CHAPTER **27**

# BRACHYMETATARSIA REPAIR WITH CALCANEAL AUTOGRAFT

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## INTRODUCTION

Brachymetatarsia is described as a developmentally arrested growth of one of the metatarsals in the foot. Multiple metatarsal arrests in the same foot is termed brachymetapodia. The condition can also occur in the upper extremity but to a more limited frequency. A familial pattern of inheritance can be seen, and is more common in female patients. With the metatarsal's growth being arrested, the ray never develops a normal size and shape. Not only is there arrested growth in the metatarsal; the adjacent toe bones typically do not develop to the usual length and width of a normal digit. The length aberration of the metatarsal impacts the parabolic alignment of the forefoot, and the adjacent digit typically rests dorsally elevated on the foot and is unable to purchase the ground. A plantar longitudinal cleft or furrow in the skin is seen beneath the short metatarsal.

Patients typically have 2 reasons for seeking medical attention – functional limitations and/or cosmetic concerns. Shoe pressure can cause pain due to malalignment of the toe, plantar adjacent metatarsals can bear extra load and lead to pressure pain or callosities, and cosmetically the toe is not in a normal position.

A variety of procedures have been described to treat brachymetatarsia. Recent interest in callus distraction via external fixation has shifted surgical attention away from more traditional methods of repair utilizing bone grafting techniques. Bone grafting, either with autograft or allograft, has been utilized for many years with acceptable results, both functionally and cosmetically. Callus distraction has gone through a zenith and nadir and the asymptote seems to be leveling-off, somewhat dependent on the length of bone correction needed.

Most brachymetatarsia require 1.0-2.0 cm of lengthening to achieve the desired functional and cosmetic results. Aggressive, acute lengthening of a metatarsal or digit is not without the risk of vascular compromise due to constriction of vascular structures. There is also a limit to the amount of correction that can be achieved in one setting. Slow lengthening, as afforded with external fixation and callus distraction, has the benefit of avoiding acute vascular insult since the vessels can accommodate the stretch and avoid vasospastic events. Greater length can also be achieved via callus distraction than with a single-setting implanted bone graft.

Although in theory callus distraction appears to be a more desirable technique, complications are common with this technique, and the process is cumbersome for both the patient and surgeon. Proper alignment of the distal direction of the metatarsal is not guaranteed. Pressure on the MP joint can lead to early arthritis. Dislocation of the toe is possible. Pin track infection is always a concern, and timely callus conversion to cortical bone is unpredictable. Most notable of the undesirable effects of callus distraction is the poor quality of the scar tissue. The slow plowing of the pins through the thin skin on the dorsum of the foot leads to hypertrophic scars, which frequently need scar revision surgery.

## TECHNIQUE

The authors' technique employs the harvesting of a section of the patient's calcaneus that is implanted into the metatarsal osteotomy site. The sequence of procedures is deliberate in that the osteotomy is first made in the metatarsal. Location of the osteotomy in the metatarsal is not critical, however, the authors prefer the proximal half of the metatarsal, to avoid aggressive manipulation of the tissues near the digit, and since the proximal metaphysis of the metatarsal closely resembles the quality and texture of the transplanted bone graft. The osteotomy in the metatarsal is made prior to harvesting the autograft, to allow the osteotomy site to be gradually stretched, providing the desired length for placement of the bone graft. A lamina spreader is used to stretch the periosteal tissue while the bone graft is harvested.

The choice for graft harvest is the posterior superior lateral aspect of the calcaneus, between the subtalar joint and the Achilles tendon insertion. Access to this site does not require a change in patient position on the operating table. The site provides desirable quality bone with both

cortical and cancellous components. The harvest site does not leave any significant weakness in the bone and does not require allograft back-filling. The incision is made just posterior and parallel to the sural nerve on the lateral side of the foot. Dissection is carried to the deep fascia and periosteum, which is longitudinally incised to expose the bone. A bone saw is used to make parallel anterior and posterior cuts, perpendicular to the dorsal cortex of the calcaneus. The depth of the cuts is approximately 1.5 cm, and the anterior-posterior length determines the length of the repair at the metatarsal osteotomy site. Typically, a 1.0 – 1.5 cm length is harvested. A curved osteotome is used to break the dorsal cortex, with care to achieve a thick section of cortical and cancellous bone.

Once harvested, the bone is skewered onto a 1.6 mm smooth Kirshner-wire, in line with the axis of the desired length, centered within the bone such that the cortex will be placed dorsally in the metatarsal osteotomy site. This allows for easy handling of the bone graft. Periodically, while the bone graft is being harvested, the lamina spreader in the metatarsal osteotomy site is stretched. By the time the calcaneal bone graft is harvested, ample distraction is achieved at the metatarsal osteotomy site. The K-wire is then driven from the distal end of the osteotomy site distally out the metatarsal, through the MP joint and the toe, out the distal end of the toe. The wire is pulled distally out the toe until the wire is at the proximal side of the bone graft. The bone graft is rotated so that the cortex is in line with the dorsal cortex of the metatarsal. A small straight osteotome is then inserted between the proximal end of the bone graft and the proximal end of the metatarsal osteotomy site. The osteotome is used to "joy-stick" the bone graft into place, pulling the osteotome from proximal to distal, and once the bone graft is in line with the proximal cortex of the metatarsal, the osteotome is removed. Final adjustments are made to center the proximal bone graft on the proximal metatarsal, and the K-wire is then driven proximally into the base of the metatarsal. It is acceptable to cross the K-wire into the cuboid, if so desired, for additional bone purchase and stability of the K-wire. The wire is then bended and cut to desired length near the tip of the toe. Primary closure of the wounds is then performed with absorbable suture. The foot is bandaged and a well-contoured, fiberglass short-leg cast is applied.

Postoperative management requires no weight bearing on the surgical limb for 12 weeks, and the original cast is left in place for the duration of this time, assuming that there is not excessive hemorrhage or concerns regarding infection or vascular compromise to the toe. The patient is seen one week following the surgery, and questioned regarding pain and constitutional symptoms to suggest infection. If the toe has good capillary refill and sensation, then the patient is instructed to return monthly until the cast is removed. At 12 weeks the cast is removed and radiographs are obtained. If adequate cortication is visible on the radiographs, the wire is removed and transitional weightbearing is initiated in a cam walker boot, allowing the patient to add 10% more body weight to the foot each day. Repeat radiographs are taken 2 weeks later (week 14) and if the bone graft is incorporating and remodeling to a sufficient degree, then transition to a shoe is begun. The patient is seen 2 weeks later (week 16) and repeat radiographs are compared with prior films. Most patients are then able to resume light exercise and gradual increase in load-bearing activities. Patients are again evaluated six and 12 months following surgery.

## PARABOLA CONTROL

Adjacent digits are assessed regarding length and deformity. After the bone graft is in place and the final length of the digit is apparent, additional procedures are done as needed to improve the comparative appearance of the adjacent digits. If the fourth toe is shorter or of equal length to the fifth toe, a simple arthroplasty of the PIP joint of the fifth toe will allow for a more normal appearing toe parabola.

## DISCUSSION

Compared with callus distraction and external fixation, the authors find that there is equal ability to achieve the desired length with either technique. The one-stage approach with bone graft has the benefit of avoiding constant maintenance required with external fixation and the pin track concerns regarding inflammation or infection. The appearance of the scar is far superior with bone grafting as compared with callus distraction. Bone grafting is not without potential complications. Sural nerve entrapment or neuritis are possible, although this has not occurred in the cases presented. Bone grafting requires an additional procedure while external fixation is more costly, not only financially but in terms of patient and physician labor. With regard to length of time to heal, both procedures require a 3-4 month window to achieve sufficient bone strength to support unprotected ambulation. All else being equal, we find that a one-stage repair with bone graft is more predictable in outcome and offers a more acceptable cosmetic scar than callus distraction with external fixation.

## SURGICAL TECHNIQUE

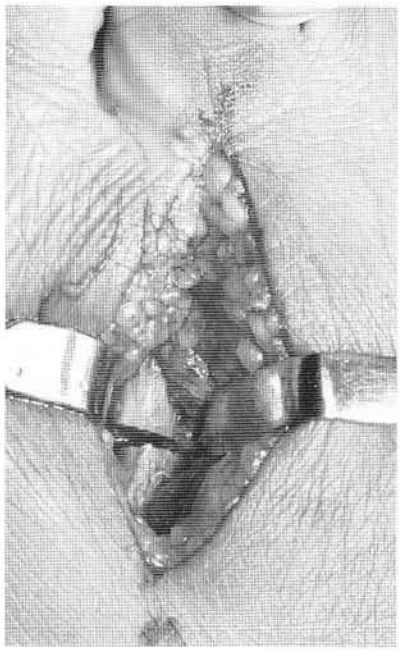

Figure 1. Dorsal incision and proximal metaphyseal osteotomy.

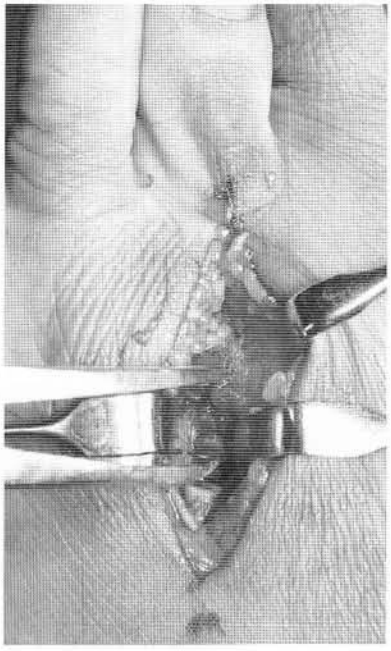

Figure 2. Lamina spreader stretching osteotomy site.

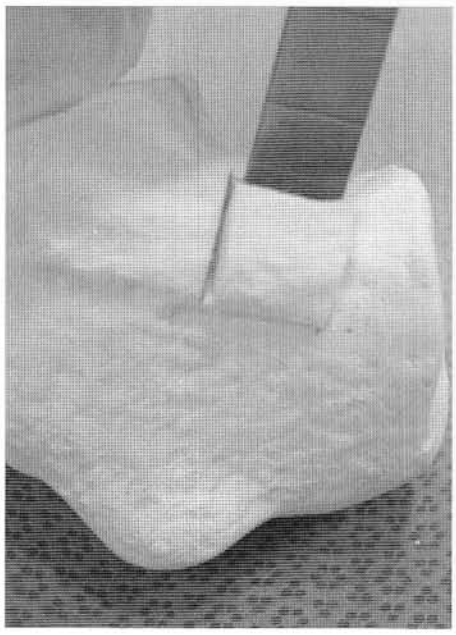

Figure 3. Bone model demonstrating location and approach to bone graft harvesting.

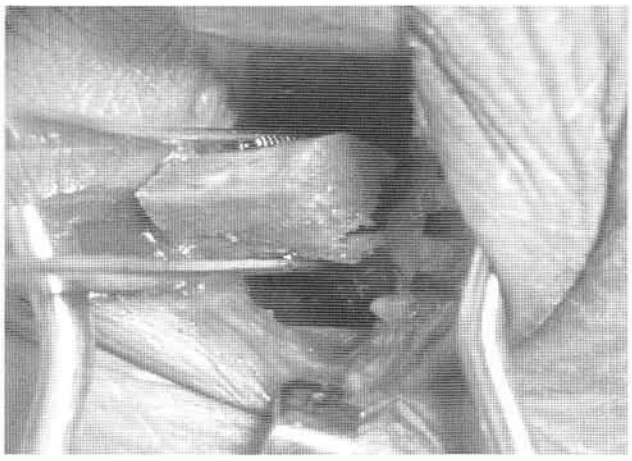

Figure 4. Calcaneal bone graft harvest.

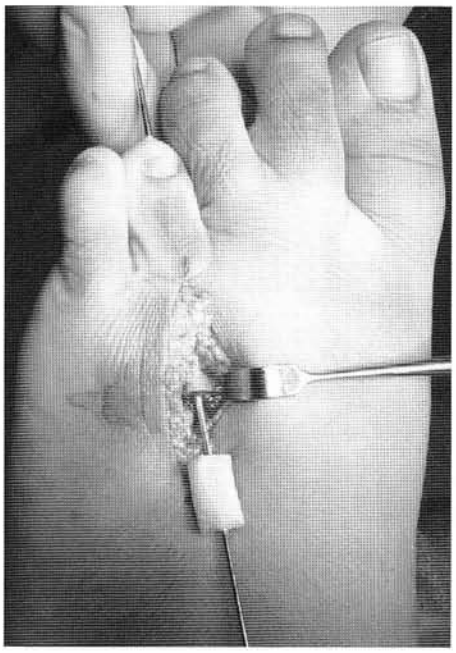

Figure 5. Bone graft skewered on K-wire which is driven out the end of the toe.

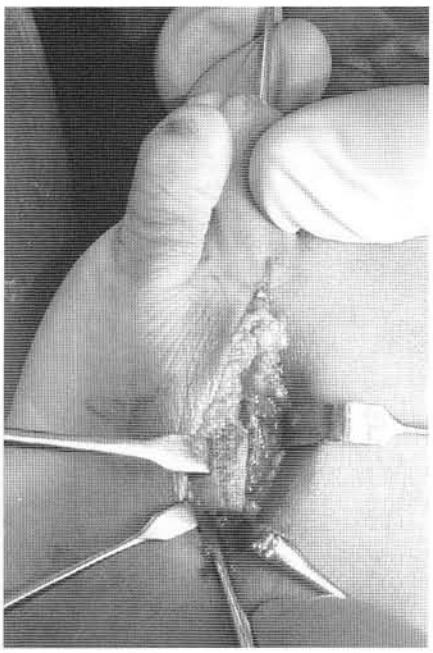

Figure 6. Manipulation of bone graft into place and transfixation of proximal interface with K-wire.

Figure 7. Preoperative DP weight-bearing radiograph of 4th brachymetatarsia.

Figure 8. Four month postoperative DP radiograph with satisfactory alignment, length (1.3 cm) correction, and bone graft incorporation.

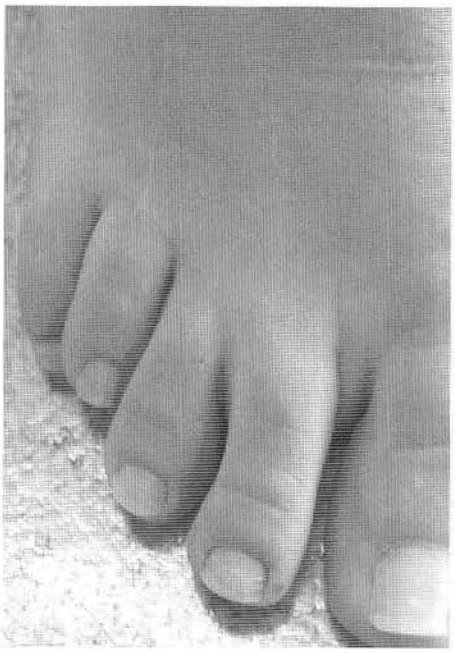

Figure 9. Four year followup brachymetatarsia repair with calcaneal autograft.

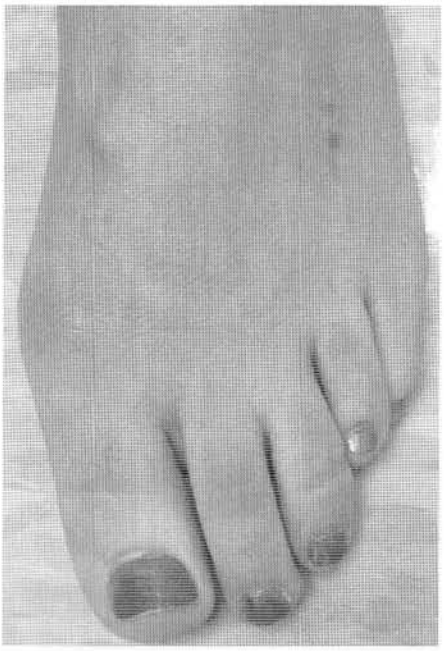

Figure 10. One year followup brachymetatarsia repair with calcaneal autograft.