DOI: https://doi.org/10.30795/scijfootankle.2018.v12.756

ORIGINAL ARTICLE

Scientific Journal of the Foot & Ankle

Treatment of hallux rigidus with percutaneous arthrodesis: a case series

Tratamento do hallux rigidus com artrodese percutânea: série de casos

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ABSTRACT

Objective: The objective of this study was to describe the percutaneous arthrodesis technique with single medial portal of the first metatarsophalangeal joint and to evaluate the results of a series of nine cases (10 feet) with a diagnosis of hallux rigidus subjected to this technique, comparing the results with literature data regarding the conventional technique.

Methods: This was a retrospective, observational study performed by analysis of medical records and radiographs of nine patients undergoing percutaneous arthrodesis of the hallux metatarsophalangeal joint. Gender, age, consolidation time, level of postoperative pain and degree of patient satisfaction were evaluated.

Results: Eight patients were female, and one patient was male. The mean age was 68.7 years, the mean consolidation time was 8 weeks, the consolidation ratio was 70%, there was pain improvement in the postoperative period, and all patients considered themselves satisfied with the surgery.

Conclusion: Percutaneous arthrodesis of the metatarsophalangeal hallux joint potentially yields results similar to those of the conventional method demonstrated in the literature but uses smaller incisions.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Hallux rigidus; Arthrodesis; Minimally invasive surgical procedures.

RESUMO

Objetivo: O objetivo do estudo é descrever a técnica de artrodese percutânea com portal medial único da primeira metatarsofalangeana e avaliar os resultados de uma série de nove casos (10 pés) com diagnóstico de hallux rigidus submetidos a essa técnica, comparando os resultados com dados da técnica convencional na literatura.

Métodos: Trata-se de um estudo observacional retrospectivo realizado através da análise de prontuários e radiografias de nove pacientes submetidos à artrodese percutânea da metatarsofalangeana do hálux, no qual avaliou-se sexo, idade, tempo de consolidação, nível de dor pós-operatória e grau de satisfação do paciente.

Resultados: Foi observado que oito pacientes eram do gênero feminino e um paciente do gênero masculino. A média de idade foi 68,7 anos, o tempo médio de consolidação foi de 8 semanas, a taxa de consolidação foi de 70%, houve melhora da dor no pós-operatório e todos os pacientes consideraram-se satisfeitos com a cirurgia.

Conclusão: A artrodese percutânea da articulação metatarsofalangeana do hálux potencialmente traz resultados semelhantes ao método convencional mostrado na literatura, utilizando incisões menores.

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

Descritores: Hallux rigidus; Artrodese; Procedimentos cirúrgicos minimamente invasivos.

How to cite this article: Nogueira VB, Pereira Filho MV, Dinato MCM, Freitas MF, Pagnano RG. Treatment of hallux rigidus with percutaneous arthrodesis: a case series. Sci J Foot Ankle. 2018;12(2):90-5

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Conflicts of interest: none. **Source of funding:** none.
Date received: March 03, 2018. **Date accepted:** March 27, 2018. **Online:** May 25, 2018.

INTRODUCTION

Osteoarthritis of the first metatarsophalangeal joint, also called hallux rigidus, is a condition that involves pain and functional limitation. Initially described in 1887 by Cotterill, it is the second most common pathology of the first ray, the first being hallux valgus[1]. Joint degeneration may be caused by trauma, microtrauma repetition, infectious and inflammatory conditions, index plus, first ray hypermobility and Achilles tendon shortening[2]. The onset of symptoms usually occurs in the fourth decade, and most cases are unilateral. However, after several years of disease development, up to 80% of cases may become bilateral[3,4]. Over time, dorsal osteophyte formation, dorsiflexion limitation, edema and pain develop. Initial treatment includes physical therapy, analgesic measures, shoe adjustments and insoles.

When conservative treatment fails, some surgical procedures may be used, such as cheilectomy, distal metatarsal osteotomies[5] and arthroplasty. Such procedures may be useful in the early stages, with cheilectomy being appropriate for younger patients and arthroplasty for older ones[6-8]. However, arthrodesis is considered the gold standard treatment for the final stages of arthropathy and facilitates symptom improvement in the long term and stability of the medial column of the foot[9-12].

Arthrodesis is traditionally performed using the open approach. However, in recent years, minimally invasive surgery has become more popular due to the reduced aggression toward soft tissue, reduced surgical time and its being associated with a more comfortable postoperative period with less intense pain[13]. This study aimed to describe the percutaneous metatarsophalangeal arthrodesis technique with a single medial portal and to evaluate postoperative results regarding consolidation time, the presence of residual pain and degree of satisfaction in a series of nine cases.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under the CAAE number:78775317.9.0000.5404.

This was an observational, retrospective study of a series of nine cases (10 feet) with a diagnosis of hallux rigidus undergoing percutaneous arthrodesis in the period from January to July 2017. Patients were evaluated in routine consultations, and the consolidation time observed using postoperative radiographs. The patients were questioned about their pre- and postoperative pain levels using the visual analogue pain scale (VAS) and degree of patient satisfaction. The following complications were considered: wound dehiscence, deep and superficial infection and need for removal of synthetic material.

The inclusion criteria were as follows: adult patients, over 18 years old, diagnosed with grade 3 or 4 hallux rigidus according to the Coughlin and Shurnas classification[14] and undergoing arthrodesis of the first metatarsophalangeal joint using the percutaneous technique. Exclusion criteria were as follows: patients younger than 18 years old and patients who underwent arthrodesis using the conventional technique.

The data were tabulated and statistically analyzed. The assumption of normal data distribution was checked using the Shapiro-Wilk test and the inspection of skewness and kurtosis measures. The *Student's t* test for paired samples was used to compare subjective perceptions of pre- and postoperative pain. The significance level adopted was 5% ($p<0.05$).

The surgical technique used was percutaneous arthrodesis via a single medial portal. The patient is placed in supine position without the use of a tourniquet. Spinal anesthesia and regional block procedures are performed. A medial portal is made on the midline of the first metatarsophalangeal joint (Figure 1) under radioscopy. The hallux is pulled up in order to open the joint space and facilitate the introduction of the cutter between the proximal phalanx and the head of the first metatarsal. Preparation of the articular surface is performed initially using a Shannon-type cylindrical cutter. It is often necessary to use a 4.3-mm conical cutter to resect the cartilage and subchondral bone of the phalangeal base, as it has a more rigid bone (Figure 2). This procedure is repeated until two congruent articular surfaces are created and it is possible to position the hallux in the desired clinical alignment. The position used for arthrodesis is 10 degrees of valgus, 10 degrees of dorsiflexion and neutral rotation.

After this process, the desired position is maintained by two crossed Kirschner wires, and fixing is performed with two cannulated screws (Figure 3). Final control is performed using two-plane fluoroscopy. The wounds are washed and closed with points on the skin using 4.0 nylon suture, followed by occlusive dressing.

Postoperatively, immediate load with hard-soled sandals is allowed for 8 weeks, and a radiographic assessment is performed to evaluate consolidation (Figure 4).

RESULTS

The study involved nine patients with hallux rigidus undergoing percutaneous arthrodesis of the first metatar-

Figure 1. Creating the medial portal at the midline of the metatarsophalangeal joint.
Source: Author's personal archive.

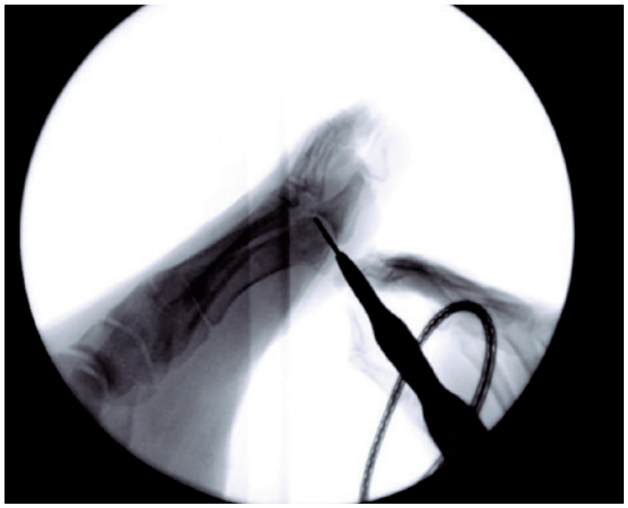

Figure 2. Preparation of the articular surface. On the right, fluoroscopic view.
Source: Author's personal archive

Figure 3. Temporary fixation with two crossed Kirschner wires and fixation with cannulated screws.
Source: Author's personal archive

Figure 4. Postoperative radiograph showing consolidation of arthrodesis.
Source: Author's personal archive

sophalangeal joint, totaling 10 feet. All patients underwent clinical and radiological evaluations (Table 1).

Eight patients were female, and one was male. The mean age was 68.7 years. The surgical procedures were perfor-

med on five right feet and five left feet. Only one case was operated upon bilaterally. The mean time between surgery and evaluation was 21.5 weeks. The postoperative radiographs revealed that the mean consolidation time was 8 weeks (Table 2). We considered an image with at least three consolidated corticals. The consolidation rate was 70%. Three cases showed no radiographic consolidation, but the patients presented with stable arthrodesis and without mobility in the hallux. There were no cases of postoperative infection. Only one patient required removal of one of the screws, which was raised.

The VAS, graded from 0 to 10, was used to compare the subjective perceptions of pre- and postoperative pain. In the preoperative evaluation, four patients (44%) had a pain level of 10, two patients (22%) had a pain level of 9, and three patients (33%) reported a pain level of 8. In the sixth postoperative month, the VAS was applied again. Six patients (66%) reported a pain level of zero, two patients (22%) reported a pain level of 1, and one patient (11%) reported a pain level of 2. A significant reduction in pain was observed, as evidenced by a decrease of approximately 9 points ($P<0.001$) on the VAS (Figure 5). All patients considered themselves satisfied with the surgery.

DISCUSSION

Metatarsophalangeal arthrodesis is the gold standard for the treatment of advanced-stage hallux rigidus. The access route may be medial or dorsal, and many types of fixation can be used, such as plate, cannulated screw, Kirschner wire, a combination of methods and other devices[15]. Some authors have shown good long-term results from arthrodesis, regardless of the implant used[16-18]. Consolidation rates reach 96%; most patients return to activities without functional limitation, with improvements when walking long distances and practicing low-impact sports, and are satisfied with the results[19,20].

However, some complications may occur, such as problems in the surgical wound, infection and implant-related complaints, which involve the removal of synthetic material. When the conventional technique is used, articular surface preparation requires an extensive surgical approach, which can become painful postoperatively[21,22].

In recent years, some series have been published of patients undergoing metatarsophalangeal hallux arthrodesis using a minimally invasive technique, always using two portals. In 2010, Bauer et al. published a study of 32 cases of minimally invasive arthrodesis and obtained good results, with 31 consolidated cases, only one case of postoperative infection and 30 cases in which patients were either satisfied or very satisfied. In 2014, Fanous et al. published a study of 26 feet undergoing percutaneous arthrodesis and obtained a 93% consolidation rate. Finally, in their 18 cases in 2016, Sott et al. obtained a consolidation rate of over 90% and a patient satisfaction rate of 91%[1,4,22].

Table 2. Study subjects' characteristics

Variable	Value	
Age (years, n=9)[a]	68.7 ± 6.4	
Consolidation time (weeks, n=6)*[b]	8.0 (7.5 a 12.0)	
Operated foot [No. (%)][c]		
Right	4	(44.4)
Left	4	(44.4)
Bilateral	1	(11.1)

*Three feet (30%) were not consolidated. [a] Data presented as the mean ± standard deviation.
[b] Data presented as median and interquartile range. [c] Data presented as absolute and relative occurrence frequencies.
Source: Prepared by the author based on the results of the study.

Table 1. Case studies.

	Case study						
	Gender	Age (years)	Laterality	VAS before	VAS after	Consolidated RX (weeks)	Situation
Case 1	Female	59	Left	9	1	Not consolidated	Satisfied
Case 2	Female	73	Right	8	0	Not consolidated	Satisfied
Case 3	Female	63	Left	10	1	8	Satisfied
Case 4	Female	67	Left	10	0	Not consolidated	Satisfied
Case 5	Female	74	Right	9	0	12	Satisfied
Case 6	Female	69	Bilateral	10	0	L foot - 6/R foot - 8	Satisfied
Case 7	Female	67	Right	8	2	8	Satisfied
Case 8	Female	79	Right	10	0	8	Satisfied
Case 9	Male	68	Left	10	0	8	Satisfied

Source: Prepared by the author based on the results of the study.

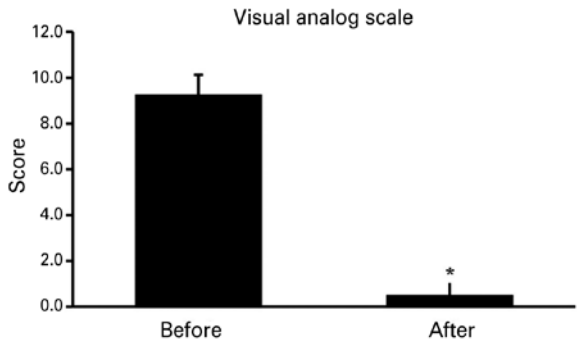

Figure 5. Subjective perception of pain before and 6 months after surgery. * Significant difference compared with pre-operative values (p<0.05).
Source: Prepared by the author based on the results of the study.

These studies show that despite the fact that data on percutaneous arthrodesis are still scarce, there is a tendency for results to be similar to those of open arthrodesis, with high consolidation rates and low complication rates.

The percutaneous method has two important advantages, which need to be explored to be better characterized. The first of these advantages is the excellent cosmetic results, with often imperceptible scars, which is highly valued in tropical countries where open shoes are used throughout the year. The other advantage is a more comfortable postoperative period, with decreased pain intensity in the first few weeks after surgery. There are no studies comparing the pain levels of patients undergoing open versus percutaneous arthrodesis. However, in a randomized prospective study of 50 subjects, Lee et al. compared pain intensity in patients with hallux valgus subjected to correction using the Scarf and percutaneous Chevron techniques. Patients in the percutaneous group had significantly lower pain levels in evaluations performed 1 day and 2 and 6 weeks postoperatively[13].

Some care is required during the minimally invasive surgical technique. The literature shows that preparation of the articular surface and positioning of the toe are critical steps that can compromise the final result. The excessive removal of osteophytes can lead to bone loss and can cause primary instability of the arthrodesis. This instability makes consolidation difficult and can lead to chronic pain. Therefore, resection should be performed cautiously and should be adapted to the patient's symptoms according to whether the main complaint is dorsal, plantar, lateral or medial.

One must also pay attention to the positioning of the arthrodesis. Studies show that the surgeon must take into consideration the varus-valgus position, dorsiflexion-plantar flexion, supination-pronation, varus metatarsal, metatarsal formula, hindfoot position, symptoms (lateral ray metatarsalgia) and footwear habits. Good alignment is not difficult to achieve when using the percutaneous technique, and the surgeon can use a rigid surface in the plantar region to simulate a load to assist in positioning[22].

The mean consolidation time was 8 weeks. Studies show that the mean radiographic consolidation times are 8 to 12 weeks for the percutaneous technique and up to 16 weeks for the open technique[4,23]. It is likely that the three cases of non-consolidation were due to insufficient resection of the phalangeal joint cartilage, which generally has tougher bone than the head of the first metatarsal. Preparation of the articular surface in percutaneous arthrodesis requires that the surgeon has experience with the method, as there is no way to view the cartilage directly to evaluate whether it has been properly resected. Evaluation by fluoroscopy is limited because it depends on the surgeon's ability to define whether the cartilage has been completely eliminated[22]. We believe that, due to the learning curve, consolidation rates tend to increase as the surgeon gains familiarity with the method.

Regarding portals for accessing the joint, we chose to use only one portal, in the medial region. In other case series, two portals have been used, with the production of an accessory portal in the lateral region. We believe that a single portal is sufficient.

CONCLUSION

Percutaneous arthrodesis of the metatarsophalangeal hallux joint potentially offers results similar to those of the conventional open method but uses smaller incisions and allows a more comfortable postoperative period with less pain.

Authors' contributions: Each author contributed individually and significantly to the development of this article: VBN (https://orcid.org/0000-0002-4283-9344)* intellectual concept of the article, writing of the article; MVPF (https://orcid.org/0000-0002-2320-9769)* intellectual concept of the article, writing of the article, performing of the surgery, critical review of the content and approval of the final version of the article; MCMD (https://orcid.org/0000-0001-6572-1771)* performing of the surgery, analysis and tabulation of data, critical review of the content and statistical analysis; MFF (https://orcid.org/0000-0001-7733-6889)* performing of the surgery, analysis and tabulation of data, critical review of the content and statistical analysis; RGP (https://orcid.org/0000-0002-6064-2027)* writing of the article, critical review of the content and approval of the final version of the article. *ORCID (Open Researcher and Contributor ID).

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