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CASE REPORT

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# One-stage correction of multiple brachymetatarsia and hallux valgus with calcaneal autograft

## Correção de braquimetatarsia múltipla e Hálux valgo em tempo cirúrgico único com enxerto autólogo do calcâneo

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## ABSTRACT

Brachymetatarsia is the shortening of the metatarsus caused by congenital premature closure of the metatarsal physis. In general, the patient presents a shortened and dorsally situated toe causing metatarsalgia in addition to aesthetic effects. The aim of surgery is to improve the symptoms and aesthetics through bone elongation and rebalancing of the metatarsal formula. This elongation may be performed through gradual distraction with an external fixator or a single procedure with a bone graft. We report a case of bilateral brachymetatarsia of the 3rd and 4th metatarsals associated with hallux valgus and deformities in the 2nd toe, in which surgery was performed on the right foot with a calcaneal autograft.

***Level of Evidence V; Therapeutic Studies; Expert Opinion.***

**Keywords:** Hallux valgus; Foot deformities, Congenital; Toes; Orthopedics.

## RESUMO

A braquimetatarsia é o encurtamento do metatarso causado pelo fechamento prematuro congênito da fise metatarsal. Em geral, o paciente apresenta artelho encurtado e situado dorsalmente provocando, além de efeitos estéticos, metatarsalgias. A cirurgia tem como objetivos a melhora dos sintomas e estética através do alongamento ósseo e reequilíbrio da fórmula metatarsal. Este alongamento pode ser por meio da distração gradual com fixador externo ou procedimento único com enxerto ósseo. Relatamos um caso de braquimetatarsia bilateral do 3º e 4º hálux valgo e deformidades no 2º dedo, no qual foi realizada cirurgia no pé direito com enxerto autólogo do calcâneo.

***Nível de Evidência V; Estudos Terapêuticos; Opinião de Especialista.***

**Descritores:** Hallux valgus; Deformidades congênitas do pé; Dedos do pé; Cirurgia ortopédica.

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## INTRODUCTION

Brachymetatarsia is an unusual deformity of the forefoot, resulting from metatarsal shortening[1]. It can occur in any of the metatarsals, with involvement of the 4th metatarsal in 72.5% and bilateral presentation in up to 45% of cases[2]. Its incidence is estimated at between 0.02 and 0.05% in the general population, with a female prevalence of 93.2%[2].

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The main cause of this deformity is the congenital premature closure of the metatarsal growth plate, but its etiology is not fully understood[2,3]. Although the vast majority of the congenital form has idiopathic etiology, it may also be associated with endocrinopathies such as pseudohyperparathyroidism and systemic syndromes such as Turner syndrome. Other described secondary causes are traumas, infections, tumors and radiation exposure[4].

Clinically, brachymetatarsia patients present shortened and dorsally situated toes causing not only aesthetic effects but also direct changes in the transverse arch, resulting in metatarsalgia and callosity, especially under the heads of the 2nd and 3rd metatarsals. Additionally, the soft tissue imbalance can cause claw toes, deformities in the adjacent toes such as hallux valgus and difficulty wearing closed shoes and walking[1,3,5].

Surgical treatment aims to correct the foot biomechanics through bone elongation and rebalance of the metatarsal formula, with symptomatic relief and aesthetic improvement[5,6]. The two most commonly used methods are osteotomy with gradual distraction[1,3,7] and osteotomy with grafting in the same surgical procedure[4,5,8-10].

The aim of this study is to describe the case of a patient who presented shortening of the 3rd and 4th metatarsals, associated with hallux valgus and deformity in the 2nd toe, who was surgically treated by metatarsal elongation with calcaneal autograft and correction of deformities of the 1st and 2nd toes in a single surgery.

## CASE REPORT

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 98573318.6.0000.0023.

The 54-year-old patient, with no comorbidities, history of foot traumas or previous foot surgery, reported deformity of the feet since birth, with progressive worsening, associated with chronic pain, limited use of closed shoes and great aesthetic dissatisfaction. On physical examination, the 3rd and 4th toes were shortened, which was associated with dorsal deviation of the 4th toe, significant valgus deviation of the distal phalanx of the 2nd toe and accentuated hallux valgus, in addition to painful bilateral plantar callosity under the head of the 2nd metatarsal (Figure 1). The radiographs showed metatarsus adductus, moderate hallux valgus, valgus of the distal interphalangeal joint (DIPJ) of the 2nd toe and brachymetatarsia of the 3rd and 4th toes (Figure 2).

**Figure 1.** Preoperative clinical aspect of the feet; a gross deformity was present in the forefoot.
**Source:** Author's personal archive.

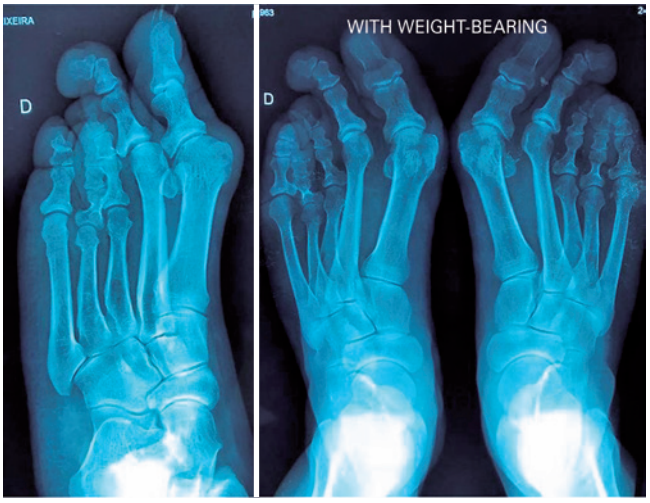


**Figure 2.** Preoperative radiographs showing brachymetatarsia of the 3rd and 4th metatarsus and hallux valgus.
**Source:** Author's personal archive.

### Surgical technique

The surgery was performed on the right foot, with the patient in dorsal decubitus, under spinal anesthesia and with a pneumatic cuff placed in the proximal region of the thigh. First, dorsal access was performed in the 3rd interdigital space (IDS), followed by Z-plasty of the 3rd and 4th toe extensors and dorsal capsulotomy of the metatarsophalangeal joints (MPJs) of the 3rd and 4th toes. The graft was then harvested from the posterior calcaneal tuberosity, according to the technique described by Sanhudo. After lateral longitudinal incision of the hindfoot, a blunt dissection was made next to the insertion of the calcaneal tendon followed by detachment of the periosteum. A microsaw was used to make a transverse cut, with the limit at the Achilles tendon insertion level, and a vertical cut respecting the posterior margin of the calcaneus, and a bicortical bone graft was harvested. Next, the 3rd and 4th metatar-

sals were elongated, and the bone graft was placed in the distal metaphyseal region and fixed with intramedullary K-wires. Via dorsal access in the 1st IDS, lateral capsulotomy of the 1st MPJ was performed, the sesamoid complex was released, and the hallux adductor tendon was transposed. Via the same access, Weil osteotomy was performed with shortening of the 2nd metatarsal. A modified DuVries procedure was performed on the 2nd toe to correct the valgus of the DIPJ followed by K-wire fixation. Lastly, varus of the 1st metatarsal was corrected with Scarf osteotomy, followed by correction of the hallux valgus (Figure 3).

The patient was discharged after 24 hours with a foot splint and remained immobilized and without weight-bearing for 4 weeks. At that time, partial weight-bearing was allowed with a forefoot offloading shoe, which was maintained until the 8th week, when the K-wires were removed, and weight-bearing was allowed with nonorthopedic sandals. Before surgery, the 1st, 2nd, 3rd and 4th metatarsals measured 7.7cm, 8.1cm, 5.9cm and 5.6cm, respectively, and the metatarsophalangeal (MPA) and intermetatarsal (IMA) angles were 38.4º and 9.5º, respectively. Bone consolidation was observed 8 weeks after surgery, with 1st to 4th metatarsal lengths of 7.4cm, 7.5cm, 7.0cm and 6.6cm, respectively. The MPA was 16°, and the IMA was 3.2° (Figure 4).

After 12 months, the patient had no pain complaints and presented residual deformities of the toes but exhibited great aesthetic satisfaction (Figure 5). The American

**Figure 3.** Intraoperative appearance of the foot and autograft removed from the posterior calcaneal tuberosity.
**Source:** Author's personal archive.

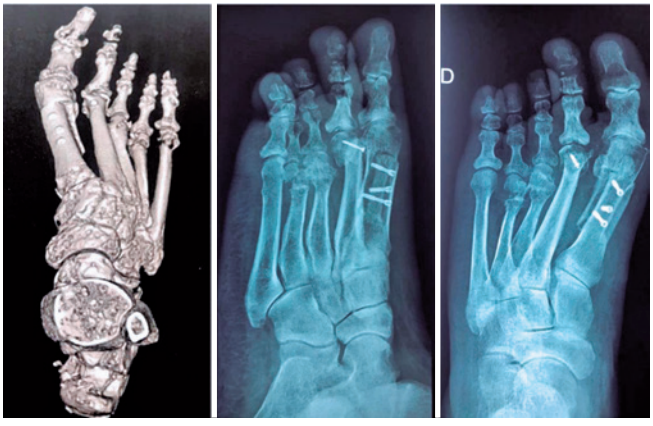

**Figure 4.** Radiographs obtained one year after surgery.
**Source:** Author's personal archive.

**Figure 5.** Clinical appearance at one year after surgery.
**Source:** Author's personal archive.

Orthopedic Foot and Ankle Society (AOFAS) forefoot score totaled 88 of 100 possible points. According to the Johnson scale, the patient was completely satisfied with the outcome of the surgery and desired to undergo the procedure on the contralateral foot.

## DISCUSSION

Because it is an uncommon deformity, the large majority of studies on brachymetatarsia are case reports, with few series comparing the different forms of surgical treatment. The only systematic review revealed a high prevalence of deformity in women, with a ratio of 13.7:1 and bilateral involvement in 45% of the patients[2]. The patient in the present study presented deformity in both feet, with involvement of the 3rd and 4th metatarsals.

There is still no consensus in the literature on which surgical method is predominant[6]. While some studies advocate elongation with bone grafting in a single surgery, others prefer gradual distraction, especially in patients with pronounced metatarsal shortening[1,3-9]. In the first technique, the graft may be autologous, preferably taken from the iliac crest[4-6,9] or even from adjacent phalanges[8], or homologous[10]. The main advantages include performing a single surgery, a lower complication rate (approximately 19.5%) and shorter consolidation time, ranging from 5 to 14 weeks. However, the gain in length is significantly less with this technique, on average 26% of the original length of the elongated metatarsus[2,5].

Woo et al.[9] performed single-stage elongation in a total of 56 feet of 41 patients with interposition of an autologous iliac crest graft in the epiphyseal region of the 4th metatarsal joint and MPJ reconstruction, fixed with K-wires. The mean fixation time was 58.5 days, with a mean length gain of 20.9mm, corresponding to 39% bone elongation. The complication rate was 26.8%, with MPJ stiffness in 23% of the cases. In another study[10], 29 patients (41 feet) were treated with interposition of a homologous bone graft from a bone bank and K-wire fixation. In 18 cases, hallux valgus correction was performed with the minimally invasive SERI technique. Patients were followed up for an average of 5 years, with 100% consolidation and mean metatarsal elongation of 13mm, corresponding to a 23% increase in length, without complications.

Gradual metatarsal elongation surgery achieved an average bone elongation of 37.3% (16.8 to 20mm) but with a consolidation time of approximately 16 weeks[2,3,10]. The greatest concern with this technique is the high complication rate. According to the literature, the complication rate varies between 12 and 81.8%, and complications include pin tract infection, joint stiffness, subluxation, poor metatarsal alignment and pseudoarthrosis, especially in cases in which the elongation is greater than 41.3% of the bone length[1-3,7].

In the study with the largest number of cases, 153 feet from 106 patients were divided into three groups according to the surgical technique. In group 1 (n=35), elongation was performed with a bone graft in a single stage. In groups 2 (n=39) and 3 (n=32), an external mini-fixator was used after an osteotomy performed with a saw or osteotome, respectively. The elongation was less in group 1 (mean of 13.9mm) than in the second and third groups (17.8mm and 16.8mm, respectively); however, less time was required for consolidation[6].

Some studies recommend that when the elongation desired is greater than 15mm or 25% of the original length of the metatarsus, elongation through gradual distraction is preferable[2,8]. Together with the patient, we opted for the single-stage elongation technique with autografting, which resulted in osteotomy consolidation at 8 weeks, great aesthetic improvement and complete symptom relief. The mean metatarsal length gain in our patient was 12mm, which represented an increase of 21% of the original size, a result similar to those of previously reported cases[4,5,8-10].

In this report, unlike all cases of brachymetatarsia correction previously published in the literature, correction was performed through bone elongation using a calcaneal autograft. We chose this site because it is a source of highly spongy graft material, with high integration and fusion rates, in addition to the shorter harvesting time, which is important for surgeries performed to correct multiple deformities.

## CONCLUSION

The management of brachymetatarsia, even when present in more than one metatarsal and associated with other deformities, can be performed in a single stage, with good evolution and without complications. Metatarsal elongation using a calcaneal block autograft was found to be a good alternative to traditional techniques, with a consolidation time similar to that of other donor sites but with a shorter surgical time.

**Authors' contributions:** Each author contributed individually and significantly to the development of this article: HM (https://orcid.org/0000-0001-7527-969X) conceived and planned the activities that led to the study, wrote the article and approved the final version; RTM (https://orcid.org/0000-0003-0686-6182) wrote the article, participated in the review process and approved the final version; LG (https://orcid.org/0000-0003-3145-2985) participated in the review process and approved the final version; CBG (https://orcid.org/0000-0003-2587-5586) participated in the review process and approved the final version; IMCJ (https://orcid.org/0000-0002-7815-6086) participated in the review process and approved the final version; FAR (https://orcid.org/0000-0002-6651-2549) participated in the review process and approved the final version. *ORCID (Open Researcher and Contributor ID).

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