BONE GRAFT RECONSTRUCTION OF A FLAIL DIGIT

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ABSTRACT

The author presents a case report with a 1-year follow-up period demonstrating successful bone graft stabilization of an iatrogenic flail second toe. The author discusses the techniques for calcaneal autogenous bone grafting for reconstruction of the iatrogenic shortened toe combined with ancillary procedures to improve the digital length pattern. After 18 months, this staged approach to stabilization of the digit and realignment of the digital length pattern appears to be successful.

INTRODUCTION

Digital surgery is one of the most common surgeries performed on the human foot. The complication rate is relatively low, and the surgery is generally predictable. Complications that can occur with digital surgery include infection, recurrence of deformity, dehiscence, prolonged swelling, circulatory embarrassment to the digit, and nerve entrapment or injury. An additional complication that can occur is an unstable digit. Two examples of an unstable digit are the floating toe and the flail toe.

The floating toe syndrome was described by McGlamry in 1982 as "...failure of the flexor mechanism to function effectively".[1] The syndrome is most commonly related to elevation of the metatarsal ray. Elevation of the ray prevents loading of the flexor mechanism, including the plantar fascia. The result is a toe that rides dorsally, failing to purchase the ground during standing or walking. The floating toe may be structurally intact, but the deformity is positional.

Friend[2] described the floating toe syndrome from base resection of the proximal phalanx. He described a case report with V-Y skin plasty, soft-tissue release, and partial metatarsal head resection. Following excessive resection of the base of the proximal phalanx, the toe may be both floating and flail.

A flail toe can be defined as one that lacks stability and structural integrity. Voluntary muscle power may be absent. Although the complication is infrequent in digital surgery, it is nonetheless quite significant. The flail toe presents functional and cosmetic considerations, as well as irritation within a shoe.

The flail toe has received very little attention in the literature. Lawton[3] described excessive bone resection during digital arthroplasty procedures as a possible cause for flail toes. The patient with a flail toe will complain of the toe catching on stockings or shoes. The toe may fold back on or under itself. The cause of the flail toe is generally either excessive bone resection or resection or over-lengthening of the extensors and flexors to the toe. Because the flail toe is usually a short toe, it also will unload the flexors and extensors to the adjacent digits, which may cause additional digital problems.

CASE REPORT

A 43-year-old Caucasian female was referred to the Foot & Ankle Institute with a chief complaint of a flail right second toe. She was concerned because the toe was riding up in shoes and causing significant irritation. She was unable to wear many types of shoes and was concerned about the cosmetic appearance of the digit. Her history for this problem had begun 4 years previously with arthroplasty procedures on multiple digits of both feet. Her chief complaint at that time had been mild hammertoe deformities. (Figure 1) The digital length pattern at that time demonstrated long toes with the second toe being slightly longer than the hallux.

Figure 1. Dorsoplantar radiograph of the right foot prior to any surgical procedures.

The initial surgery was unsuccessful and additional surgical procedures were performed on multiple digits 1 year later. Following this second surgery, there was a significant length discrepancy between the second toe and the tip of the hallux. The second toe extended out only to the interphalangeal joint of the hallux. The third toe at that point was longer than the second toe, and the fourth toe became increasingly curled in a flexion deformity. One year later, an additional arthroplasty procedure was performed on the second toe, compounding the shortening. At the time of her presentation to the Foot & Ankle Institute,

Figure 2. The patient's right foot at the time of initial presentation. Note the transverse crease in the second toe and the lack of toe purchase.

Figure 3. Dorsoplantar radiograph of right foot at the time of initial presentation. Note the severe shortening of the second toe compared to the length pattern in Figure 1.

the second toe was riding dorsally in the sagittal plane and was unstable. (Figures 2, 3)

The patient's medical history was significant for an asymptomatic mitral valve prolapse. Her surgical history included a tonsillectomy, hysterectomy, dental surgeries, and four foot surgeries. These had all been tolerated well. At the time of presentation she was not taking any medications and denied any allergies. Musculoskeletal examination revealed the digital length pattern to be severely disturbed, with the hallux being much

longer than the remaining lesser digits. The second toe was significantly shorter than the first and third toes. The second toe was unstable and displaced dorsally in the sagittal plane at the level of the proximal interphalangeal joint. There was no voluntary muscle control to the second toe. A hallux abductus interphalangeous deformity was also noted to be present. The remaining toes had normal active flexion and extension. All muscle groups were +5/5. Neurologic evaluation revealed a severe decrease in sensation to the second toe, with a more minor decrease in light touch to the fourth toe. The remainder of the neurologic exam was normal.

The dermatologic exam demonstrated a small heloma durum on the lateral side of the fourth toe. The second toe demonstrated linear and transverse scars with atrophic dorsal skin. The vascular examination demonstrated strong dorsalis pedis and posterior tibial pulses. The capillary refill was immediate to the hallux and 4 to 5 seconds for the second toe.

The right foot repair was performed in a staged sequence in order to decrease the risk of circulatory embarrassment to the second toe. The second toe skin was thin and scarred as a result of the four prior surgeries. The decision to stage was made to avoid performing surgery on the second toe and on both sides of the second toe at the same time. The initial stage was a bone graft lengthening from the calcaneus to the second toe and an arthroplasty of the fourth toe with a derotation skin wedge. The second toe was approached through the previous linear incision. The subcutaneous tissue was particularly thin. The scarred extensor tendon was lengthened by means of an open Z-plasty to expose the proximal phalanx and the middle phalanx. The long flexor tendon to the second toe had been disrupted during prior surgeries. The plantar scar tissue was incised in order to allow for lengthening of the digit. The distal end of the proximal phalanx was remodeled until an area of healthy bleeding bone was observed. The base of the middle phalanx was also remodeled until raw, bleeding bone was observed. This served to remove sclerotic bone and present two healthy bone surfaces. It also served to increase the shortening of the toe.

A corticocancellous graft was procured from the posterior superior aspect of the ipsilateral calcaneus. (Figure 4) The approach for procuring the

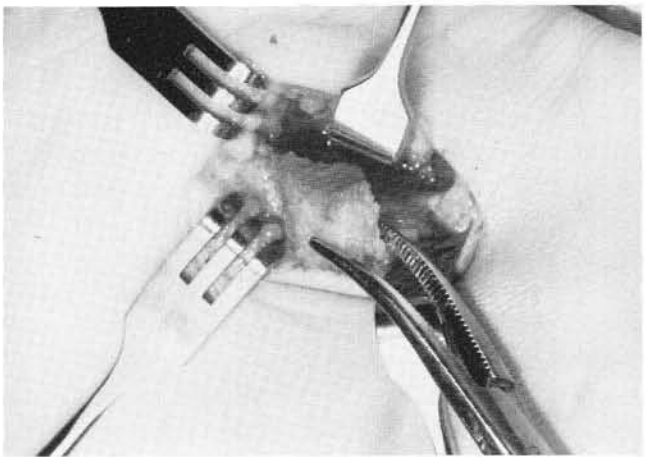

Figure 4. Bone graft as it is being removed from the calcaneus.

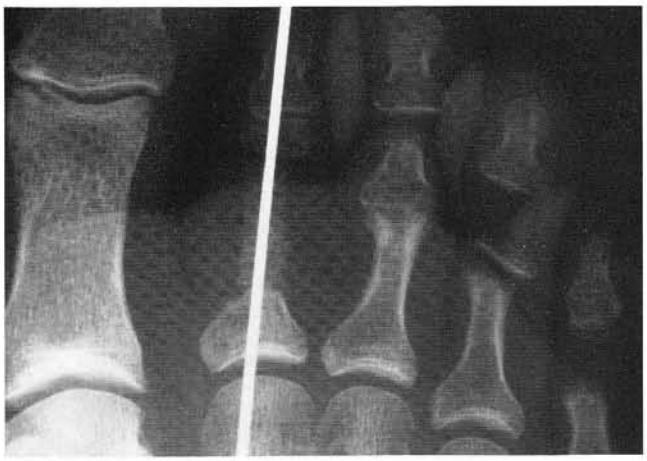

Figure 5. Dorsoplantar radiograph of right foot immediately postoperative. Note Kirschner wire fixation and the amount of bone resected from the second toe base of the proximal phalanx.

calcaneal bone graft was through a lateral incision with careful attention being paid to insure protection of the sural nerve. The graft was pre-drilled with a .035 K-wire. The graft was trimmed to a length of 18 mm and a width of 5 mm. A .045 K-wire was then retrograded out through the end of the toe and drilled from distal to proximal through the distal and middle phalanges, and through the bone graft, and through the remaining base of the proximal phalanx into the second metatarsal. (Figure 5)

Following completion of the second toe correction, an oblique skin wedge was removed from the fourth toe to provide correction for the adducto varus deformity, as well as to provide exposure to the middle phalanx which was remodeled. The procedures were performed under thigh tourniquet hemostasis. At the conclusion of the procedure, immediate capillary refill

occurred to all the digits except the second, which refilled within 5 min. A below the knee cast was applied, and the patient was allowed to walk non-weight bearing with crutches. At 8 weeks postoperatively, the pin was removed when consolidation was noted at the proximal

Figure 6. Oblique radiograph of right foot at 8 weeks postoperatively.

and distal graft host junctions. (Figure 6) The patient was allowed partial weight bearing in a cast for 2 weeks. The cast was removed at 10 weeks, and the patient was given a surgical shoe and allowed partial weight bearing for 1 additional week in an elastic wrap and then allowed full weight bearing for 2 weeks. By 3 months, there were good consolidation and stability along the graft, and by 6 months, excellent remodeling had occurred.

Seven months after the initial surgery, the second stage was performed. A modified McBride bunionectomy and shortening Akin osteotomy of the right hallux were performed, as well as an arthroplasty of the third toe. The procedures were performed under ankle tourniquet. A truncated wedge was removed from the proximal phalanx of the hallux in order to correct the hallux abductus interphalangeous and shorten the hallux enough to create a more normal digital length pattern. Fixation was achieved with a percutaneous .045 Kirschner wire and a 2.7-mm cortical screw. Attention was directed to the third toe, which was remodeled at the proximal interphalangeal joint and stabilized with a .045 K-wire. The patient was given a surgical shoe and instructed to remain non-weight bearing on crutches. At 4 weeks postoperatively, the pins were removed and the patient was returned to partial weight bearing for 1 week, followed by full weight bearing in a surgical shoe.

At 10 months postoperatively, following the first stage of the surgery, and 3 months postoperatively, following the second surgery, the patient was pleased with both the cosmetic and functional results. (Figures 7, 8) The patient was able to wear all types of footgear and she was pleased with the digital length pattern. Approximately 1 year following the first surgery, similar procedures were performed on the left foot. Because the second toe on the left foot did not have the same degree of soft tissue atrophy, all the procedures were performed at one time. The patient is now 18 months postoperative following her original surgery on her right foot and is walking comfortably. All of her osteotomy and bone graft sites are well healed.

DISCUSSION

The treatment of a flail toe can be difficult. In order to create stability in an unstable toe, the primary alternatives are implant arthroplasty, syndactilization to an adjacent toe,[4] and bone graft stabilization. Amputation of the digit is an option that some of these patients would be more than happy to consider because of the pain, disability and nuisance associated with this deformity. In this particular case, implant arthroplasty was discarded as a surgical option because of the poor quality of the soft tissues, and as the questionable vitality of the bone stock. Syndactilization was an alternative that the patient refused to consider. The syndactilization would have provided some increased stability to the toe, but would not have achieved complete stability, nor would it have restored the digital length pattern.

A bone graft repair for this type of deformity must be considered to be an extraordinary measure. The graft-host interface is small in this area, particularly for such a long bone graft as was required in this case. Debridement of necrotic bone is mandatory to provide a good bed for the

Figure 7A. Radiograph of right foot at 10 months postoperatively. Dorsoplantar view demonstrating digital length pattern re-alignment and consolidation of second toe bone graft.

Figure 7B. Oblique view of right foot at 10 months postoperative.

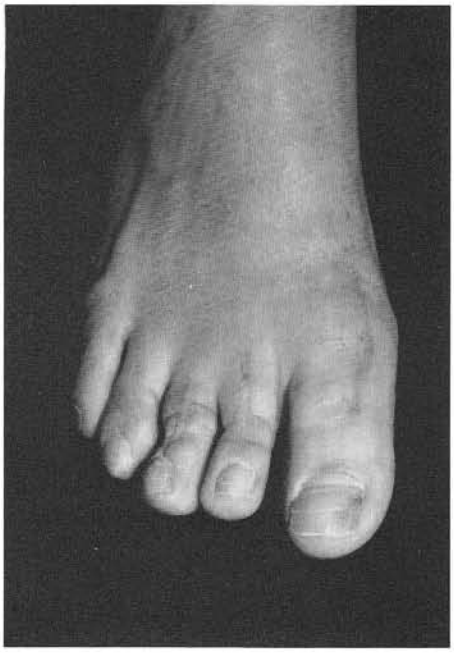

Figure 8. Photograph of right foot at 10 months postoperatively.

bone graft. The use of autogenous bone is also important in order to improve the chances of a successful take. A variety of sources can be used for an autogenous bone graft. The hip, fibula and tibia have all been suggested.[5] The calcaneus is an excellent source for small bone grafts such as this. The quality of the bone is good. It provides a strong cortical surface with outstanding cancellous bone. The cortical surface is not circumferential, but it does span approximately 30% to 40% of the circumference. The cortical surface is placed on the dorsal side of the toe in order to maintain stability.

Complications from calcaneal bone grafts are infrequent and certainly are less than the documented complication rates from the procurement of iliac crest bone grafts.[6] Because the calcaneus is vascular, a hematoma may develop after procurement of an autogenous calcaneal bone graft. The risk of this can be minimized by three techniques: application of bone wax to the raw cancellous bone, use of a closed suction drain, or packing of the defect with freeze-dried allogeneic corticocancellous chips. Each of these techniques seems to be effective, as hematoma has not been a problem in the author's series of calcaneal bone grafts.

The reconstruction was staged in order to decrease the chances of circulatory embarrassment. Four prior surgeries had resulted in a thin layer of superficial fascia in the second toe. Lengthening procedures can also place a digit at risk for ischemia. The subsequent surgeries on the third and first toes might have placed the second toe at risk by decreasing cutaneous blood supply

from lateral to the second toe and by risking injury to the metatarsal artery medial to the second toe.

SUMMARY

Bone grafting is one treatment for stabilization of a flail toe. As a treatment choice, it must be weighed carefully against the possible disadvantages of circulatory embarrassment caused by overlengthening of the toe, and the possibility of failure of the bone graft. A patient who has already had multiple surgeries on the digit should be advised that additional surgery may cause loss of the toe.

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