



Distraction Osteogenesis for Brachymetatarsia

Clinical Results and Implications on the Metatarsophalangeal Joint

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INTRODUCTION

Brachymetatarsia (congenital shortening of the metatarsal [MT]) results in deformity, psychological dysphoria and potential transfer metatarsalgia. Surgical management requires lengthening to restore the parabolic arch (Figure 1) and the length of the MT, to normalize load transfer and improve appearance. Distraction osteogenesis (DO) using external fixation has revolutionized the management of brachymetatarsia, yet not without complications (30%-100% incidence), the most common of which involves the metatarsophalangeal (MTP) joint.

The aim of this study was to answer the following questions:

- 1- What are the clinical outcomes of DO for brachymetatarsia?
- 2- What are the complications particularly related to the MTP joint?
- 3- Does the method for stabilizing the MTP joint affect the outcome?

Figure 1: Anteroposterior (AP) radiograph of the foot. The dotted lines demonstrate the metatarsal head parabola in a. normal foot and b. disruption of this parabolic arc in a patient with first and fourth brachymetatarsia. The yellow lines represent the distance required to achieve an ideal parabola by distraction osteogenesis. c. Clinical photograph of the foot of the patient in a standing position demonstrating the first and fourth brachymetatarsia.



MATERIAL AND METHODS

Retrospective review of 44 MTs in 27 patients (2 males, 25 females), mean age 37.09 ± 13.98 years, who had undergone DO in our institution by the two most senior authors were included in this study. Lengthening was done at a rate of 0.5mm/day. Regarding MTP stabilization; 43% were fixed with K-wire pinning across MTP joint, 32% with pinning of phalanges short of MTP and attaching the K-wire to the external fixator, 7% by pinning of phalanges and distraction arthroplasty of the MTP (Figure 2), 2% no stabilization and 16% by other methods. Time to follow up was 14.71 ± 20.34 months. Clinical outcomes were analyzed by administering a non-validated 9 item questionnaire at the latest follow up visit. In addition, complications, particularly pertaining to the MTP joint were recorded from chart review and postoperative radiographs at the same time points. Statistical significance was set at $p < 0.05$.

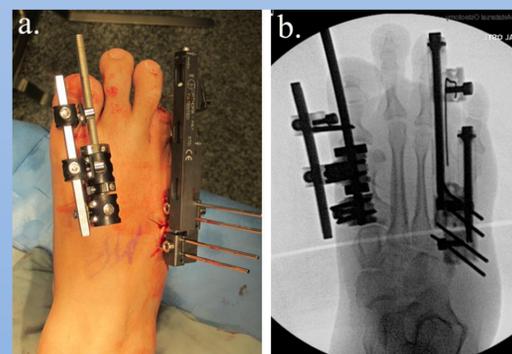


Figure 2: Intraoperative a. clinical photograph and b. fluoroscopic image of the mini-external fixators after application to the affected first and fourth metatarsal in the same patient. The first MTP has been spanned with an additional external fixator to distract the joint. The 4th MTP has been pinned with a K-wire attached to an additional external fixator as well.

RESULTS

Preoperatively, there was MT shortening of 13.2 ± 3.51 mm or $28.96 \pm 9.04\%$ in relation to the normal MT length. Postoperatively, MT length increased from 46.34 ± 4.89 mm to 59.30 ± 5.10 mm with an increase of 12.98 ± 3.74 mm ($p < .0001$). Time to healing was 3.83 ± 2.5 months with a mean healing index of 3.32 ± 2.4 month/cm. The parabola was restored in 75% cases (Figure 3). There were no MT nonunions or refractures. Regarding complications of the MTP joint, 74% of patients experienced MTP stiffness, 32% had MTP subluxation and 8% had MTP dislocation requiring additional surgery in 6/44 cases. There were no significant differences in the rate of complications by MTP fixation method. There was a significant difference in the proportion of patients who felt comfortable wearing open toe shoes in public ($p < .0001$) and standard shoes ($p < 0.022$) after surgery compared to before surgery. Toe stiffness after surgery was reported by 40% of patients. Improved or same function was reported by 85% of patients. Satisfaction with surgery and claim that they would do it again was reported by 95% of patients.

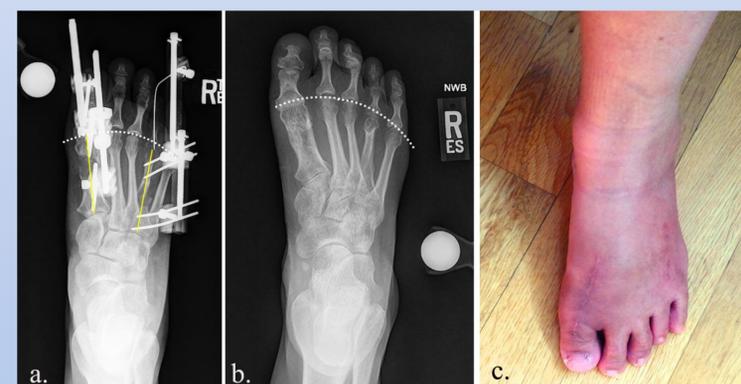


Figure 3: a. Anteroposterior (AP) radiograph of the foot 4 weeks post-operatively. The yellow lines represent the mid-diaphyseal lines of the 1st and 4th MTs extending towards the most proximal and distal ends for MT length measurement. The radiograph demonstrates achievement of planned first metatarsal length where the 1st MT head lies on the MT head parabolic arc. The fourth MT was found to be 3 mm short and distraction was resumed. Note the K-wire transfixing the 4th MTP joint. This wire was removed 4 weeks later (8 weeks post-operatively). b. Final AP radiograph of the patient's foot 8 months post-operatively showing complete consolidation of the bone regenerate and almost complete restoration of the MT parabolic arc. The 4th MT was 1.5 mm short of the arc but c. the clinical appearance of the 4th toe had an ideal cosmetic outcome. She had mild residual stiffness of both 1st and 4th MTP joints 1 year post-operatively.

CONCLUSIONS

Distraction osteogenesis is an effective treatment option for brachymetatarsia, with high patient satisfaction rates despite problems. The most commonly reported complication was MTP stiffness, which concurs with what was previously reported in the literature. MTP dislocation was successfully managed with further surgery. There was no significant difference in the rate of MTP-specific complications by MTP fixation method, likely due to the small sample size per method of fixation. Larger patient numbers with longer follow up periods are still required for further validation of the optimum method of MTP stabilization.

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