoperative complications that required the removal of material due to superficial infection and skin necrosis. This patient was not excluded from the study and was followed up.

DISCUSSION

The postoperative overall AOFAS scores indicated satisfactory clinical outcomes. The scores ranged from 10 to 51 points, with a mean increase of 27.78 points relative to the preoperative period. A slightly larger increase in the scores was observed for the group with additional screw fixation, with an improvement of 31.1 points compared with 25 points in the non-fixation group. Although the postopera-

Table 2. Variations in the value of the IMA

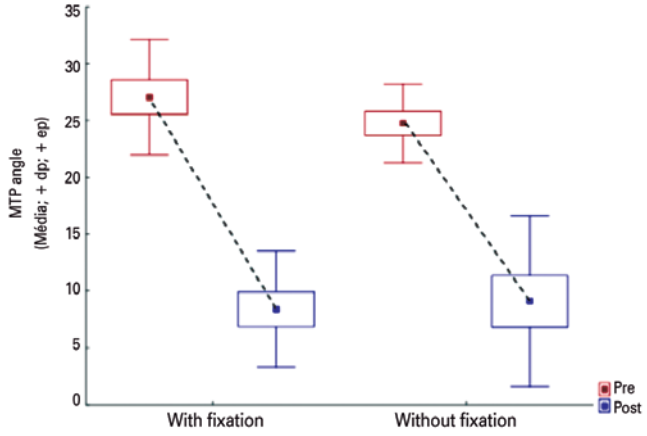
Evaluation	Fixation	Ângulo IMT						p-value*
		N	Mean	Medium	Minimum	Maximum	Standard deviation	
Pre	Without	11	14.6	15.0	12.0	18.0	1.7	0.991
	With	11	14.6	15.0	12.0	17.9	1.9	
Post	Without	11	10.4	11.6	3.9	16.6	4.8	0.44
	With	11	9.0	9.7	4.2	12.4	3.2	
Reduction (pre-post)	Without	11	4.2	3.5	-2.4	10.7	4.4	0.358
	With	11	5.6	6.0	2.1	8.5	2.0	

* Student's t-test for independent samples, p<0.05.
Source: Prepared by the author based on the results of this study.

Table 3. Variations in the value of the MTP angle

Evaluation	Fixation	MTP angle						p-value*
		N	Mean	Medium	Minimum	Maximum	Standard deviation	
Pre	Without	11	24.7	25.0	20.0	30.0	3.5	0.225
	With	11	27.1	26.0	20.2	37.5	5.1	
Post	Without	11	9.1	10.0	0.3	22.1	7.5	0.804
	With	11	8.4	7.6	2.4	18.8	5.1	
Reduction (pre-powders)	Without	11	15.7	14.8	0.6	29.7	8.6	0.306
	With	11	18.7	17.8	13.2	24.0	3.6	

* Student's t-test for independent samples, p<0.05.
Source: Prepared by the author based on the results of this study.



sd: standard deviation; se: standard error.
Figure 6. Graphical comparison of the two groups according to the changes in the MTP angle.
Source: Prepared by the author based on the results of this study.

tive follow-up time was considerable, the evaluations were performed only 3 months after surgery, and these tend to improve with the progression of bone consolidation. The statistical analysis shown in Table 1 does not indicate a significant difference (p<0.05).

Other studies also have used the clinical criteria of the AOFAS after different follow-up times to evaluate the clinical status of patients undergoing the surgical correction of hallux valgus deformity using a minimally invasive technique. Bauer et al.[12] also showed a mean AOFAS score increase of 38.5 points. In one of the studies with the largest sample, Cervi et al.[13] evaluated 213 procedures and observed an increase in the mean AOFAS score from 45 to 90 points. These recent studies did not include additional fixation.

When analysing the variations of the angles, the results were similar and effectively satisfactory for both groups. A superiority of 3° for the MTP angle was observed for the group with fixation compared with the group without. Similar results were observed for the IMA (Table 2).

Regarding the interphalangeal angle, no previous angular evaluation was conducted, although the Akin procedure was performed in eight cases. We believe that because of the equal distribution in the groups, and despite the possibility that the Akin phalangeal osteotomy also affected the measurement of the MTP angle, this result does not affect the comparison of the results between the groups based on whether the Reverdin-Isham metatarsal osteotomy was fixed.

According to the results of this study, the percutaneous Reverdin-Isham surgical procedure can improve the clinical condition of patients in both groups, even in the short term. Pain relief, improvements in the difficulty of wearing shoes and the ability to walk are the major expectations of patients before hallux valgus correction surgery, and these results were achieved in the vast majority of patients.

The results regarding the group with percutaneous fixation, although not significant, were superior on average. The only reported complication was related to the superficial infection around one of the screws. In addition, the longer surgery time when fixation was used, as well as the need to perform an additional incision for screw fixation did not affect patient satisfaction based on the AOFAS score evaluation. One possible weak point of this study is its small sample size. Evaluations with longer follow-up times are needed, and future studies should confirm the results obtained here using another scale.

CONCLUSIONS

The clinical and radiological outcomes of the inclusion of percutaneous fixation in the standard Reverdin-Isham

technique did not differ significantly; however, this result might be because of the small sample size, given that the results of the group with fixation were slightly higher than the traditional technique group.

In addition, the postoperative radiological evaluation is one possible way to evaluate the results in a more objective manner; however, angle measurement should be standardised for better pre- and postoperative comparisons.

This study should be continued to compare the inclusion of percutaneous fixation in the Reverdin-Isham technique with more patients and a longer follow-up period to evaluate the real benefits in improving the quality of life of patients with hallux valgus.

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