CHAPTER **38**

FASCIOCUTANEOUS FLAPS WITH EXTERNAL FIXATION OF THE FOOT AND ANKLE

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External fixation has evolved considerably in component design and the scope of application. We routinely use external frames at our institution for comminuted or unstable fractures, infected pseudoarthroses, axial length discrepancies, and static compression for arthrodesis. In cases of insufficient bone integrity or the severely compromised skeletal anatomy seen in Charcot's neuroarthropathy, osseous fixation can be achieved through external means because the fixation is spread over a wider region of bone. The latter condition is often accompanied by mal perforans ulcerations, underlying osteomyelitis, and significant soft tissue destruction. Often skeletal platform reconstruction is delayed while wound care, subtotal ostectomy, and systemic antibiosis are carried out.

The focus of major rearfoot and ankle reconstructive surgery for the podiatric surgeon categorically revolves around osseous reconstruction, while soft tissue reconstruction is often secondarily considered. This paradigm is clearly faulty, most profoundly in the surgical management of osteomyelitis and mal perforans ulcerations in the neuropathic foot. Almost any bone pathology can generally be reconstructed, whether chronically infected, grossly prominent, or severely malaligned. Even after extensive debridement and amputation, utilization of external frames now allows for controlled bone development along corridors in the foot previously unatainable. It would seem that in the hands of a surgeon trained in the Ilizarov method there is almost no osseous condition that cannot be managed or reconstructed using a smooth wire ring fixator. However the success of any reconstruction truly lies with the ability to manipulate and reconstruct soft tissue structures as well, allowing for closure over a stable osseous substrate and establishment of a healed wound.

This ideology has resulted in an "orthoplastic approach" to foot wounds, which combines two interdependent methodologies; first, the formation of a clean, stable, healthy osseous frame which can sustain anatomic loads and provide an acceptable level of function. Second, plastic reconstruction is carried out to repair and replace absent tissue and to protect the foot from further contamination and breakdown. In many cases these reconstructions are performed in stages over a relatively long period of time and through multiple operations. However, the two approaches can occasionally be combined in a single-stage operation consisting of osseous remodeling through debridement, osteotomy or arthrodesis, and soft tissue repair using flaps, grafts, or both. The ability to manipulate soft tissues and monitor wound progress despite incisional approach and choice of fixation is fundamental to these radical procedures. Consequently, significant pre-operative evaluation and planning must be carried out.

Fixation distanced from infected or otherwise compromised bone permits skeletal support for tension and compression forces. Fixation in this manner has another clear and equally impressive advantage: spanning affected bone and soft tissue allows access for wound monitoring or additional procedures such as plastic reconstruction. Percutaneous placement of small diameter smooth wires used with ring fixation allows for creation and advancement of local fasciocutaneous flaps. In contrast, this type of flap construction is often compromised with large sweeping incisions utilized for exposure and placement of internal fixation. Moreover, when flaps and grafts are used in reconstruction wound monitoring becomes essential. Adequate access can be impeded by cast application despite using window techniques. The rigid skeletal stabilization provided by the external frame permits early or immediate weight bearing on the operative extremity, and patients can forgo the cast immobilization that is often necessary with internal fixation.

In this report, the authors present two cases of a combined approach to chronic foot ulcers in patients with underlying osseous deformity. Extensive preoperative planning was undertaken to determine a satisfactory single-stage reconstruction for these otherwise high-risk individuals. A combination of internal and external fixation was used as a means to achieve joint fusion and stabilization. Fasciocutaneous flaps were raised and advanced to fill soft tissue voids after ulcer excision.

CASE #1: ADULT EQUINOCAVOVARUS DEFORMITY

A 66-year-old caucasian female initially presented with a chronic nonhealing ulceration on the lateral aspect of the left foot over the fifth metatarsal head. The ulceration had been present for greater than one year. Gross examination demonstrated a rigid equino-cavovarus (clubfoot) foot type with gross clinical and radiographic malalignment of the ankle and rearfoot complex (Figures 1 – 4). Despite a lengthy course of conservative management of the cutaneous ulceration and bracing of the ankle deformity it was elected to proceed with reconstruction. The goals of surgical correction included development of a stable osseous platform for ambulation, ulcer excision and O-to-L fasciocutaneous advancement flap to close the lateral foot wound. External fixation was utilized, allowing continuous visualization of the large lateral flap through the postoperative course.

Figure 1. Rigid equino-cavovarus deformity in a 66-year-old, minimally ambulatory female. Lateral column ulceration over the fifth metatarsal head does not undermine or probe to bone.

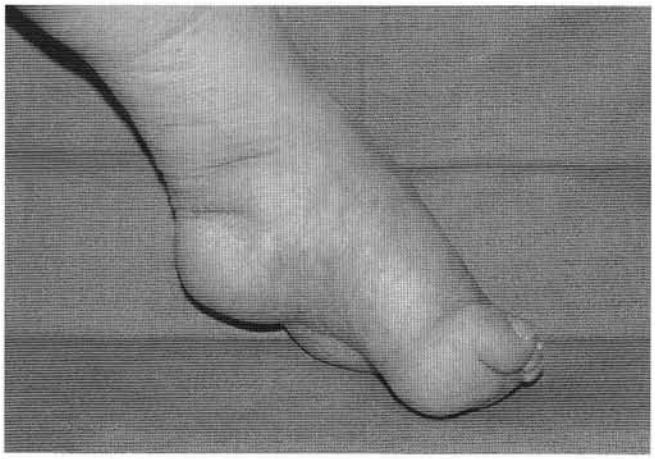

Figure 2. Medial aspect of the left foot demonstrating significant cavo-varus position of both forefoot and rearfoot.

A talectomy was performed. The anterior portion of the talus was separated from the body and all cartilage was removed from the talar head. The cortical substance on the anterior tibia was debrided for fusion with the talar head. The posterior facet of the navicular was prepared and cannulated screws were placed from distal to proximal through the navicular and talar head into the tibia for anterior navicular-talar-tibial fusion. The remaining calcaneal portion of the posterior facet of the subtalar joint was debrided of cartilage and the calcaneus was brought up to meet the previous tibial plafond for fusion. A distal fibulectomy was performed. An axial 5/64" Steinman pin was placed to secure the tibio-calcaneal fusion.

The decision to perform a primary talectomy was made for several reasons. The severe osseous deformation and angular distortion necessitated radical bone reconstruction. Preservation of the talus and correction through wedging and remodeling would have resulted in near complete degloving and potential devascularization of this deformed bone. This surgical plan also predicted an axial length reduction in both leg and foot segments. This would have an additional advantage reducing tension on contracted soft tissues. Additionally, we predicted a redundancy of tissue laterally due to the angular varus-to-valgus correction. Shortening the foot and derotating the forefoot into a valgus position by removing the talus

Figure 3. AP radiograph of the ankle demonstrating severe degeneration, with varus tilting of the talus within the ankle mortise. Osteophytes can be seen medial to the tibial malleolus. An osseous block can be visualized between the inferior pole of the lateral malleolus and the lateral talar process, which would ultimately impede talar body relocation within the ankle joint.

Figure 4. Lateral radiograph of the same foot demonstrating flattening of the talus and degeneration of the subtalar joint. Severe equinus deformity is evident as a negative calcaneal inclination angle, as well as an overall plantarflexed position of the forefoot and midfoot on the leg.

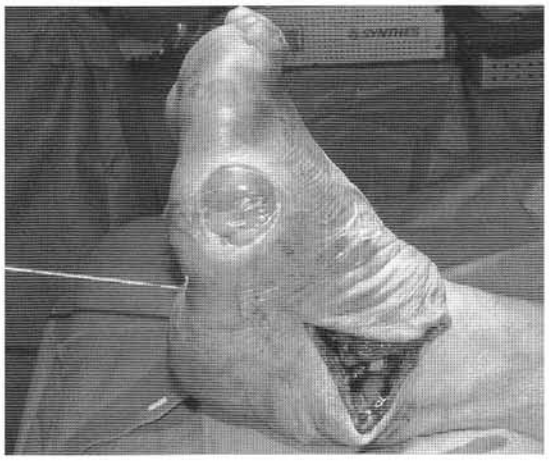

Figure 5. The lateral column ulceration was protected with an occlusive dressing while osseous reconstruction of the ankle and rearfoot was carried out. The correction was maintained with an axial Steinman pin. Significant soft tissue redundancy was developed over the anterolateral ankle region, which will become the basis for advancing a fasciocutaneous flap anteriorly to close the distal foot wound.

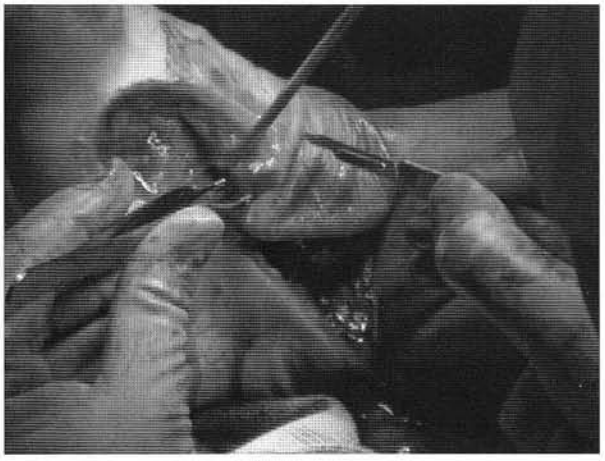

Figure 6. The ulcer was completely excised and an incision was carried from the inferior aspect of the wound over the 5th ray to the lateral ankle incision. This flaps was raised from the underlying deep fascia and periosteal tissues.

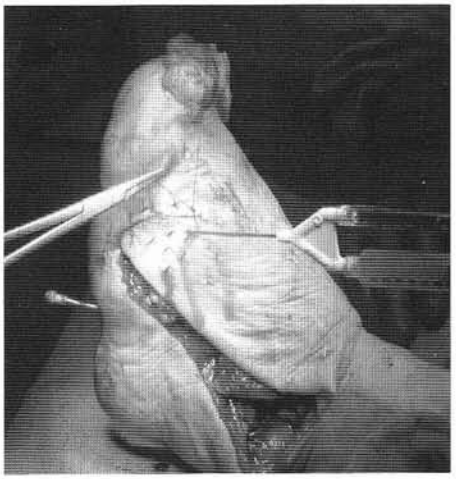

Figure 7. The flap was secured distally. Platelet-rich plasma was infiltrated throughout the tissues in the region of this chronic ulcer.

allowed pressure relief on the lateral forefoot, creation of redundant tissue over the lateral ankle, and the ability to primarily close the lateral foot wound through advancement flap. Fibula take-down was required for access to the entire lateral side of the rearfoot and ankle complex. Maintenance of this lateral strut would have impeded lateral and proximal calcaneal reduction on the tibia. The medial malleolus was also removed due to impingement with the sustentaculum tali of the calcaneous.

Once the osseous reconstruction was carried out and stabilized, the redundancy in the anterolateral soft tissues could be appreciated (Figure 5). The ulceration was excised circumferentially. In order to primarily close the wound, a linear incision was carried from the inferior portion of the previously excised ulcer towards the lateral incision at the level of the fibular malleolus (Figure 6). The entire fasciocutaneous flap was undermined and then advanced distally on the dorsal pedicle. Primary closure was performed under minimal tension (Figure 7).

The standard Ilizarov foot and ankle construct was applied utilizing two 160 mm rings and a corresponding footplate. Smooth wire, four-point fixation was achieved on the tibial ring block. Two counter opposed wires were used to purchase the calcaneus, and the metatarsal and midfoot levels were also secured with smooth wires. An olive wire was passed from medial to lateral through the metatarsal segment to assist in carriage of the foot from its varus position and maintain correction in a plantigrade and slight valgus alignment with the long axis of the leg (Figures 8 – 11).

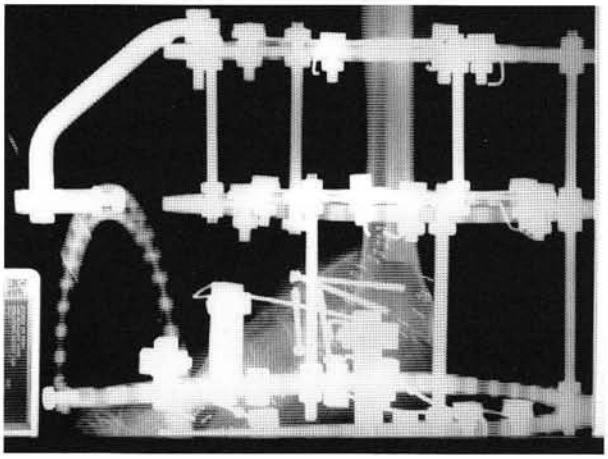

Figure 8. Postoperative lateral radiograph. The foot was moved posteriorly on the tibia to allow for more effective ambulation. The navicular-talar-tibial fusion was carried out using the anterior portion of the talar head as a strut to prevent further posterior migration of the foot on the leg, and to increase fusion mass and stability.

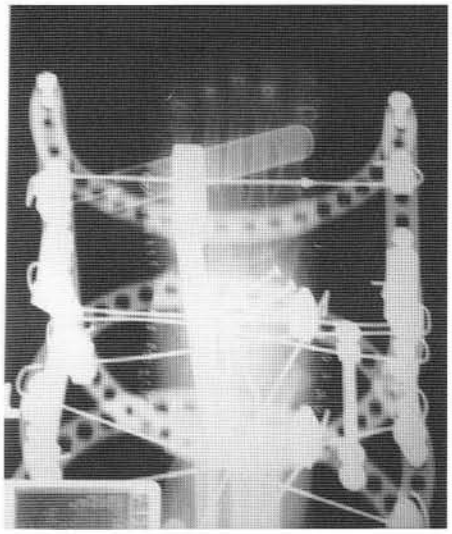

Figure 9. Dorso-plantar view of the foot demonstrating rectus foot position with respect to the leg. An olive wire was used across the metatarsal level to assist in reduction of the forefoot adductus deformity.

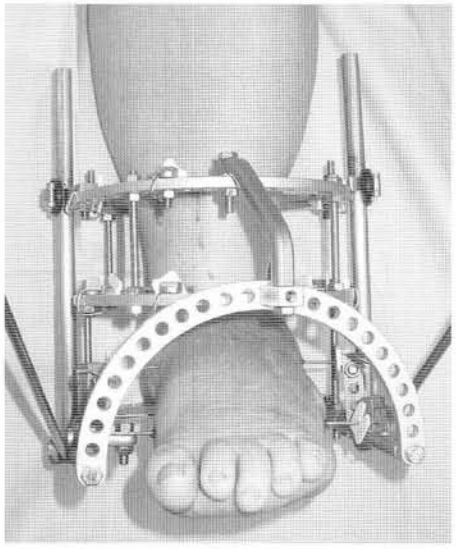

Figure 10. The triplanar deformity has been reduced and the foot now sits in a plantigrade position on the leg.

Figure 11. 3 months postoperative view demonstrating near-complete healing of the lateral foot wound. There is still some scab formation over the flap incision, however this will go on to heal uneventfully.

CASE #2: CHARCOT'S NEUROARTHROPATHY

A 47-year-old diabetic female initially presented with a plantar ulceration and enlarged soft tissue mass on the right foot which had been present for approximately 8 months. Clinical examination revealed a mal-perforans ulceration on the plantar aspect of the foot, and open, non healing wounds on the medial and lateral sides of the right foot from a previous incision and drainage procedure. At the time of examination she was non-ambulatory due to wheelchair restriction.

Radiographic examination revealed complete obliteration and collapse of the midfoot complex with osseous plantar protrusion of the cuboid bone. It was elected to reconstruct the foot, with the primary goals being restoration of midfoot stability through Lisfranc complex fusion, and ulcer excision with primary closure in O-to-Z fashion with advancement flaps (Figures 12 – 15).

The surgical plan necessitated creation of redundant plantar tissue. Lisfranc complex fusion would stabilize the midfoot, while a radical plantar ostectomy would relax the plantar cutaneous tissues overlying the ulcer. The ulcer excision was planned to permit adequate access to the plantar cuboid, while maintaining viability to the plantar skin for creation of medial and lateral flaps.

The plantar foot was approached and circumferential rhomboid-type ulcer excision was performed, with complete removal of the underlying fibrous bursa-type tissue. Exostectomy was then performed. Plantar skin redundancy was assessed and additional bone was removed as needed to allow creation of medial and lateral flaps. The flaps were mobilized and primarily closed using a combination of 2-0 and 3-0 nonabsorbable suture (Figures 16 – 20).

Figure 12. Plantar mal-perforans type ulceration in a 47-year-old diabetic female. This ulcer probes deep into the soft tissues however no sinus is detected and the base does not communicate with bone.

Figure 13. A large soft tissue mass is apparent beneath the ulceration encompassing the entire plantar aspect of the foot.

Figure 14. Lateral wound from a previous incision and drainage procedure.

Figure 15. Sever midfoot collapse and degeneration of the tarsus is a hallmark of Charcot's neuroarthropathy.

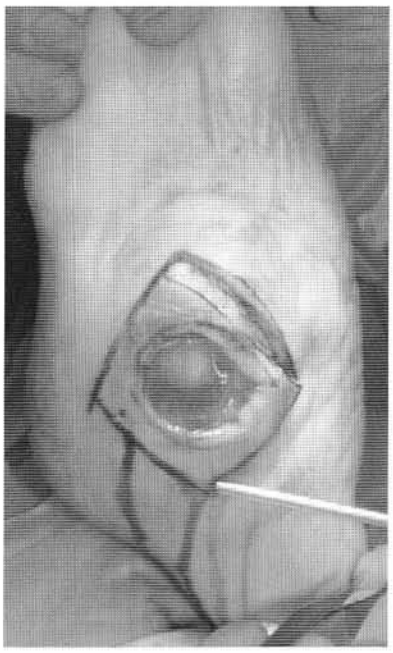

Figure 16. The ulceration was completely circumscribed and excised in a rhomboid-fashion.

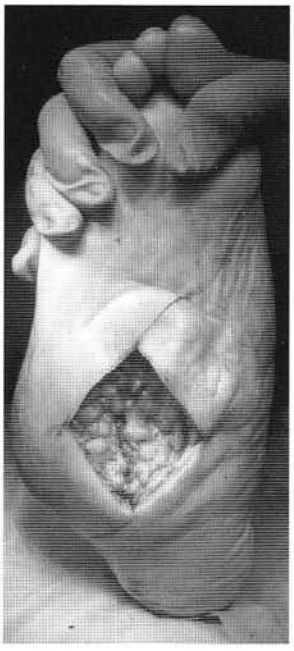

Figure 17. Radical plantar ostectomy with bursal excision was carried out. This relieved tension on the plantar cutaneous tissues, and this redundant tissue will be used to creat two large advancement flaps for closure of the wound.

Figure 18. The flaps are undermined with minimal subcutaneous dissection.

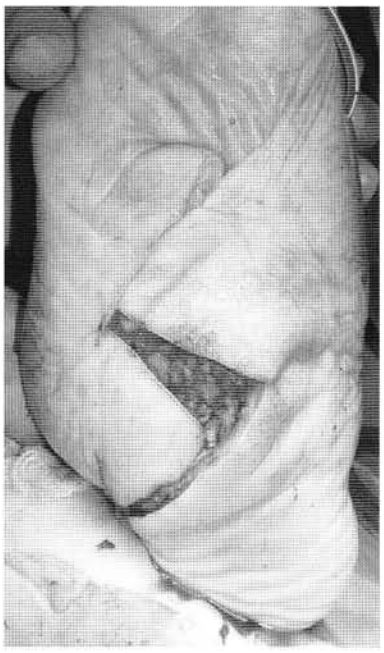

Figure 19. The flaps are mobilized and advanced into approximation.

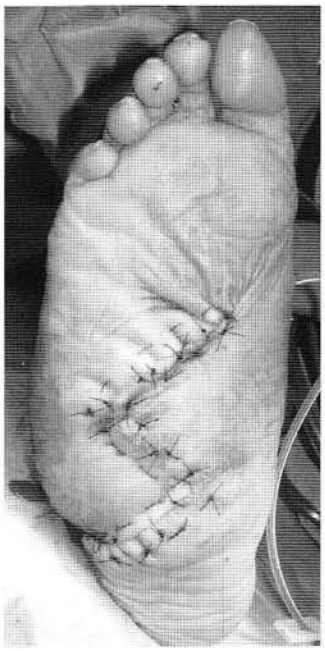

Figure 20. The flaps are secured with nylon suture.

A limited incisional approach was planned for access to the Lisfranc complex due to the presence of previous medial and lateral incisions. A 2 cm linear incision was made over the fifth metatarsal cuboid joint. A trephine was passed from lateral to medial through Lisfranc's joint under fluoroscopic image intensifier, and the cartilage was removed from both anterior and posterior surfaces of this joint complex. Fixation was achieved with 4.5 mm cannulated screws inserted from dorsal to plantar across the 1st and 2nd metatarsal cuneiform joints and the 4th and 5th metatarsal cuboid joints. A 5th screw was inserted from the medial cuneiform down through the neck of the talus to stabilize the medial foot. Circular external fixation was employed using the standard foot and ankle frame assembly, which allowed us to monitor the plantar flaps (Figures 21 – 26).

DISCUSSION

One of the understated advantages of external skeletal fixation in limb reconstruction is the ability to monitor soft tissues postoperatively. This is especially important in traumatic degloving-type injuries or blunt trauma with impending cutaneous necrosis and demarcation. Spanning these regions with external fixators allows for plastic reconstruction after the initial bone stabilization. Moreover, external frames allow plastic soft tissue reconstruction to be performed simultaneous with osseous procedures due to this ability to monitor wound progress. The cases presented illustrate this point, highlighting this advantage of their use of reconstructive foot and ankle surgery.

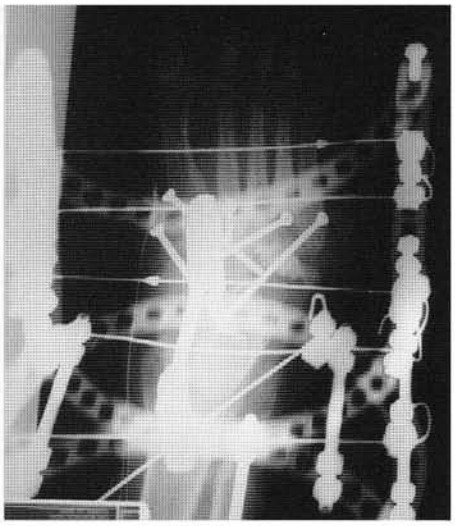

Figure 21. Trephine arthrodesis across the Lisfranc joint complex was carried out and percutaneous cannulated screw fixation was used to stabilize the fusion site.

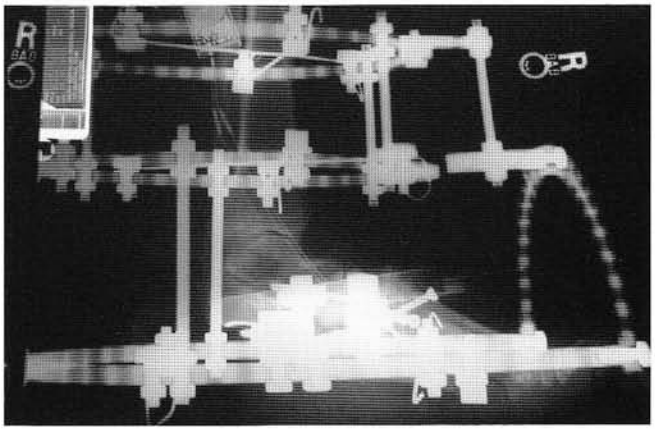

Figure 22. External fixation was employed consisting of a 2-ring distal tibial segment and a foot plate. An internal bone stimulator was also utilized to enhance fusion.

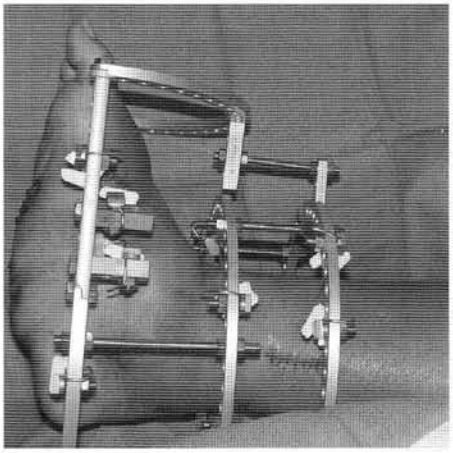

Figure 23. Clinically the foot is rectus on the leg.

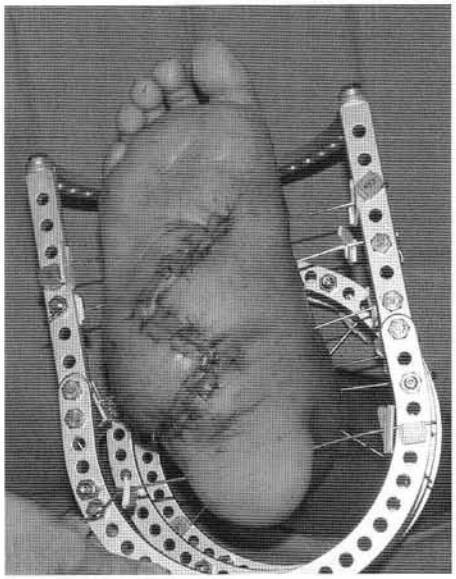

Figure 24. The flaps are able to be monitored throughout the postoperative course, and on the third postoperative day appear healthy and vascular.

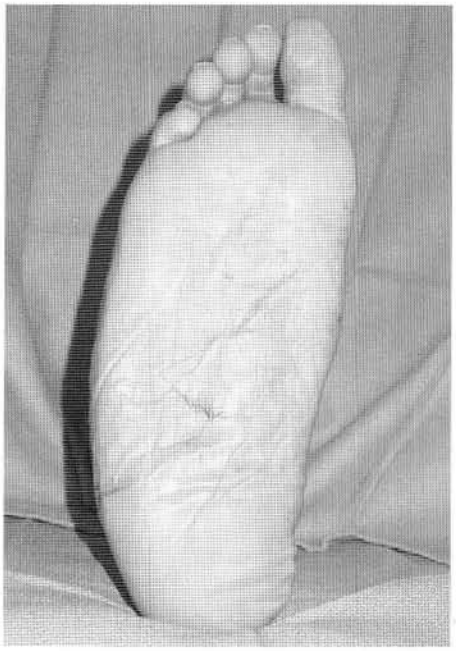

Figure 25. One year postoperative with complete healing of the plantar wound.

Figure 26. Complete soft tissue remodeling has occurred and an anatomic appearance has been restored to the foot. The patient is completely weight-bearing and ambulating at this point.