

A Modified Deformity Correction Method for Congenital Brachymetatarsia of Bilateral Fourth Toe Using an External Fixator

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Learning Point of the Article:

Use of distraction osteosynthesis to correct bilateral brachymetatarsia of the fourth ray and stabilization of the metatarsophalangeal joint using an external rail fixator.

Abstract

Introduction: Brachymetatarsia is a rare congenital deformity characterized by a shortened metatarsal, frequently affecting the fourth ray. It can result in cosmetic concerns, pain, and functional discomfort. While distraction osteogenesis has been widely used, complications, such as joint subluxation remain a concern.

Case Report: A 21-year-old female presented with bilateral congenital brachymetatarsia of the fourth metatarsal, associated with pain and deformity. She underwent gradual lengthening using external rail fixators combined with axial trans-articular K-wire stabilization of the metatarsophalangeal (MTP) joints to prevent subluxation during distraction.

Results: The procedure resulted in satisfactory lengthening (2 cm/metatarsal), restoration of the metatarsal parabola, and full functional recovery of the MTP joints (MTPJ) without subluxation or major complications. Clinical and radiological outcomes were excellent at 6 months post-operatively.

Conclusion: The modified technique combining external rail fixators and trans-articular K-wire stabilization effectively corrected bilateral fourth metatarsal brachymetatarsia. It provided enhanced joint stability during distraction and minimized complications, such as MTPJ subluxation. This approach may be preferred in cases requiring gradual lengthening with structural joint protection.

Keywords: Metatarsal lengthening, external rail fixator, brachymetatarsia, distraction osteogenesis, axial trans-articular K-wire.

Introduction

The rare foot ailment known as brachymetatarsia is characterized by the metatarsals becoming shorter. The reported occurrence is between 0.02% and 0.05%, with female patients outnumbering males by approximately 25:1 [1,2]. It is believed to result from either slowed growth or early fusion of the epiphysis[3]. The toe next to the shortened metatarsal may gradually shift over the adjacent metatarsal as a result. In addition to being congenital and having no known etiology,

brachymetatarsia has been related to a number of systemic disorders, including sickle cell anemia, poliomyelitis, multiple epiphyseal dysplasia, enchondromatosis, Turner's syndrome, Apert syndrome, and Down's syndrome [4,5]. Brachymetatarsia can affect more than one metatarsal and can be present in one foot or both. Reports indicate that over 50% of cases occur in both feet[6]. Typically, the deformity is identified between the ages of 1 and 5. Accompanying features, such as underdevelopment of the phalanx, soft tissue underdevelopment, short fingers, and

Author's Photo Gallery



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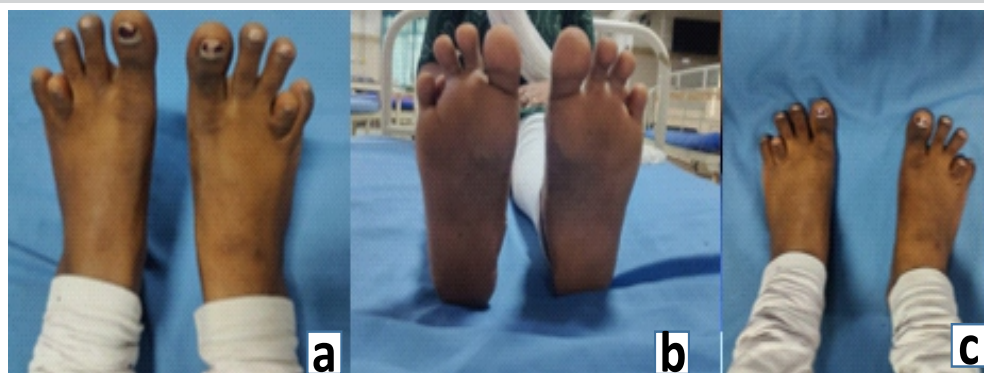


Figure 1: Clinical image taken before surgery. (a-c) Shortening of bilateral fourth metatarsal and fourth proximal phalanx with cock-up deformity.

toes, or osteochondromatosis are typically seen. Patients seek treatment, often concerned about their appearance. Nonetheless, many experience discomfort in the front of the foot or toes, calluses, or difficulties with footwear due to toe alignment issues[7]. There have been numerous surgical methods reported for addressing brachymetatarsia. The techniques include acute lengthening with plates and grafts and sequential lengthening through distraction osteogenesis[8]. All the methods require the use of pins to stabilize the metatarsophalangeal (MTP) joint during the lengthening process; however, no technique has been specified[9]. This article describes a variation on the distraction osteogenesis method that prevents MTP joint (MTPJ) subluxation by incorporating an axial wire into MTP joint. The benefit of this approach is the increase in structural stability, avoiding setbacks and complications.

Case Report

A 21-year-old female patient complained of deformity of both feet since her childhood associated with pain. The patient had undergone conservative modalities, such as orthotics, medical

treatments, and insoles. The patient took physiotherapy with lifestyle modifications but had no pain relief. The patient felt that her feet were esthetically unpleasing (Fig. 1a and b). The patient was clinically evaluated and had shortening of bilateral fourth toes (Fig. 1a and b), tenderness over the bilateral fourth metatarsal ray, cock-up deformity over bilateral fourth toes, and sulcus sign over the plantar aspect of bilateral fourth

toes. The patient had no comorbidities. The patient was evaluated for any associated syndromes and found to be negative. Pre-operative blood investigations and anesthesia fitness for surgery were obtained. A pre-operative plan was made using a bilateral foot X-ray. Anteroposterior and oblique views showed a 2-cm shortening in both fourth metatarsals (Fig. 2a, b) and a 5-mm shortening of the bilateral proximal phalanx (Fig. 2a, b) and malalignment of the Lelièvre parabolic arch [10] (Fig. 2c). A diagnosis of congenital bilateral brachymetatarsia of the fourth metatarsal was made. The patient was planned for lengthening of bilateral metatarsals using distraction osteogenesis with an external rail fixator[11,12].

Surgical technique

Under sterile aseptic precautions, under spinal and epidural anesthesia, the patient was positioned supine, and the parts were painted and draped. Skin markings for the extent of the fourth metatarsal were made under an image intensifier (Fig. 3a). A K-wire was passed into the fourth toe to immobilize the

MTPJ to prevent dislocation (Fig. 3a, b, c, d, e)[13]. A 4cm skin incision was made along the fourth metatarsal extent (Fig. 3b). Subcutaneous tissue was cut and retracted. The extensor digitorum longus tendon was visualized and retracted. Four Schanz pins of size 2.5 mm were inserted (two proximally and two distally) (Fig. 3b). An osteotomy was performed after the circumferential drilling of the metatarsal shaft with a 1.5 mm K-wire with one entry and

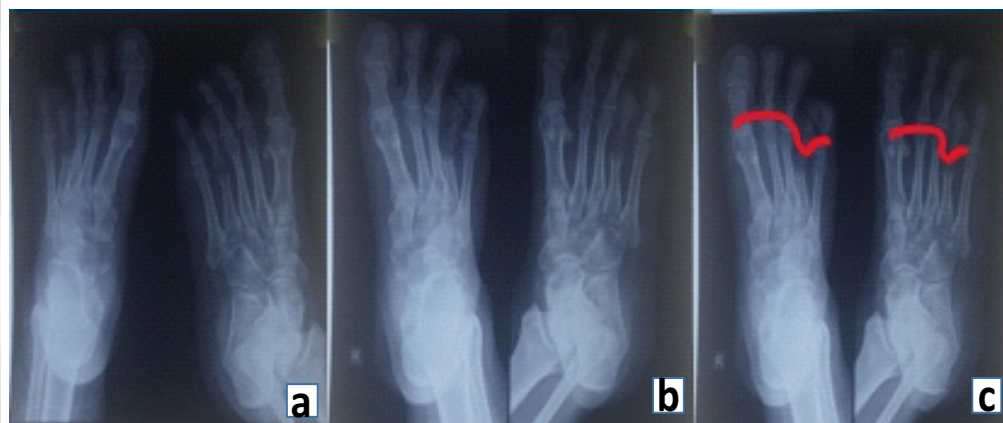


Figure 2: Pre-operative X-ray. (a) Anterior posterior and oblique view of left foot with short 4th metatarsal and fourth proximal phalanx. (b) Anterior posterior and oblique view of the right foot with a short 4th metatarsal and fourth proximal phalanx. (c) Parabola not maintained.

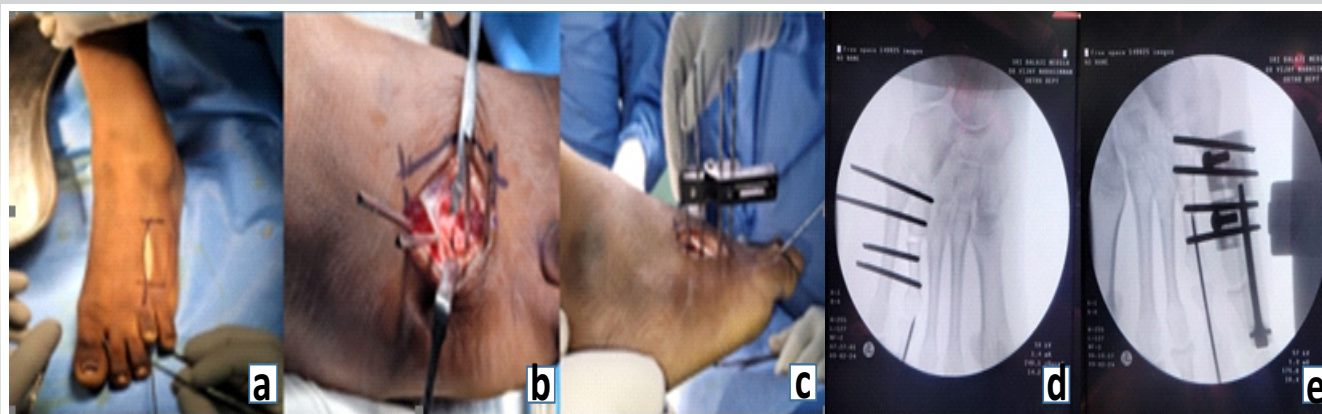


Figure 3: Intraoperative images. (a) Incision marked and K wire fixed from tip of fourth distal phalanx. (b) Osteotomy of fourth metatarsal done along with schanz pins. (c) External rail fixator fixed. (d and e) Intraoperative image intensifier images.

three exits. The external fixator was attached to the Schanz pins (Fig. 3c). Skin was closed in layers, and a sterile dressing was applied [14]. (Fig. 4 & 5).

Post-operative management and assessment

Post-operative management with analgesics and antibiotics was started. Pin sites were regularly dressed to prevent post-operative infections. The patient was advised to be strictly non-weight bearing after surgery. Ten days post-operatively, the patient was given time for soft tissue healing and swelling to reduce. Distraction of the metatarsal was started with 0.25 mm twice daily. X-rays were taken every 10 days to check for callus formation, bone alignment, and MTPJ stability. Distraction was conducted for 40 days, with X-ray showing regeneration of 2 cm along with callus and satisfactory arch of parabola connecting all metatarsal heads (Fig. 6a, b). The external fixator was removed after 2 months (Fig. 7a, b). After the fixator was removed and time was given for the callus to gain satisfactory strength, the patient was mobilized with full weight-bearing on day eighty [15].

Discussion

Brachymetatarsia, though rare, can lead to both functional and esthetic concerns, especially when bilateral and symptomatic. The fourth metatarsal is the most frequently affected, and treatment is warranted in cases of pain, deformity, or patient-driven cosmetic dissatisfaction [1-3]. Among available surgical options, distraction osteogenesis is increasingly favored due to its ability to achieve gradual lengthening without bone grafts [12]. This method, originally described by Kawashima et al. allows for controlled soft tissue adaptation and minimization of neurovascular complications [16]. However, it carries risks, such as MTPJ subluxation, pin tract infection, and delayed union [9]. In our case, a modified technique using external rail fixators with axial trans-articular K-wire stabilization was employed. This approach ensured stability of the MTPJ during the distraction phase and helped maintain alignment of the regenerating segment, a modification supported by Peña-Martínez et al. [1], who reported improved outcomes with joint stabilization during lengthening [13]. Compared to acute

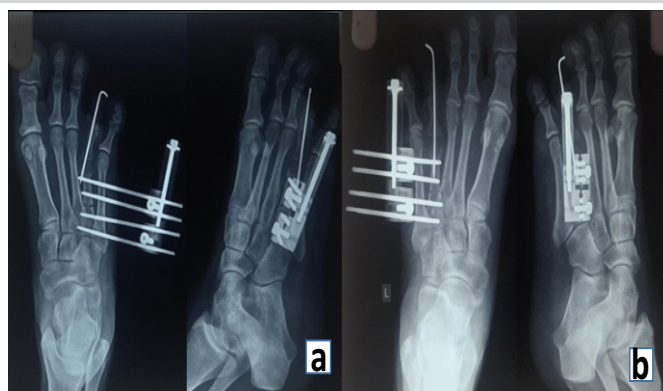


Figure 4: Immediate post-operative X-ray. (a) Left foot anterior posterior view and oblique view. (b) Right foot Anterior posterior view and oblique view.



Figure 5: One month post-operative. (a) Left foot anterior posterior view and oblique view with distraction. (b) Right foot anterior posterior view and oblique view with distraction.

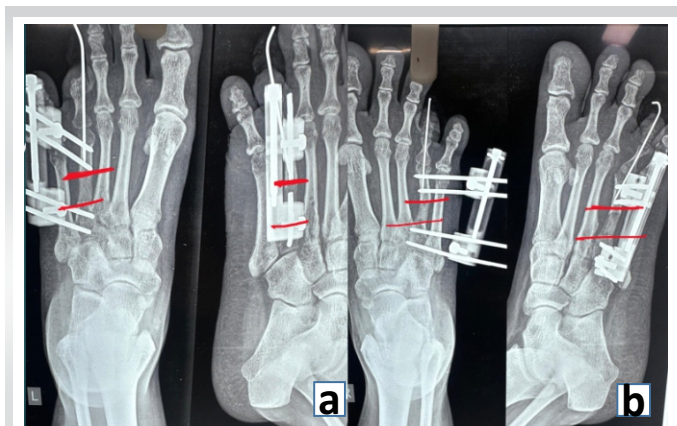


Figure 6: Fifty days post-operative. (a) Left foot anterior posterior view and oblique view with callus formation in the distracted phalanx after 50 days. (b) Right foot anterior posterior view and oblique view with callus formation in the distracted phalanx 50 days.

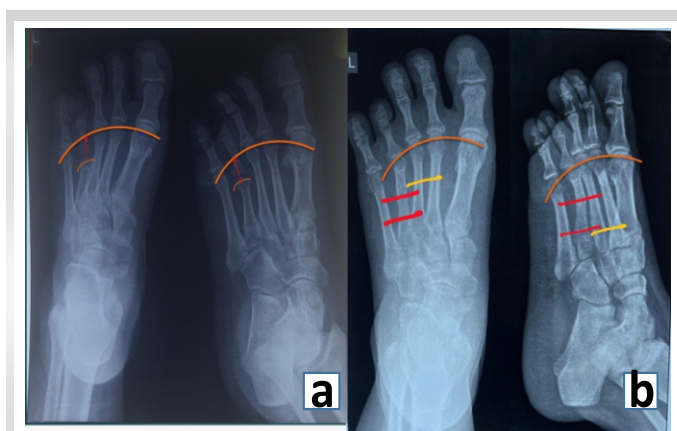


Figure 8: X-ray after 6 months. (a) Left foot anterior posterior view and oblique view with metatarsal lengthening of 2 cm. (b) Left foot anterior posterior view and oblique view with arch of parabola achieved with metatarsal lengthening of 2 cm.

lengthening methods, which can achieve immediate correction but carry a higher risk of ischemia and graft complications [9], distraction osteogenesis enables more predictable biological regeneration [15]. Baek and Chung have shown that gradual distraction results in fewer complications and better cosmetic outcomes in multi-ray deformities [11]. Nonetheless, callotaxis is not devoid of complications. Masada et al. documented premature consolidation and MTPJ stiffness as frequent drawbacks [3]. Our use of a trans-articular K-wire likely contributed to the prevention of these issues in this case. Moreover, the incorporation of the Lelièvre metatarsal parabola concept guided the endpoint of distraction to restore functional forefoot geometry [10]. The results were clinically and radiologically satisfactory, with restored alignment, joint mobility, and complete resolution of the patient's pain and deformity. No MTP subluxation, pin site infection, or hardware failure was observed, aligning with outcomes reported by Shim and Park [12]. This technique presents a reproducible and safe alternative for managing bilateral brachymetatarsia, particularly

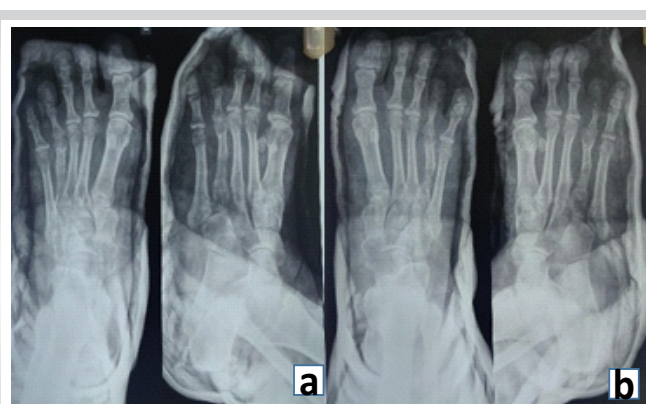


Figure 7: Post-exit X-ray after 2 months. (a) Left foot anterior posterior view and oblique view with callus formation in the distracted phalanx after external fixator exit. (b) Right foot anterior posterior view and oblique view with callus formation in the distracted phalanx after external fixator exit.

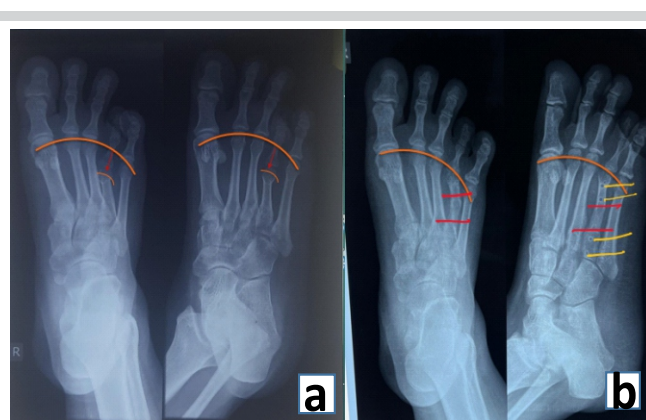


Figure 9: X-ray after 6 months. (a) Right foot anterior posterior view and oblique view with metatarsal lengthening of 2 cm. (b) Right foot anterior posterior view and oblique view with arch of parabola achieved with metatarsal lengthening of 2 cm.

in young adults with high cosmetic expectations and good bone healing potential.

Results

The patient's primary complaint of pain was treated as the parabolic arch of the metatarsal head (Fig. 8a, b and 9a, b-b) was restored, along with a lengthening of 2 cm. After removal of the external fixator (Fig. 10a, b, c, d), the patient was pain-free and functionally restored.

Conclusion

Bilateral congenital brachymetatarsia can cause significant functional limitations and psychosocial discomfort. Distraction osteogenesis offers a safe and effective method for gradual lengthening of the metatarsal, allowing both bone and soft tissue to adapt. Our case demonstrates that with proper planning, including joint stabilization using trans-articular K-wires, excellent radiographic and clinical outcomes can be



Figure 10: (a-d) Clinical images after deformity correction. Here the cock-up deformity is corrected along with full restoration of movements in fourth metatarsophalangeal joint.

achieved with minimal complications. This technique remains a preferred approach for managing symptomatic brachymetatarsia, especially in patients concerned about cosmetic restoration and foot function.

Clinical Message

Distraction osteogenesis remains the best method for lengthening procedures using various external fixators and reducing neurovascular complication rates associated with lengthening procedures.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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