

## Distraction osteogenesis of fourth brachymetatarsia



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### ABSTRACT

**Background:** Brachymetatarsia is a rare congenital or developmental condition that results in a short metatarsal. The condition most commonly affects the fourth metatarsal of young and adolescent females. It does not usually produce a functional problem. However, it may produce a significant cosmetic problem especially in young women. The authors present their experience in gradual distraction of the fourth metatarsal to tackle this problem in adults.

**Methods:** That was done using a monolateral frame in 11 feet of female patients with an average age of 23 years. Evaluation depended upon the achievement of the target length, angulation, pain, and satisfaction of the patient.

**Results:** There were eight excellent and three good results after an average follow up of 2.6 years. Aside from nine cases of mild pin-tract infection, complications were few and minor.

**Conclusions:** We recommend distraction osteogenesis as the treatment of choice for brachymetatarsia of the fourth toe.

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### 1. Introduction

Brachymetatarsia is a rare foot condition characterized by a short metatarsal. Brachymetatarsia is diagnosed when one metatarsal ends 5 mm or more proximal to the parabolic arc [1]. A morphofunctional study described the angle of fourth metatarsal shortening or second-fourth angle to enable quantification of the shortening of the fourth metatarsal in brachymetatarsia. Brachymetatarsia is defined as a second-fourth angle of less than 52.2° in males and 50.5° in females [2].

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's syndrome, Down's syndrome, Apert syndrome, and poliomyelitis [3–7]. The idiopathic congenital etiology, which refers to the early closure of the epiphyseal plate, is thought to be the most common [2].

The reported incidence is 0.02–0.05% and the condition is predominant among females at a ratio of 25:1 [8,9]. The fourth metatarsal is most frequently affected followed by the first and the

fifth toes and 72% of these cases occur in both feet [10]. Accompanying hypoplasia of the phalanx, hypoplasia of the soft tissue, brachydactyly, brachymetacarpia, or osteochondromatosis are common [9]. Patients seeking treatment commonly have cosmetic concerns. However, many may also complain of pain in the forefoot or toes, callosities, or problems with shoe wear due to toe alignment and mechanical insufficiency of the short metatarsal [9,11,12].

Conservative treatment consists of accommodative shoe treatment and padding. This treatment regime is often unsatisfactory to the patient, because it does not alleviate the chief complaint of cosmesis [9]. Multiple surgical procedures have been described for brachymetatarsia. The most widely used ones include one-stage elongation with bone graft and gradual elongation by distraction osteogenesis with or without shortening of the adjacent metatarsals and phalanges, and shortening of adjacent metatarsals and phalanges [10,13–15]. Metatarsal lengthening for brachymetatarsia by a hydroxyapatite graft has also been reported [16].

The aim of this case series study was to evaluate the validity of gradual distraction of the fourth metatarsal to tackle this problem in adults.

### 2. Patients and methods

From March 2004 till April 2014, six patients of congenital shortening of the fourth metatarsal were referred to our center

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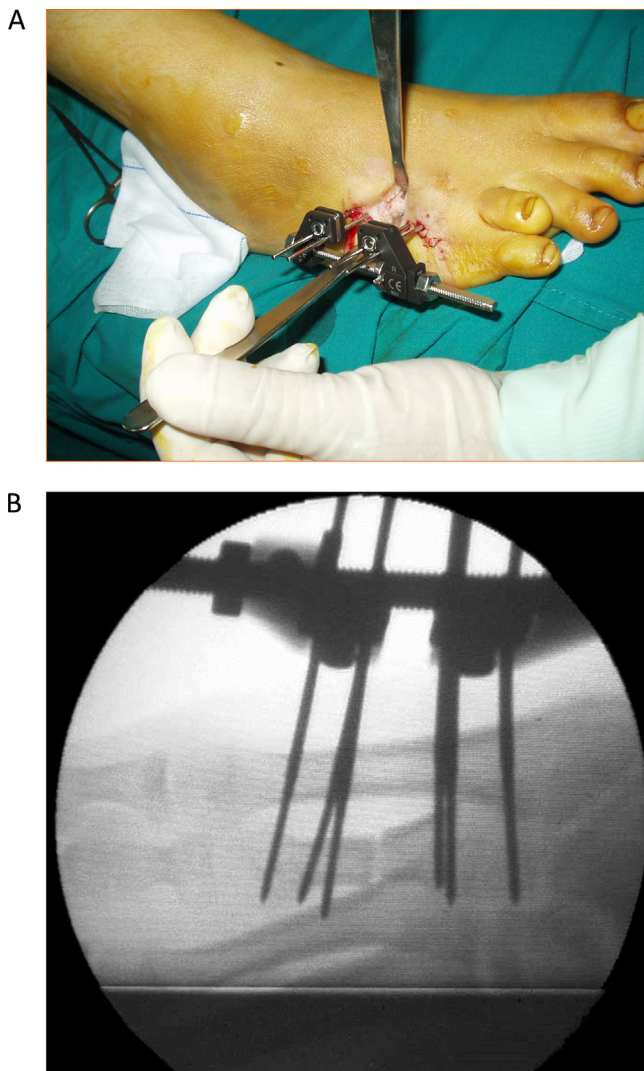
with bilateral brachymetatarsia in five cases [total: 11 feet]. Metatarsal shortening was congenital in all patients. All cases were females. Age of patients ranged from 19 to 30 years [average 23 years]. Shortening ranged from 8 to 24 mm [15–64% of the original length]. The second-fourth angle ranged from 38° to 47° with a mean of 41.7°. There was no functional problem preoperatively. Before surgery, we discussed the procedure in details with the patients. Hence, they became aware of the various complications associated with distraction osteogenesis (e.g., the temporary loss of motion and pin tract infection) and consented to distraction osteogenesis. Surgery aimed at anatomical restoration to recover proper weight bearing and to minimize cosmetic problems. However, the patients were concerned mainly by the cosmetic problem.

### 2.1. Operative technique

The patient was positioned supine on a radiolucent table, and a support was placed under the ipsilateral hip to internally rotate the leg and facilitate access to the lateral foot. Spinal or general anesthesia was used. There was no need for tourniquet use. The lengthening was performed using a rigid minifixator (Penning Fixator), and self-drilling, self-tapping screws with 2 mm

diameter. This frame is unilateral with two proximal and two distal screws placed on the dorsolateral aspect into the proximal metaphysis and the distal metaphysis under fluoroscopic guidance. Sometimes, extra-pins were used. After the application of the screws, the frame was temporarily removed, and osteotomy was performed in the middle third through 1 cm incision (Fig. 1A). Multiple drilling by 1.6 mm K-wire was done before osteotomy. Then the frame was applied. Fluoroscopic imaging was used to check the completeness of osteotomy (Fig. 1B). Sterile gauze and crepe bandage were applied thereafter (Fig. 2A).

The patients were instructed to be non-weight bearing. After a waiting period of 12 days, distraction started at a rate of 0.75 mm/day. Then the rate was modified according to radiographic findings of callus formation and the degree of developing stiffness in the metatarsophalangeal joint. Radiographs were checked every other week to inspect the degree of osteogenesis and joint condition. Distraction was continued until a satisfactory metatarsal length had been achieved (Fig. 2B). After radiographic confirmation of consolidation, guarded weight bearing was initiated. The external fixators were removed when the callus had matured (Figs. 3 and 4). The frame was removed as an office procedure. Evaluation



**Fig. 1.** Intraoperative images. (A) Osteotomy was performed in the middle third through 1 cm incision. (B) Fluoroscopic image to show the completeness of osteotomy.



**Fig. 2.** Postoperative clinical photographs. (A) Postoperative clinical photograph showing brachymetatarsia of the 4th metatarsal with an external fixator applied. (B) Clinical photograph of bilateral fourth brachymetatarsia with right side corrected by external fixator.

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