CHAPTER **18**

CALLUS DISTRACTION OF THE FIRST METATARSAL

J. Christopher Benson, DPM

INTRODUCTION

Callus distraction has been used for the correction of a variety of long bone deformities for many years.[1,2] It has most often been done for the treatment of 4th metatarsal congenital brachymetatarsia.[3-14] Brachymetatarsia may also be present in the first metatarsal through a congenital deformity, or more frequently, as the result of previous surgery or a traumatic event. This shortened first metatarsal has been a documented source of lesser metatarsalgia and other problems related to forefoot symptomatology.[15-18] Restoration of anatomic metatarsal length may be a consideration in patients with a significantly shortened first metatarsal. There are several surgical options one may employ to gain this necessary length. These include lengthening osteotomies, bone grafting, and callus distraction. This article will focus on the author's technique used to perform callus distraction osteogenesis on a first metatarsal.

PROCEDURE

A uniplanar, non-hinged external fixator is often used for this procedure. The device the author uses is the Orthofix M-100 external fixator (Orthofix, Inc., McKinney, TX) (Figure 1). It provides distraction in a single plane and uses a 2.0 mm diameter pin that resists bending under the necessary stresses of this process.

The fixator is applied by driving 4 parallel threaded pins into the metatarsal. The pins may be inserted following surgical exposure of the metatarsal through a dorsal incision or may be placed percutaneously. It can be helpful to use the pin slots on the fixator as a guide to keep these pins parallel. Two pins are inserted distal to the osteotomy, and 2 proximal. The pins are usually inserted prior to the osteotomy being performed because the metatarsal is more stable at this time. If done through an open incision, special care should be taken to preserve the periosteal layer surrounding the osteotomy site.

Developing a periosteal envelope around the osteotomy allows for closure of this layer, which enhances the regeneration of bone (Figure 2).[19,20] The osteotomy should be performed at the proximal metaphysis due to the increased vascularity of the bone in this area. The wider diameter of the bone also gives increased stability and a larger surface area for later osteogenesis. Once the osteotomy is

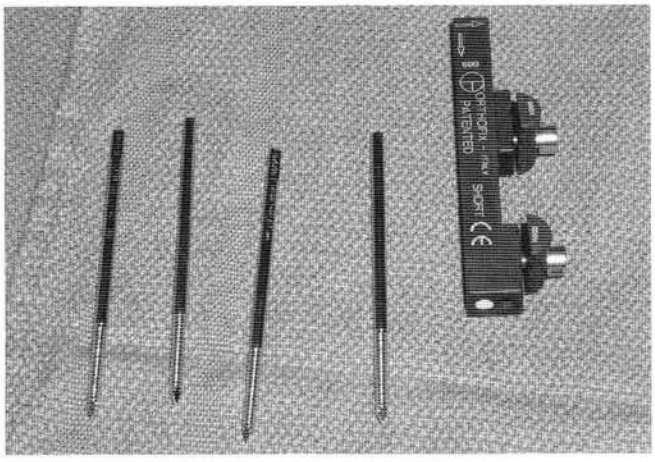

Figure 1. Orthofix M-100 external fixator (Orthofix, Inc., McKinney, TX).

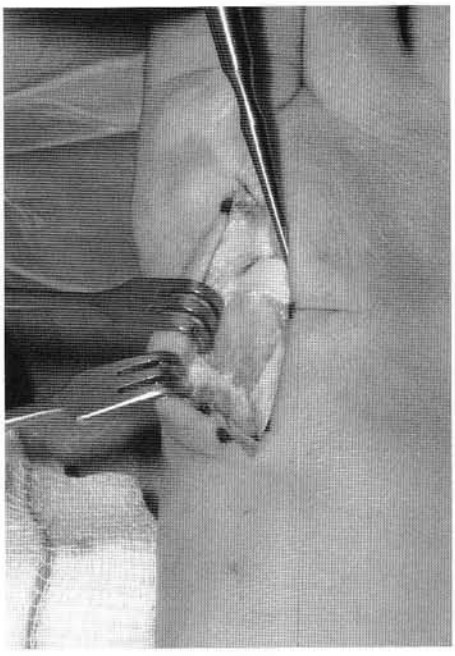

Figure 2. Periosteal envelope around the osteotomy.

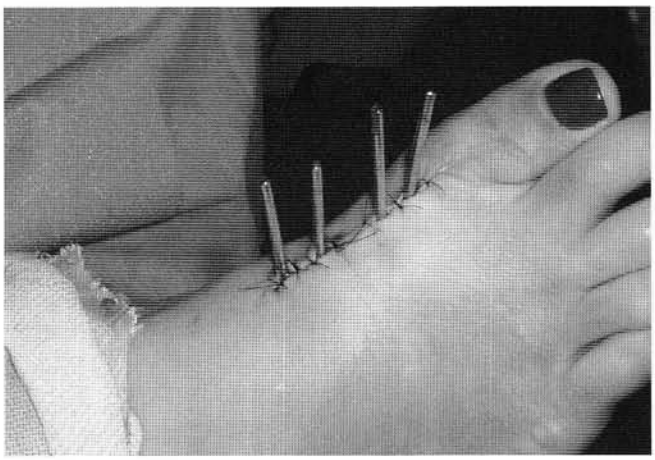

Figure 3. Wound closure is completed prior to attaching the external fixator.

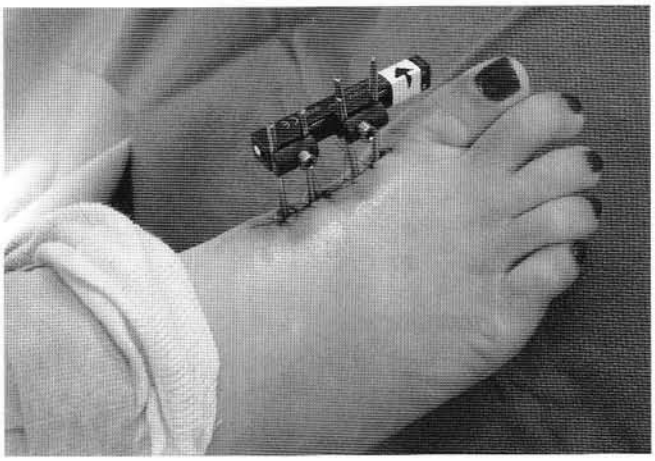

Figure 4. External fixator attached and arrow placed to help the patient to know which way to turn the device.

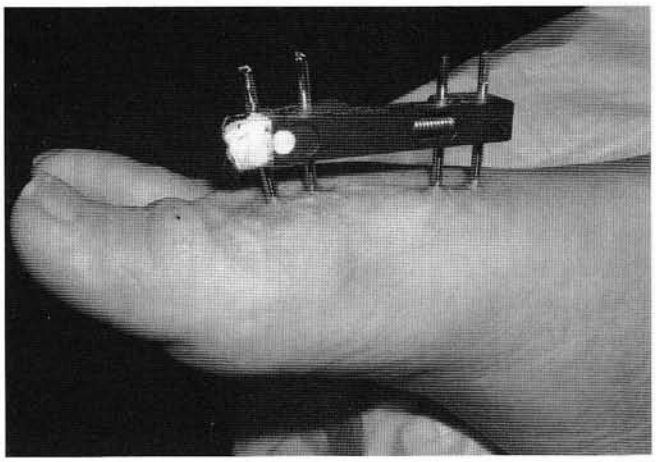

Figure 5. External fixator prior to removal.

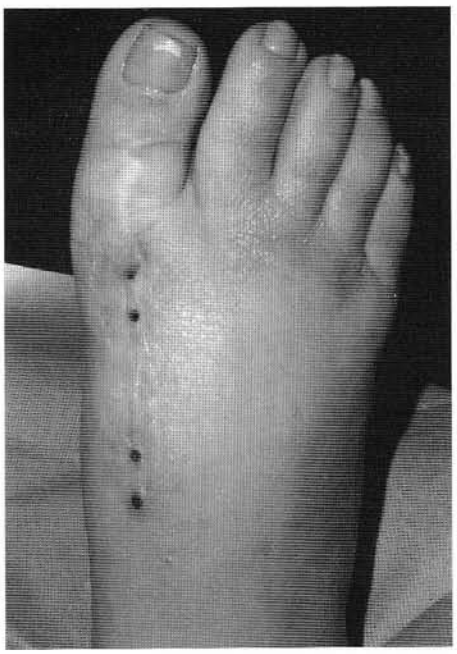

Figure 6. External fixator removed.

completed, wound closure is completed prior to attaching the external fixator onto the 4 pins. This makes the wound closure easier, as the surgeon only has to suture around the pins without the additional interference of the fixators (Figure 3).

Once the fixator is tightened to the pins, the osteotomy is compressed and the distraction process is delayed for approximately 10-14 days. It is during this time period that the soft bone callus forms. If the metatarsal is distracted prior to the formation of this soft callus, osteogenesis is interrupted and bone healing will not occur. After this postoperative latency period it is time to begin distraction. It is often helpful to the patient to make an arrow on the fixators to show them which way to turn the device (Figure 4). This can be an area of confusion for the patient and has the potential to jeopardize the outcome of the whole process. The author suggests a rate of distraction of 0.25 mm (one quarter turn) every 8 hours.

Once the appropriate metatarsal length has been gained, the distraction process is discontinued and the external fixation device is left in place until osseous consolidation has occurred. This generally takes approximately 6-8 weeks, but can vary with each patient. The fixator can be easily removed under a local anesthetic (Figures 5, 6). Weightbearing is delayed until radiographs show bony consolidation.

CASE STUDY

A 59 year-old female presented with a chief complaint of significant pain below the second metatarsal head of her right foot as well as pain in her first metatarsophalangeal joint (Figure 7). This pain was limiting her weightbearing activity. She had undergone previous placement of a stemmed silastic implant in her first metatarsophalangeal joint approximately 10 years earlier.

Due to the sub-second metatarsal head pain and the radiographs showing failure of the implant, it was felt that a first metatarsophalangeal joint arthrodesis would be the appropriate procedure to perform. Unfortunately, the radiographs also displayed an already shortened first metatarsal that would be left even shorter following joint arthrodesis preparation. With all of this information it was deemed that callus distraction would be the most effective means of achieving correction. Callus distraction was performed following a proximal metaphyseal osteotomy and application of an Orthofix M-100 external fixator. Following a 10-day latency period, distraction was initiated at a rate and frequency of 0.25 mm, 3 times a day. After 23 days of distraction the patient achieved a total increase in length of 17 mm. The fixator was left on for approximately 6 weeks after the distraction process was halted. Once the external fixator was removed the patient remained nonweightbearing for 2 more weeks and then was transitioned to full weightbearing as tolerated. The patient has had the fixator off for approximately 2 months, has rehabilitated this extremity and is scheduled for a first metatarsophalangeal joint arthrodesis in the very near future.

Figure 7A. Preoperative AP radiograph.

Figure 7B. Preoperative lateral radiograph.

Figure 7C. Intraoperative AP radiograph after application of fixator and osteotomy.

Figure 7D. Intraoperative lateral radiograph after application of fixator and osteotomy.

Figure 7E. Postoperative AP radiograph at 1 month during the callus distraction process.

Figure 7F. Postop AP radiograph at 2 months following distraction process. The external fixator is left on for stabilization.

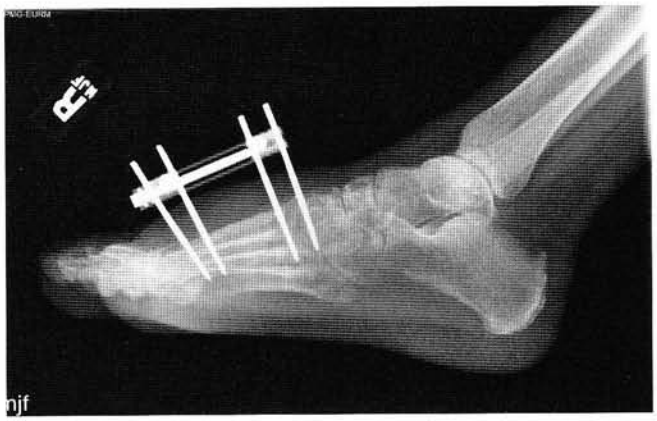

Figure 7G. Postoperative lateral radiograph at 2 months following distraction process

Figure 7H. Postoperative AP radiograph at 4 months. Full consolidation of first metatarsal callus distraction site. Now ready for implant removal and arthrodesis of first metarsophalangeal joint.

REFERENCES

1. Grill F. Correction of complicated extremity deformities by external fixation. *Clin Orthop* 1989;241:166.
2. Vidal J. External fixation: yesterday, today, tomorrow. *Clin Orthop* 1983;180:7-14.
3. Magnan B, Bragantini A, Regis D, et al. Metatarsal lengthening by callostasis during the growth phase. *J Bone Joint Surg Br* 1995;77:602-7.
4. Masada K, Fujita S, Fuji T, et al. Complications following metatarsal lengthening by callus distraction for brachymetatarsia. *J Ped Ortho* 1999;19:394-7.
5. Wakisaka T, Yasui N, Kojimoto H, et al. A case of short metatarsal bones lengthened by callus distraction. *Acta Orthop Scand* 1988;59:194-
6. Saxby T, Nunley JA. Metatarsal lengthening by distraction osteogenesis: a report of two cases. *Foot Ankle Int* 1992;13:536-9.
7. Ferrandez L, Yubero J, Usabiaga J, Ramos L. Congenital brachymetatarsia: three cases. *Foot Ankle* 1993;14:529-33.
8. Masuda T, Matoh N, Nakajima T, Tomi M, Ohba K. Treatment of brachymetatarsia using a semicircular lengthener. *Acta Orthop Scand* 1995;66:43-6.
9. Levine SE, Davidson RS, Dormans JP, Drummond DS. Distraction osteogenesis for congenitally short lesser metatarsals. *Foot Ankle* 1995;16:196-200.
10. Fox IM. Treatment of brachymetatarsia by the callus distraction method. *J Foot Ankle Surg* 1998;37:391-5.
11. Oh CW, Satish BR, Lee ST, Song HR. Complications of distraction osteogenesis in short first metatarsals. *J Ped Orthop* 2004;24:711-5.
12. Choi HI, Chung MS, Baek GH, Cho TJ, Chung CY. Metatarsal lengthening in congenital brachymetatarsia: one-stage lengthening versus lengthening by callotasis. *J Pediatr Orthop* 1999;19:660-4.
13. Kim HT, Lee SH, Yoo CI, Kang JH, Suh JT. The management of brachymetatarsia. *J Bone Joint Surg Br* 2003;85:683-90.
14. Song HR, Chang-Wug O, Hee-Soo K, Sung-Jung K, Guille JT, Sung-Man L, et al. Fourth brachymetatarsia treated with distraction osteogenesis. *Foot Ankle Intl* 2003;24:706-11.
15. Wilson DW. Hallux valgus and rigidus. In: Helal B, Wilson D, editors. The foot. London: Churchill Livingstone;1988. p. 411-33.
16. Viladot A Sr. The Metatarsals. In: Jahss MH, editor. Disorders of the foot and ankle, medical and surgical management. 2nd edition. 1991,pgs 1229-1268, Philadelphia: WB Saunders; 1991. p. 12290-68.
17. Reynolds JC. Metatarsalgia. In: Gould JS, editor. The Foot book. Gould JS, ed, Baltimore: Williams and Wilkins; 1988. p. 219-27.
18. Mann RA, Coughlin MJ. Adult hallux valgus. In Coughlin MJ, editor. Surgery of the foot and ankle. 6th edition.St. Louis, Mosby; 1993. p. 167-296.
19. Shevtsov VI. Professor GA Ilizarov's contribution to the method of transosseous osteosynthesis. *Bull Hosp Jt Dis* 1997;56:11.
20. Ilizarov GA, Frankel VH. The Ilizarov external fixator, a physiologic method of orthopaedic reconstruction and skeletal correction; a conversation with Prof. GA Ilizarov and Victor H Frankel. *Orthopaedic Rev* 1988;17:1142.