

## Original article

## Elongation with callotaxis for congenital brachymetatarsia

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**ABSTRACT. Objective:** To present 10 cases of congenital brachymetatarsia treated with elongation by means of callotaxis with external mini-fixators. **Introduction:** Brachymetatarsia of one or more of the metatarsals involving one or both extremities is a congenital condition, more frequent in the right foot, with the 4th metatarsal most commonly affected. **Material and methods:** From May 2007 to September 2008, 7 patients with congenital brachymetatarsia, ages 8 to 15 years, were operated on. Two metatarsals were involved in 3 of them and thus the series included 10 procedures. All of them underwent lengthening through callotaxis with a monoaxial external mini-fixator. **Results:** Mean lengthening was 21.1 mm, with a range of 17 to 25 mm. The complications included two cases of lengthening regression of 5 mm each. Delayed healing was reported in one of these two cases, and healing occurred spontaneously at 6 months. Nine metatarsals healed without any problems; no infections or material intolerance occurred. **Conclusion:** Lengthening of metatarsals through callotaxis with external mini-fixators is an appropriate procedure for pediatric and adolescent patients with congenital brachymetatarsia.

**Key words:** fixation, foot, abnormality, bone lengthening.

**RESUMEN. Objetivo:** Presentar 10 casos de braquimetatarsia congénita tratados con elongación por callotaxis con minifijadores externos. **Introducción:** La braquimetatarsia de uno o más de los metatarsianos que afecta una o ambas extremidades, es una patología congénita, más frecuente al pie derecho, siendo más comúnmente afectado el 4to metatarsiano. **Material y métodos:** De Mayo de 2007 a Septiembre de 2008 se operaron 7 pacientes de edades de 8 a 15 años con braquimetatarsia congénita, en tres de ellos estaban afectados 2 metatarsianos, por lo que la serie incluye 10 procedimientos. A todos se les efectuó elongación por callotaxis con minifijador externo monoaxial. **Resultados:** Se obtuvo un alargamiento de 21.1 mm en promedio, con rango de 17 a 25 mm. Como complicaciones se detectaron dos casos de regresión del alargamiento de 5 mm en cada uno. En uno de estos dos casos mencionados existió retardo de consolidación, la cual se logró de manera espontánea a los 6 meses. Nueve metatarsianos consolidaron sin eventualidades, no se presentaron casos de infección ni de intolerancia al material. **Conclusión:** La elongación de los metatarsianos por callotaxis con minifijadores externos es un procedimiento satisfactorio para pacientes pediátricos y adolescentes con braquimetatarsia congénita.

**Palabras clave:** fijación, pie, anomalía, alargamiento óseo.

**Level of evidence: IV (Act Ortop Mex, 2010)**

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## Introduction

Congenital brachymetatarsia is an infrequent foot condition. It is defined as an abnormal shortening of one or more metatarsals caused by a premature closing of the epiphysis, with an incidence rate of 0.02% - 0.05% in the United States.<sup>1,2</sup> It may be unilateral and in 72% of cases it is bilateral. The fourth metatarsal is most frequently affected, the condition is predominant among females at a ratio of 25:1.<sup>3,4</sup> The etiology is unknown and is associated with congenital and developmental causes, traumatic or iatrogenic factors, and it is also related with certain systemic conditions like pseudohypoparathyroidism, Turner and Down syndrome or Albright disease.<sup>3,5,6</sup> The usual reasons why patients go to the doctor are esthetic complaints and pain.<sup>7</sup> The treatment may be divided into conservative and surgical procedures. Multiple surgical procedures have been described for brachymetatarsia. The most widely used ones include single-stage elongation with bone graft, and gradual elongation with callotaxis. The advantages of the former over the latter include a shorter bone healing period and a smaller scar. The possible disadvantages include morbidity at the graft harvesting site, neurovascular injury due to rapid stretching, and a poor length gain due to the tension in the surrounding soft tissues.<sup>1</sup> The main advantages of gradual lengthening with callotaxis include the fact that no bone graft is needed, that the gradual elongation of the soft tissues prevents neurovascular complications, and permits early weight bearing. The disadvantages include stiffness and deformity of the adjacent joint, scars in the nail region, transient hyperpigmentation in the skin surrounding the nail site, nail tract infection and a longer time to achieve bone union. The use of external fixation for metatarsal elongation was reported by Skirving and Newman in 1983; the fixators designed specifically to be used in the hand and foot have been used for metatarsal elongation. Some of them are rigid monoaxial devices that are used solely for elongation.<sup>2,5,7</sup>

The purpose of this paper is to present a series of 10 cases of congenital brachymetatarsia in 7 pediatric patients in whom elongation with callotaxis was performed with an external monoaxial fixator for distraction purposes, together with the results after a 3-year follow-up.

## Material and methods

A retrospective, descriptive, observational study was conducted at General Ignacio Zaragoza Regional Hospital, ISSSTE in Mexico City from May 2007 to September 2008. The results of elongation with callotaxis in patients with a diagnosis of congenital brachymetatarsia of one or more metatarsals were assessed.

The inclusion criteria were: patients age 8-15 years with a clinical and radiographic diagnosis of congenital brachymetatarsia of one or more metatarsals. The exclusion criteria were: patients under 8 and over 15 years of age, traumatic shortening and gait problems. The elimi-

nation criteria were: patients who did not comply with the follow-up (*Figures 1,2*).

The variables that we analyzed and assessed were the age and gender of patients, the affected toe and foot, the reason for the consultation, function, symptomatology, lengthening, lengthening period, healing (measured in weeks/centimeter), infection and residual pain.

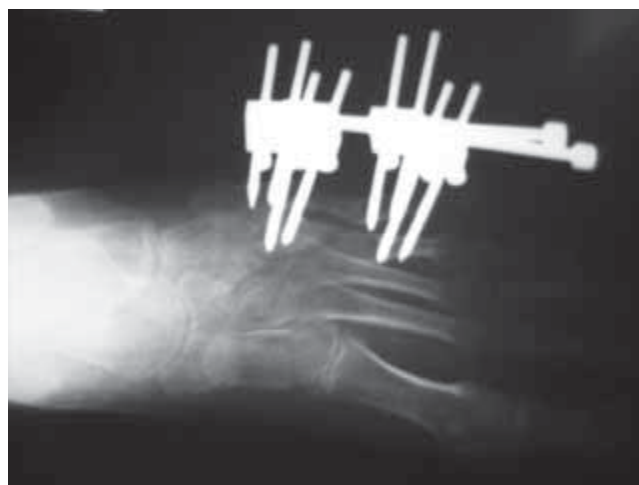
The surgical treatment consisted of an approximately 2 cm dorsal approach at the level of the affected metatarsal, from the proximal to the distal metaphysis; four 2 mm threaded screws were placed aligned on the metatarsal axis, with a 35° lateral inclination, two in the base and two in the mid shaft. Fan perforations were performed at the level of the proximal metaphysis with a 2 mm drill bit, and a complete osteotomy was performed with a thin osteotome; then the minifixator was placed and fixed once the fragment alignment had been checked (*Figures 3,4*). No intraoperative complications occurred. After a 3-day latency period, the process was started with three turns for distraction and one for regression to achieve a daily lengthening of 0.5 mm for a mean period of 6.1 weeks (5-7.3 weeks) (*Figures 5,6*). Weight bearing was allowed only 2 months after starting the treatment, and was followed by 3 weeks of 50% partial weight bearing and then complete weight bearing. The lengthening process was clinically controlled. The fixators were removed after a mean of 11.1 weeks (10-12 weeks). Bone healing was verified with a two-view radiographic study in all cases; normotrophic secondary bone callus was found in the 10 metatarsals treated. The length and healing obtained were determined by measuring the length achieved and the time it took. Descriptive statistics were applied to the results.

## Results

A total of 7 patients were included, 6 girls and 1 boy; mean age was 11.6 years (8-14 years); five had shortening of the 4<sup>th</sup> right metatarsal, one of the 3<sup>rd</sup> and 4<sup>th</sup> right metatarsals, one of the 4<sup>th</sup> and 5<sup>th</sup> right metatarsals, and finally, one had shortening of the 4<sup>th</sup> metatarsals in both feet. The reasons for the consultation were the esthetic complaint and the dysfunction, which could not be assessed initially due to the malformation. All patients were referred as asymptomatic. In the 10 metatarsals of the 7 patients treated a mean lengthening of 21.1 mm was achieved. (17-25 mm.) The lengthening period was 6.03 weeks (4.9-7.1 weeks), the period with external fixators in place was 12.6 weeks (10-14 weeks). A mean healing of 2.9 weeks/cm was obtained (2.4-3.1 weeks/cm). Females were predominant over males, with a ratio of 6:1; the right foot was more frequently affected than the left one, with a ratio of 9:1. The most affected metatarsal in this series was the 4<sup>th</sup>, with an 80% incidence rate, followed by the 3<sup>rd</sup> and the 5<sup>th</sup>, each one with a 10% incidence rate. An appropriate lengthening and bone healing were reported in all cases (*Figures 7-9*). A 5 mm regression of lengthening was reported in two metatarsals. Healing was delayed in one of them, but it was successfully and spontaneously achieved



**Figure 1.** Brachymetatarsia of the 4<sup>th</sup> metatarsal.



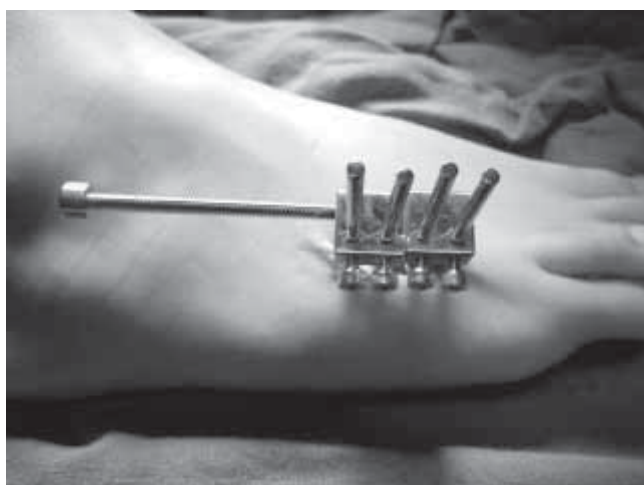
**Figure 4.** Oblique X-ray of the foot, appropriate bone healing of the 4<sup>th</sup> and 5<sup>th</sup> metatarsal osteotomies.



**Figure 2.** Brachymetatarsia of the 3<sup>rd</sup> and 4<sup>th</sup> metatarsals.



**Figure 5.** Clinical image at 14 weeks with an external fixator.



**Figure 3.** External fixator in the 4<sup>th</sup> metatarsal.



**Figure 6.** Clinical image at 14 weeks with a double external fixator.

at 6 months; in the other case rupture of the distal nails in the plantar cortex occurred without loosening of the external fixator. No infections were reported. After the observation period the gait was normal, the function of the metatarsophalangeal, and proximal and distal interphalangeal joints was normal; no deformities were found in the metatarsals and no cases of residual pain were reported either. Patients reported esthetic and functional satisfaction with the results.

## Discussion

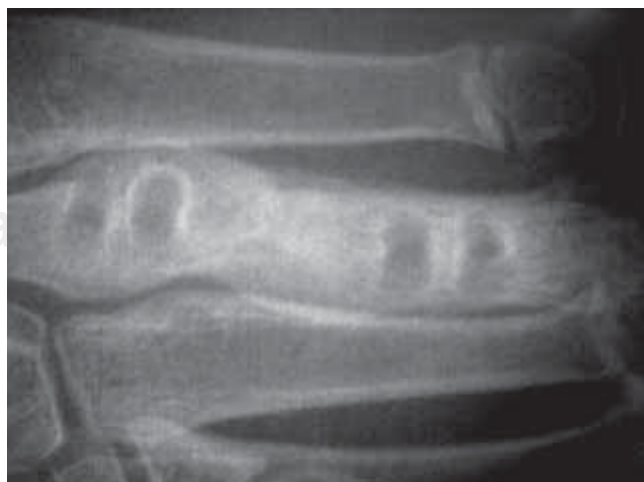
Congenital brachymetatarsia of one or more metatarsals is predominant among females, with the 4<sup>th</sup> metatarsal as the most commonly affected one; it may be bilateral or two metatarsals in the same foot may be affected.<sup>5</sup> In our case series, of the 7 patients treated, 90% were females and only 10% males; 80% of the cases had involvement of the 4<sup>th</sup> metatarsal, and 10% had involvement of the 3<sup>rd</sup> and 5<sup>th</sup> metatarsals. The reason for the consultation in the case of this condition was the esthetic complaint,<sup>1,2</sup> and the results in our series were the same for all patients. At the end of treatment all 7 patients reported esthetic satisfaction and they had a normal range of motion of the affected toe and plantigrade gait. Concerning the invasive treatment, there are 3 goals for the surgical correction of brachymetatarsia: 1) pain relief, 2) having an esthetically acceptable foot, 3) restoring the function of the metatarsal parabola.<sup>8</sup> Various surgical methods for the treatment of this malformation have been published; the main ones and the most widely used ones by several authors, with variable results, are: single-stage lengthening with the placement of a bone graft, and lengthening using callotaxis.<sup>2,7,9</sup> In the case of lengthening with callotaxis, wearing an external fixator on the foot for a long period of time is quite uncomfortable for children and adolescents, so the cooperation of both the patient and the physician is necessary.<sup>9</sup> The patients in our series reported discomfort with the fixator, but they finally got used to it, to the extent that they modified their footwear by making holes in it for daily use. The complications of this technique include reports of fracture of the bone callus, which was properly managed with immobilization.<sup>10</sup> An ongoing follow-up and surveillance of bone healing are of the utmost importance, as well as a cautious lengthening without exceeding 0.75 mm per day, in order to obtain a callus that can stand the activities allowed to the patient. The option of single-stage lengthening, with the placement of an autologous bicortical iliac crest graft has also shown favorable results; however, undercorrection, together with neurovascular compromise and soft tissue tension, represent common obstacles for a satisfactory result, so this option is indicated only for lengthenings under 15 mm; complications have been observed, like the erosion of the metatarsal head due to the intramedullary Kirschner nail, and pseudoarthrosis.<sup>9</sup> Each type of treatment has its own indications and it has been described that the lengthening with callotaxis is recommended in patients in whom the target length is 15 mm or more. In our series the



**Figure 7.** Clinical image one month after the fixator was removed, correction of the deformity.



**Figure 8.** Clinical image one month after the fixator was removed, correction of the deformity.



**Figure 9.** Control X-ray one month after the external fixator was removed.



minimum length achieved was 17 mm and the maximum 25 mm. Therefore, with this technique we obtained appropriate results from the esthetic and healing perspectives. Some authors have reported bone healing of 5, 8, 9 and 10 weeks/cm,<sup>1,2,7,9</sup> but the healing we obtained in our series was 2.9 weeks/cm, without any fractures, angulations or pseudoarthroses. There are many publications about lengthening with callotaxis and single-stage lengthening, but no long-term results have been reported once the patient's development has been completed; at this point one may find shortening of the previously lengthened toe due to the growth of the remaining toes during the patient's development. We need to continue following-up all cases to determine if there is any mechanical complication of the foot, loss of the metatarsal parabola or any other long-term alteration that may modify the normal foot geometry.

### Conclusion

Lengthening of the metatarsals by means of callotaxis using an external fixator is a treatment option that provides appropriate results in the treatment of congenital brachymetatarsia in pediatric and adolescent patients. This study has shown that it is possible to restore the normal anatomy and biomechanics of the developing foot, it is only necessary to achieve a long-term follow up to observe the complications

that may arise as a result of the growth and development of the patients we operated on.

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