

Effect of plantar incision for metatarsal head resection arthroplasty of the small toes

Avaliação da influência da incisão plantar para artroplastia de ressecção das cabeças metatarsais dos dedos menores

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ABSTRACT

Objective: To evaluate the clinical outcome of metatarsal head resection arthroplasty of the small toes using a plantar approach in patients with severe forefoot deformities.

Methods: Twelve patients (15 feet), 10 females and two males, age 53 to 81 years old, with diabetes and rheumatoid arthritis were evaluated between January 2014 and September 2017. All patients underwent the same surgical technique – metatarsal head resection arthroplasty of the small toes via a plantar approach. The evaluation was based on pain according to the visual analogue scale, the type of footwear used and the index of patient satisfaction with the surgery.

Results: In the series studied, all 12 patients (15 feet) presented significant pain improvement. Regarding wound healing, only one patient had a calloused scar, but without painful or functional impairment. Eleven individuals (14 feet) could wear all types of footwear, and only one had to use custom footwear.

Conclusion: Metatarsal head resection arthroplasty of the smaller toes using a plantar approach is a safe, reliable and effective technique for the treatment of patients with severe forefoot deformities.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Foot deformities; Arthritis, rheumatoid; Arthroplasty.

RESUMO

Objetivo: Avaliar o resultado clínico da artroplastia de ressecção das cabeças metatarsais dos dedos menores através da via de acesso plantar, em pacientes com deformidades graves do antepé.

Métodos: Foram avaliados 12 pacientes (15 pés) entre janeiro de 2014 e setembro de 2017, sendo dez do sexo feminino e dois do sexo masculino, com idade entre 53 e 81 anos, portadores de diabetes e artrite reumatoide. Todos foram submetidos à mesma técnica cirúrgica com artroplastia de ressecção das cabeças metatarsais dos dedos menores por via plantar. A avaliação foi feita através de uma escala visual analógica de dor, tipo de calçado utilizado e o índice de satisfação dos pacientes com a cirurgia.

Resultados: Na série estudada, todos os 12 pacientes (15 pés) apresentaram melhora do quadro doloroso com resultado estatístico significativo. Analisando o aspecto cicatricial da ferida, apenas um paciente apresentou calosidade na cicatriz, mas sem comprometimento doloroso e funcional. Onze indivíduos (14 pés) podiam usar todo tipo de calçado e apenas um utilizava calçado sob medida.

Conclusão: A artroplastia de ressecção das cabeças metatarsais dos dedos menores utilizando a via de acesso plantar é uma técnica segura, confiável e eficaz no tratamento de pacientes com deformidades graves do antepé.

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

Descritores: Deformidades do pé; Artrite reumatoide; Artroplastia.

Work performed at the Hospital das Clínicas da Universidade Estadual de Campinas, São Paulo, Brazil.

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INTRODUCTION

Metatarsal head resection arthroplasty is a procedure used to treat complex forefoot deformities, especially when there is dislocation of the metatarsophalangeal joints of the smaller toes⁽¹⁻³⁾. This technique was first described by Hoffmann in 1912, in which a transverse plantar approach just below the digitoplantar fold is used to extract the metatarsal heads⁽⁴⁾.

When describing where the incision should be performed, Hoffmann notes that a distal approach to the metatarsal heads, outside the loading area, would avoid pressure on the surgical scar during walking, thus minimizing complications (Figure 1).

The more distal incision, however, makes the dissection more aggressive because it is necessary to expose the neck of the metatarsals, where the surgical section for extraction of the heads is performed. When performing the incision below the metatarsal heads and consequently within the loading area, the dissection is less aggressive because the neck is nearer. Often, patients undergoing forefoot reconstruction surgery have diabetes or rheumatoid arthritis, which are systemic diseases associated with surgical wound complications. Our hypothesis is that performing the incision at the level of the metatarsal heads minimizes these complications given the easier and less aggressive dissection of the anatomical structures involved.

The aim of this study is to present a case series of patients who underwent resection arthroplasty through a plantar incision below the metatarsal heads of the smaller toes, hence more proximal than the incision described by Hoffman but less aggressive on the soft tissues, and to evaluate the possible consequences of the approach to the loading area.

METHODS

This study was approved by the Ethics Committee with registration in the Brazil Platform under CAAE number: 80591917.1.0000.5404.

This is a retrospective, observational study in which all patients signed an informed consent form and the study met all human rights requirements.

Fourteen patients who underwent metatarsal head resection arthroplasty of the smaller toes, performed between January 2014 and September 2017, were invited for clinical evaluation.

Patients were asked which type of footwear they were able to wear: any model, only custom shoes or no type of shoe. The visual analogue scale (VAS) was used to measure pain.

On physical examination, the wound healing aspects, such as hypertrophy or callosity and the distance between the digitoplantar fold of the third toe and the surgical scar, were observed.

The following method was used as the outcome criterion: patients with minimal or absent pain who could wear any type of footwear presented an excellent outcome (VAS score less than 3); the outcome was good if pain was minimal or absent but the patient only used custom shoes (VAS score less than 3); the outcome was fair if the patient

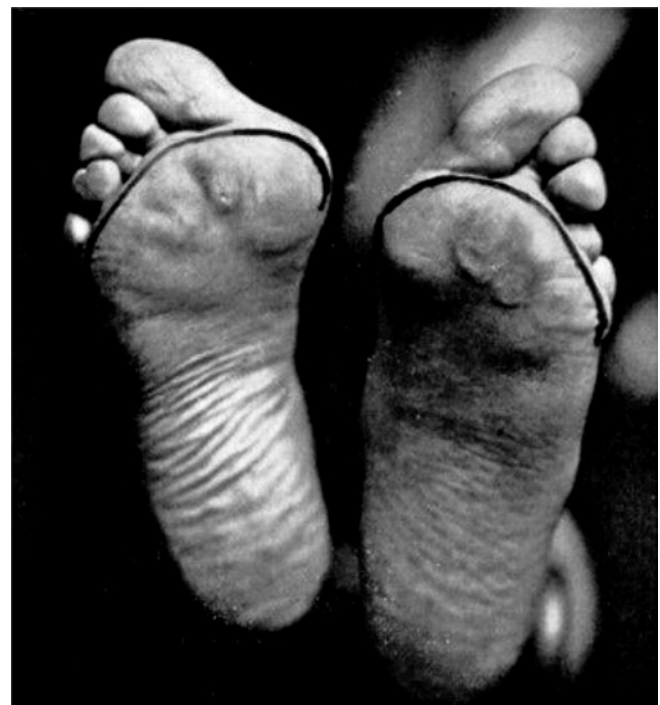


Figure 1. Hoffmann's plantar approach to metatarsal head access. **Source:** Authors' personal archive.

had moderate pain but showed an improvement compared to the preoperative level, regardless of the shoe type (VAS score between 3 and 7); the outcome was considered poor if the patient had severe pain regardless of the shoe type (VAS score greater than 7).

At the end of each evaluation, the patients were asked about the degree of satisfaction with the surgery and whether or not they would undergo the surgery again.

Surgical technique

The patient was placed in a supine position, and an Esmarch tourniquet was applied to the middle third of the limb to be operated. A curved plantar incision approximately 3cm below the digitoplantar fold of the third toe was performed under the metatarsal heads, extending from the second to the fifth toe (Figure 2).

Next, dissection of the plantar fat was performed, followed by haemostasis with electrocautery and resection of the cystic hygromas found. The flexor tendons were located and preserved. Through longitudinal incisions, arthrotomies were performed to expose the metatarsal heads (Figure 3). The metatarsal necks were osteotomised at 45° ("flute beak") after isolation and protection of the adjacent neurovascular bundles. With the aid of a Backhaus forceps, the metatarsal heads were resected respecting the metatarsal formula, keeping the second toe larger than the third, the third larger than the fourth, and so on. The plantar fat was repositioned and the fascia retensioned when necessary. Subcutaneous suturing was performed with 3.0 absorbable sutures and skin suturing with 4.0 non-absorbable sutures.

Toes were aligned with 1.5mm Kirschner sutures through the phalange following the medullary canal of the metatarsals, or simply by manual osteoclasia of the toes, maintaining the position with bandages. Regardless of the technique used for toe alignment, the patients used Barouk shoes after surgery, with a maximum load restriction during the first two weeks. When the stitches were removed, gradual loading was allowed until the fourth week, and when the Kirschner sutures (when used) were removed, full loading was allowed with the use of rigid footwear. Thereafter, the patients were followed-up monthly through the first six months (Figure 4).

Statistical analysis

Data distribution was tested using the Shapiro-Wilk test, and skewness and kurtosis were also evaluated. Student's t-test for paired samples was used to compare the subjective perception of pre- and postoperative pain. The signi-



Figure 2. Delineation of the plantar incision.
Source: Authors' personal archive.

ficance level adopted was 5% ($P < 0.05$). The analyses were conducted in SPSS (SPSS Inc., Chicago, USA).

RESULTS

Of the 14 patients who underwent surgery, two did not report for evaluation: one of them indicated improvement and did not want to be followed-up at the outpatient clinic, and the other had moved from the municipality and would be followed-up at an orthopaedic service in their new place of residence. Thus, the sample consisted of 12 patients, three with bilateral involvement, for a total of 15 operated feet.

Nine patients had rheumatoid arthritis and complex forefoot deformities, with dislocation of the metatarsophalangeal joints of the smaller toes and painful plantar callosities, and three patients had neuropathic feet secondary to diabetes and developed ulcers under the metatarsal heads.

The descriptive data of the sample are presented in Table 1. After surgery, a significant reduction in pain was observed, as evidenced by a decrease of approximately 7 points ($P < 0.001$) on the VAS (Figure 5).

The distance between the digitoplantar fold proximal to the third toe and the surgical scar ranged from 3 to 3.5cm with a mean of 3.2cm. All patients had healed wounds, and only one patient presented a calloused scar, but without painful or functional impairment.

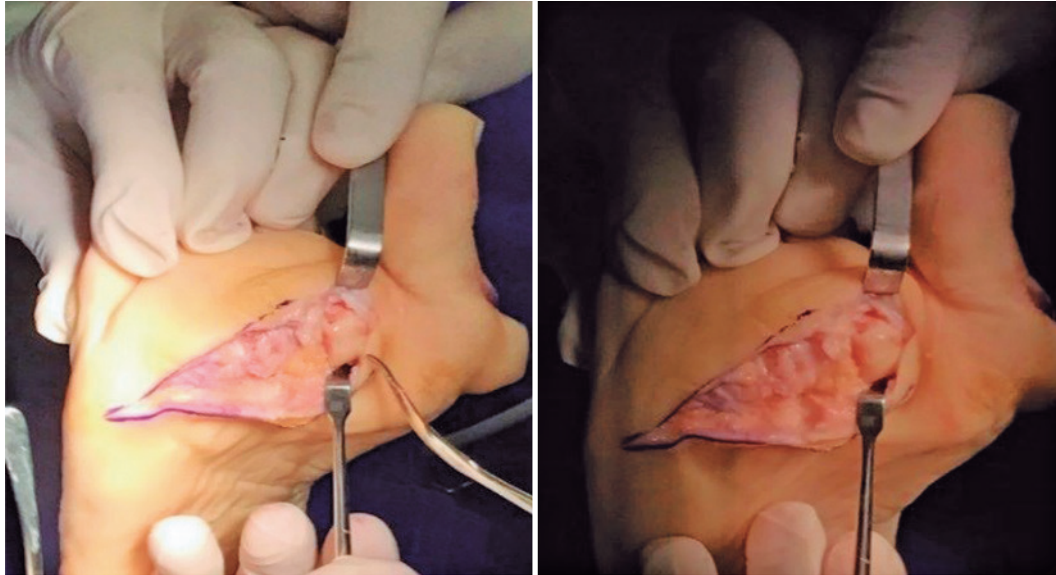


Figure 3. Visualization of the metatarsal heads from the second to the fifth toe.
Source: Authors' personal archive.



Figure 4. Postoperative radiograph and plantar scar after six months.
Source: Authors' personal archive.

The mean preoperative pain intensity was 8 (5 to 9), which significantly ($P < 0.001$) dropped to 0.9 (0 to 2) after the procedure.

When asked whether they would undergo surgery again, all patients were satisfied because they experienced a substantial improvement in pain and deformity and could wear conventional or custom-made footwear.

DISCUSSION

Surgical treatment in patients with severe forefoot deformities presents a challenge to the orthopaedic surgeon due to the potential for postoperative complications related to both the degree of deformity and the presence of underlying diseases such as diabetes and rheumatoid arthritis⁽⁵⁾.

Table 1. Characteristics of the patients studied (n = 12)*

Variables	Values
Age (years) ^a	71.2±9.7
Follow-up time (months) ^a	14.8±8.4
Gender [No. (%)] ^b	
Male	2.0 (16.7)
Female	10.0 (83.3)
Operated limb [No. (%)] ^{b*}	
Right	5 (41.7)
Left	4 (33.3)
Bilateral	3 (25.0)
Type of shoe [No. (%)] ^{b*}	
Any type	14 (93.3)
Custom-made	1 (6.7)
Degree of satisfaction [No. (%)] ^b	
Satisfied	15 (100.0)
Unsatisfied	0 (0.0)

*Data from 15 feet were analysed, from a total of 12 patients.

^a Data presented as the mean ± standard deviation

^b Data presented as frequencies of absolute and relative occurrences

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

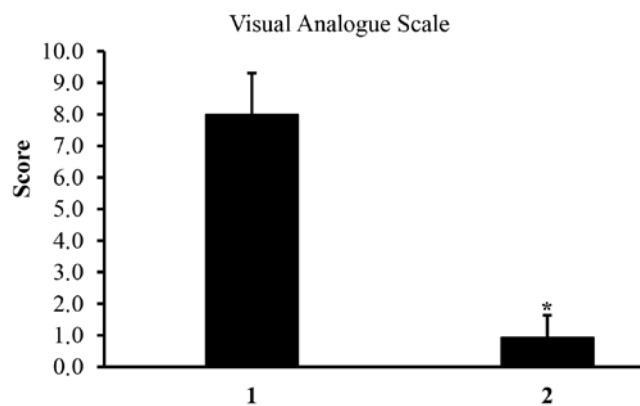


Figure 5. Subjective perception of pre- and postoperative pain. * Significant difference compared to the preoperative level (P<0.001).

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

Metatarsal head resection arthroplasty is a technique frequently used to correct these deformities. It can be performed via a dorsal or plantar approach. Most authors use the dorsal approach and report complications such as recurrence of deformity caused by soft-tissue retraction during healing, shortening and overlap of the phalanx over the adjacent metatarsals, suture dehiscence and postoperative infection⁽⁶⁻⁹⁾.

The recurrence of deformities is associated with the development of painful callosities^(1,3), being present in 40 to 58% of cases with unsatisfactory outcomes⁽³⁾.

Ishie et al.⁽⁵⁾, Amin et al.⁽⁹⁾ and Hamalainen⁽¹⁰⁾ all used a plantar approach with satisfactory results for most patients,

but none of the studies included a clear description of the effect of the scar on the outcome or patient satisfaction.

Although the dorsal approach is the most used, we chose the plantar approach because it offers better exposure of and easy access to the metatarsal heads, especially if the metatarsophalangeal joints are dislocated. The plantar approach at the level of the metatarsal heads allows retensioning the fascia and repositioning the plantar fat pad, producing a more anatomical reconstruction of the soft tissues.

However, many authors avoid this approach, claiming a risk of injury to the neurovascular bundle (plantar location), injury to the plantar fat pad and the risk of painful callosities associated with the incision in the forefoot loading area.

In a series of 45 rheumatoid feet subjected to dorsal reconstruction reported by Hulse et al.⁽³⁾, 15.5% of patients presented severe pain and 11% presented moderate pain, with callus formation in 40% of the cases. The reappearance of callosities was considered a consequence of inadequate bone resection during the extraction of the metatarsal heads.

In the present study, patients had very satisfactory healing, with only one case showing a callosity, suggesting that the incision in the loading area does not seem to be related to the development of painful scars.

Regarding the presence of pain analysed through the VAS, the patients showed a significant decrease in pain: all 12 patients (15 feet) reported a significant decrease in pain after surgical treatment.

Other studies describe a plantar incision through an ascending access via the root of the fifth toe but do not precisely report the location of the surgical approach.

Although this is a retrospective study with few literature references for support and few cases in the analysed series, the plantar approach at the level of the metatarsal heads is a very satisfactory approach with a high rate of good results.

Comparative studies between plantar and dorsal incisions, which could identify the safer and more efficient approach, have not yet been performed. Our case series shows that the plantar approach at the level of the metatarsal heads, even when performed in the loading area, presents satisfactory outcomes with few complications.

CONCLUSION

Although further studies are needed, the plantar incision used for metatarsal head resection of the smaller toes in severe forefoot deformities is a safe, reliable and effective procedure with a high rate of good results.

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REFERENCES

1. Matsumoto T, Kadono Y, Nishino J, Nakamura K, Tanaka S, Yasui T. Midterm results of resection arthroplasty for forefoot deformities in patients with rheumatoid arthritis and the risk factors associated with patient dissatisfaction. *J Foot Ankle Surg.* 2014;53(1):41-6.
2. Parra-Télez P, López-Gavito E, Vázquez-Escamilla J. Metatarsophalangeal arthrodesis of the hallux and arthroplastic resection of the second to fifth metatarsal heads in the rheumatic foot. *Acta Ortop Mex.* 2013;27(2):78-86.
3. Hulse N, Thomas AM. Metatarsal head resection in the rheumatoid foot: 5-year follow-up with and without resection of the first metatarsal head. *J Foot Ankle Surg.* 2006;45(2):107-12.
4. Hoffmann P. An operation for severe grades of contracted or clawed toes. 1911. *Clin Orthop Relat Res.* 1997(340):4-6.
5. Ishie S, Ito H, Azukizawa M, Furu M, Ishikawa M, Ogino H. et al. Delayed wound healing after forefoot surgery in patients with rheumatoid arthritis. *Mod Rheumatol.* 2015;25(3):367-72.
6. Tillmann K. Surgery of the rheumatoid forefoot with special reference to the plantar approach. *Clin Orthop Relat Res.* 1997(340):39-47.
7. Lui TH. Technical tips: Modified resection arthroplasty for correction of rheumatoid forefoot deformity. *Foot Ankle Surg.* 2010;16(2):74-7.
8. Jaakkola JI, Mann RA. A Review of Rheumatoid Arthritis Affecting the Foot and Ankle. *Foot Ankle Int.* 2004;25(12):866-74.
9. Amin A, Cullen N, Singh D. Rheumatoid forefoot reconstruction. *Acta Orthop Belg.* 2010;76(3):289-97.
10. Hamalainen M, Raunio P. Long-term followup of rheumatoid forefoot surgery. *Clin Orthop Relat Res.* 1997(340):34-8.