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Original Article

Surgical treatment of hallux rigidus with percutaneous Watermann-Moberg technique

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Abstract

Objective: Evaluate patients with hallux rigidus grades 1 and 2 by Coughlin and Shurnas classification, operated in two medical centers using an association of Watermann-Moberg osteotomies and cheilectomy by minimally invasive technique. In addition, evaluate clinical and functional parameters in the pre-and postoperative, using The American Orthopaedic Foot & Ankle Society (AOFAS) questionnaire and visual analog scale (VAS).

Methods: Twenty-five patients, 28 feet, hallux rigidus with grades 1 and 2, were operated on from July 2014 to December 2023. The AOFAS and VAS questionnaires were applied in the pre-and postoperative, with a minimum follow-up of six months.

Results: The preoperative AOFAS score was 41.18 (± 12.45) and 80.71 (± 12.01) in the postoperative, with a mean variation of 39.53 (± 14.68) ($p < 0.001$). Preoperative VAS was 7.61 (± 2.29) and 2.68 (± 2.86) in the postoperative, with a mean variation of 4.92 (± 3.75) ($p < 0.001$).

Conclusion: The combination of Watermann-Moberg percutaneous osteotomies showed a significant increase in the mean AOFAS score postoperatively compared to preoperatively. The mean VAS score postoperatively also showed a significant improvement in the level of pain presented by the patients included in the study. When properly indicated, the Watermann-Moberg percutaneous surgical technique is a safe and reliable option for treating hallux rigidus grades 1 and 2.

Level of evidence IV; Therapeutics studies, Case series.

Keywords: Hallux rigidus; Minimally invasive surgery; Surveys and questionnaires; Osteotomy.

Introduction

Hallux rigidus had its first descriptions in literature in the late nineteenth century. Davies-Colley[1] described it as hallux flexus in 1887, and Cotterill[2], in 1888, named it "hallux rigidus", a term still used today. Initially, it was characterized as a flexion deformity of the first metatarsal and a limitation of the extension of the first metatarsophalangeal joint (MTF)[3].

Its presentation follows a well-described pattern in which a dorsal osteophyte in the head of the first metatarsal is visualized radiographically, which can be palpable and cause discomfort when wearing shoes[4]. Clinically, the patient usually complains of pain when mobilizing the first MTF at the end of its flexion-extension, with progressive worsening of the pain and limitation of the range of motion of this joint[3,4].

Hallux rigidus has a multifactorial etiology and may be linked to family history, local trauma (recurrent microtraumas or intra-articular fractures), and anatomical changes (such as hallux valgus, first ray hypermobility, metatarsus primus elevatus, equine foot, and flat foot)[4,5].

The treatment of this condition begins conservatively, using measures such as analgesia, cryotherapy, physiotherapy, shoe adaptation, use of orthoses, and/or intra-articular

Study performed at the Hospital Municipal Universitário de Taubaté, Taubaté, SP, Brazil.

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infiltrations[6,7]. Surgical intervention is indicated for cases that are unresponsive to conservative treatment or directly indicated for moderate and severe cases[8,9]. Among the available surgical procedures are cheilectomy, osteotomies of the first proximal phalanx and the first metatarsal, resection of the proximal third of the first phalanx, resection arthroplasties, interposition and replacement, resurfacing and arthrodesis of the first MTF[9]. More recently, minimally invasive surgical (MIS) techniques have emerged as a treatment option for hallux rigidus, offering advantages such as reduced postoperative pain, early ambulation, lower infection rates, and the ability to perform the procedure under locoregional anesthesia[10].

The objective of this study is to evaluate patients with hallux rigidus grades 1 and 2, by Coughlin and Shurnas classification, operated in two medical centers using an association of Watermann-Moberg osteotomies and cheilectomy by minimally invasive technique. In addition, evaluate clinical and functional parameters in the pre-and postoperative, using The American Orthopaedic Foot & Ankle Society (AOFAS) questionnaire and visual analog scale (VAS).

Methods

This study was approved by the Institutional Review Board. All participating patients signed the Informed Consent Form, a mandatory criterion for participation in the study.

Twenty-five patients with hallux rigidus were operated on from July 2014 to December 2023, totaling 28 feet. The surgeries were performed in two medical centers. The patients were submitted to the percutaneous MIS technique, in which it was performed cheilectomy, osteotomy of the first metatarsal (Waterman technique), and osteotomy of the first proximal phalanx (Moberg technique), according to de Prado et al.[11].

Patients with symptomatic conditions were included, assessed by Coughlin and Shurnas classification grades 1 and 2 (Figure 1), with a minimum of six months of conservative treatment with physiotherapy, analgesia, and adequate footwear. Patients with hallux rigidus grades 3 and 4, rheumatoid arthritis, neurological feet, sequelae of fractures, and those submitted to previous surgery on the first ray were excluded.

Figure 1. Anteroposterior, lateral, and oblique preoperative radiographs of a patient classified as grade 2 by Coughlin and Shurnas classification.

The AOFAS and VAS questionnaires were collected in the pre-and postoperative, with a minimum follow-up time of six months. These data were analyzed to determine whether or not functional and pain improvement occurred. All questionnaires were administered by specialist foot and ankle surgeons.

Surgical technique

All procedures were performed by a team of two orthopedists specialized in foot and ankle surgery. The patients were positioned in horizontal dorsal decubitus, with their feet out of the operating table, without a tourniquet. They underwent locoregional anesthesia (penta-block) at the ankle.

Special materials were used for the surgeries, including the MIS beaver 64 scalpel blade, Wedge 4.1mm cutter, long Shannon cutter, and shavings, using a 6000 rpm drill motor.

All patients were submitted to percutaneous surgical techniques consisting of cheilectomy, osteotomy of the first metatarsal (Waterman technique), and osteotomy of the first proximal phalanx (Moberg technique).

Cheilectomy: A 5 mm incision was made on the medial surface at the transition from dorsal to plantar skin of the first metatarsal, proximal and dorsal to the sesamoid. This perpendicular incision was performed on the skin through the capsule towards the bone. A rasp was used in a dorsal and plantar direction, detaching the entire capsule and creating a space between the bone and the capsule to perform oscillatory movements. Then, the cutter was introduced, and with a 6000 rpm motor, the exostosis was thinned with oscillatory movements to the desired level. The entire procedure was performed using fluoroscopy guidance. The bone fragments were removed by expressing the operative wound, followed by thorough irrigation with saline. The removal of the dorsal spur, when present, was also sought during cheilectomy.

Osteotomy of the first metatarsal: A dorsal base wedge osteotomy was performed using the same anterior route, preserving the plantar cortical, aiming to decompress the MTP joint by extending the head of the first metatarsal.

Osteotomy of the first proximal phalanx: As the last step of the procedure, a 2-3 mm dorsomedial incision was made, through which we introduced the cutter through the medial portion of the first phalanx, crossing the lateral cortical and making a dorsal base wedge, followed by the closing of this wedge, shown in Figure 2. These procedures aim to allow an MTP extension of at least 70°. Synthesis material was not routinely used.

Postoperative: Patients were released for weight-bearing using rigid sole sandals from the first postoperative day. The dressing aims to maintain the immobilization of the first metatarsal and phalanx osteotomies, stabilizing even the neighboring toes. The immobilization was changed weekly by the surgical team until the fourth week, after the patients were instructed to change the immobilization at home every 3-4 days until the eighth week, when control radiographs were performed to show consolidation (Figure 3). Patients were then released from wearing the stiff-sole sandal.

Figure 2. Intraoperative radiography, showing the osteotomy performed by the Waterman and Moberg technique performed on the patient in Figure 1.

Figure 3. Postoperative radiographs (5 months) in anteroposterior, lateral, and oblique of the same patient.

Statistics

Clinical and functional evaluations were performed using the following pre- and postoperative parameters:

- AOFAS score for hallux: assessed functionality, pain, joint alignment, and range of motion (MTP flexion and extension).
- VAS quantified the pain on a scale of 0 to 10.

The data were analyzed descriptively. For categorical variables, absolute and relative frequencies (complications, sex, laterality) were presented. For the numerical variables (quantitative results of each parameter), summary measures (means and standard deviation) were used.

The Shapiro-Wilk test was used to evaluate the normality of the data. After confirming the normality of the data, it was decided to use the Student's T test to compare the variables AOFAS and VAS in the pre-and postoperative, evaluating the functional and clinical improvement. The significance level was set at $p < 0.05$.

Results

The sample consisted of 25 patients (28 feet). The mean age was 55.6 years, with a minimum age of 31 years and a maximum of 76 years. Nineteen (76.0%) patients were female, and six (24.0%) were male. Among the cases, 22 (88.0%) were approached unilaterally and 3 (12.0%) bilaterally. As for laterality, 14 were (50.0%) right feet, and 14 (50.0%) left.

Table 1. Paired sample statistics

		Mean	N	SD	Mean standard error
AOFAS	preop	41.18	28	12.455	2.354
	postop	80.71	28	12.018	2.271
VAS	preop	7.61	28	2.299	0.434
	postop	2.68	28	2.868	0.542

SD: Standard deviation; AOFAS: Forefoot score of the American Ortthopaedic Foot & Ankle Society; VAS: Visual analog scale.

The minimum postoperative follow-up time was six months and a maximum of 125 months, with a mean of 43.2 months, and of these, only five cases had a follow-up of less than 12 months.

The preoperative AOFAS score was 41.18 (± 12.45) and 80.71 (± 12.01) in the postoperative, with a mean variation of 39.53 (± 14.68) ($p < 0.001$).

Preoperative VAS was 7.61 (± 2.29) and 2.68 (± 2.86) in the postoperative, with a mean variation of 4.92 (± 3.75) ($p < 0.001$), as shown in Tables 1 and 2.

The results and their categorical and numerical variables are shown in Tables 3 to 7.

As complications related to surgical procedures, it was observed two cases of temporary hypoesthesia in hallux (7.1%), one case of prolonged edema (3.5%), one case of complex regional pain syndrome (3.5%), without improvement of preoperative pain, and one case of pain (3.5%) when submitted to exertion, totaling five complications (17.8%).

Discussion

In the literature, few published studies were found with significant casuistry showing surgical correction of hallux rigidus grades 1 and 2 using the MIS technique.

The mean AOFAS scores showed a significant increase (comparing the preoperative with the postoperative), as verified in the study by Arruda e Baptista[12] and Del Vecchio et al.[13], with surgical treatment by percutaneous technique, also implying an improvement in the MTP joint function. Also, the VAS scores demonstrated considerable improvement in the presence of pain, as noted by Arruda e Baptista[12], allowing patients to return to occupational and recreational activities with little or no restriction.

Osteotomies were performed to reposition the articular faces of the first metatarsal and proximal phalanx of the hallux, causing the articular cartilages, in better condition, to come into contact.

Cullen et al.[14], in their study comparing 341 feet that underwent isolated cheilectomy and 82 feet that underwent cheilectomy combined with osteotomy, reported a surgical revision rate of 8.21% in the isolated cheilectomy group vs.

Table 2. Paired specimen testing

		Mean	SD	Mean standard error	95% confidence interval		t-student	df	Significance (2 extremities)
					Inferior	Superior			
AOFAS	preop postop	-39.536	14.686	2.775	-45.230	-33.841	-14.246	27	0.000
VAS	preop postop	4.929	3.751	0.709	3.474	6.383	6.953	27	0.000

SD: Standard deviation; AOFAS: Forefoot score of the American Ortthopaedic Foot & Ankle Society; VAS: Visual analog scale.

Table 3. Paired sample statistics[a]

		Mean	N	SD	Mean standard error
AOFAS	preop	38.86	21	12.823	2.798
	postop	80.90	21	12.653	2.761
VAS	preop	7.81	21	2.442	0.533
	postop	2.81	21	2.857	0.623

[a]Sex = 1(female).
SD: Standard deviation; AOFAS: Forefoot score of the American Ortthopaedic Foot & Ankle Society; VAS: Visual analog scale.

Table 4. Paired specimen testing[a]

		Mean	SD	Mean standard error	95% confidence interval		t-student	df	Significance (2 extremities)
					Inferior	Superior			
AOFAS	preop postop	-42.048	13.757	3.002	-48.310	-35.786	-14.007	20	0.000
VAS	preop postop	5.000	3.834	0.837	3.255	6.745	5.976	20	0.000

[a]Sex = 1(female).
SD: Standard deviation; AOFAS: Forefoot score of the American Ortthopaedic Foot & Ankle Society; VAS: Visual analog scale.

Table 5. Paired sample statistics[a]

		Mean	N	SD	Mean standard error
AOFAS	preop	48.14	7	8.630	3.262
	postop	80.14	7	10.761	4.067
VAS	preop	7.00	7	1.826	0.690
	postop	2.29	7	3.094	1.169

[a]Sex = 2 (male).
SD: Standard deviation; AOFAS: Forefoot score of the American Ortthopaedic Foot & Ankle Society; VAS: Visual analog scale.

Table 6. Paired specimen testing[a]

		Mean	SD	Mean standard error	95% confidence interval		t-student	df	Significance (2 extremities)
					Inferior	Superior			
AOFAS	preop postop	-32.000	15.853	5.992	-46.662	-17.338	-5.340	6	0.002
VAS	preop postop	4.714	3.773	1.426	1.225	8.204	3.306	6	0.016

[a]Sex = 2 (male).
SD: Standard deviation; AOFAS: Forefoot score of the American Ortthopaedic Foot & Ankle Society; VAS: Visual analog scale.

Table 7. Correlations

		Age	Follow-up (months)	Extension postop (degree)	Flexion postop (degree)
Age	Pearson correlation	1	-0.084	-0.076	-0.252
	Significance (2 extremities)		0.672	0.701	0.195
	N	28	28	28	28
Follow-up (months)	Pearson correlation	-0.084	1	-0.216	-.418*
	Significance (2 extremities)	0.672		0.270	0.027
	N	28	28	28	28
Extension postop (degree)	Pearson correlation	-0.076	-0.216	1	0.368
	Significance (2 extremities)	0.701	0.270		0.054
	N	28	28	28	28
Flexion postop (degree)	Pearson correlation	-0.252	-.418*	0.368	1
	Significance (2 extremities)	0.195	0.027	0.054	
	N	28	28	28	28

*. The correlation is significant at the 0.05 level (2 extremities).

only 1.22% in the combined procedure group. These findings suggest that osteotomy of the phalanx and metatarsal contributes to improved outcomes.

Monteiro et al.[15] performed open surgical treatment of hallux rigidus grade 2 with cheilectomy associated with the fixed Moberg technique and also showed good results.

Teoh et al.[16] performed isolated cheilectomy by MIS technique in 89 patients and had two cases of infections and two surgical wound healing delays, unlike what was found in our study, in which we did not have any cases of these complications.

It was noted that there was a need to indicate phalangeal metatarsal arthrodesis in only one case due to the persistence of pain. On the other hand, Teoh et al.[16] reopened 12 feet, and arthrodesis was performed in seven.

Unlike other studies, there was no injury to the extensor hallucis longus and the dorsal medial cutaneous nerve of the hallux[16-18].

The complication rate in our study (17.8%, five cases) corroborates other studies of MIS surgery for mild to moderate cases of hallux rigidus, showing to be a safe and effective technique when well indicated and performed by a qualified professional[13,16,17].

A limitation of our study is that we did not analyze the isolated mobility of the MTF joint using degree measurements preoperatively and postoperatively. However, the AOFAS score was utilized to assess joint mobility in one of its items, and no severe joint limitations were identified.

Despite the long follow-up period of this study, it was observed that our sample is small due to the low indication of surgical treatment for hallux rigidus grades 1 and 2, which limits a better evaluation of osteotomies and cheilectomy.

Conclusion

The combination of Watermann-Moberg percutaneous osteotomies showed a significant increase in the mean AOFAS score postoperatively compared to preoperatively. The mean VAS score postoperatively also showed a significant improvement in the level of pain presented by the patients included in the study. When properly indicated, the Watermann-Moberg percutaneous surgical technique is a safe and reliable option for treating hallux rigidus grades 1 and 2.

Author's contributions: Each author contributed individually and significantly to the development of this article: LCRL* (https://orcid.org/0000-0003-1158-2643) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, performed the surgeries, data collection, bibliographic review, survey of the medical records, clinical examination, approved the final version; GB* (https://orcid.org/0000-0001-5273-4303) Conceived and planned the activities that led to the study, participated in the review process, performed the surgeries, formatting of the article, approved the final version; LFL *(https://orcid.org/0000-0003-1048-7134) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, performed the surgeries, approved the final version; FPL *(https://orcid.org/0000-0002-9888-5614) Participated in the review process, performed the surgeries, bibliographic review, formatting of the article; NRX *(https://orcid.org/0009-0005-9113-3902) Interpreted the results of the study, participated in the review process, performed the surgeries, formatting of the article; LTSC *(https://orcid.org/0009-0000-1870-352X) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, data collection, bibliographic review, survey of the medical records, formatting of the article, clinical examination; VCL *(https://orcid.org/0009-0000-1762-5654) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, statistical analysis, bibliographic review, formatting of the article; LFGM *(https://orcid.org/0009-0001-7596-5945v) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, statistical analysis, bibliographic review, formatting of the article; NPB *(https://orcid.org/0009-0006-8659-0081) Interpreted the results of the study, participated in the review process, bibliographic review, formatting of the article; GARV *(https://orcid.org/0009-0001-1903-3289) Data collection, survey of the medical records, clinical examination. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID)Surgical treatment of hallux rigidus with percutaneous Watermann-Moberg technique iD.

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