CHAPTER 5

THE APPLICATION OF THE ILIZAROV EXTERNAL FIXATOR FOR ARTHRODESIS OF THE ANKLE

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The use of the Ilizarov external fixator provides an ideal and minimally invasive method for fusion of the ankle joint. In the appropriate clinical setting, consideration should be given to employing the Ilizarov technique as a method of performing the difficult tibiotalar fusion. It is imperative that the surgeon be well versed in the Ilizarov technique, and experienced enough to recognize and treat complications when they arise.

The Ilizarov technique provides substantial interfragmentary compression which is dynamic in nature. With the use of internal compression fixation, final tightening of the screw is performed while the wound is still open, without the possibility of adjustment after closure. However, adjustments can be made to the Ilizarov external fixator under fluoroscopic visualization postoperatively. In addition, adjustments can be made to the frame up to four weeks postoperatively.

The use of other external fixators has been well documented in the literature. The Charnley, Hoffman, Muller four-pin, Muller two-pin, Calandruccio, and the EBI are examples of various external fixators. All are uni-planar in construction, and use pins ranging in diameter from 4.0 to 6.0 mm (Fig. 1). Four to six pins are used to fixate the bone to the frame. Therefore, the devices must be used with caution when attempting to place the large diameter pins through the talus, especially in the presence of aseptic necrosis or a previous fracture of the talus. Being uni-planar in construction, the previously mentioned frames are not meant for weight-bearing use. Due to the large diameter of the pins used with these devices, few are required for rigid fixation of the frame to the bone. However, if pin tract infection occurs requiring removal of one or more of the pins, stability of the frame will be seriously compromised.

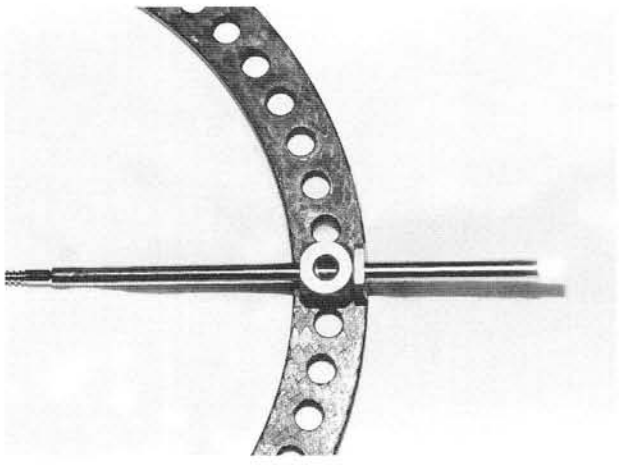

Figure 1. A 4.0-mm half-pin attached to the frame.

The Ilizarov external fixator is a circular multi-planar frame utilizing 1.6-mm to 1.8-mm pins for fixation of the bone to the frame (Fig. 2). Ten to twelve pins are used to stabilize the limb to the circular frame (Fig. 3). Therefore, if an infection develops around one of the pins, necessitating its removal, only minimal stability is lost. Because the pins are only 1.6-mm to 1.8-mm in diameter, placement of the pins through the talus is much less traumatizing to the bone, as well as the adjacent soft tissues. Being multi-planar in construction, full-weight bearing of the extremity is allowed on postoperative day one. This becomes increasingly valuable in obese patients, as well as those with Charcot ankle deformities. In these instances, non-weight bearing is extremely dangerous to the general health of the patient, and may predispose the opposite extremity to potential breakdown.

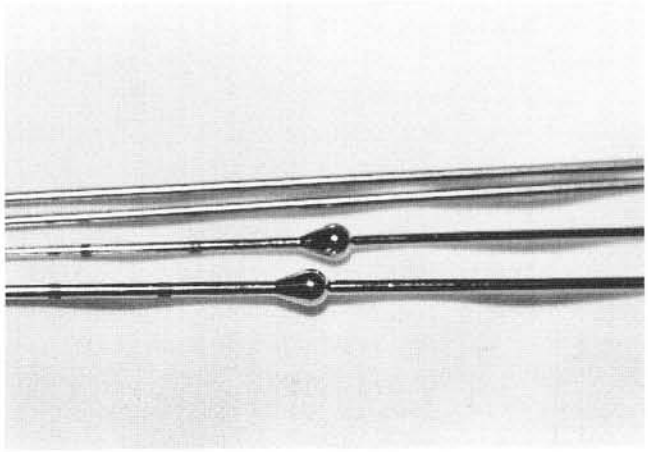

Figure 2. A Standard 1.6-mm diameter wires (top). Olive wires used for bone transport (bottom).

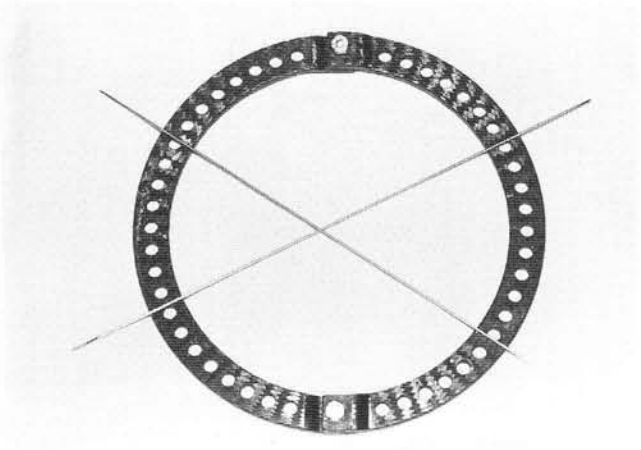

Figure 3. The pins are driven through the tibia and fibula and then attached to the frame.

SURGICAL TECHNIQUE

Initially, an antero-medial incision is made to gain access to the anterior and medial aspect of the ankle mortise. A second lateral incision is used to expose the fibula and the anterior-lateral aspect of the joint. At approximately 8 to 10 cm proximal to the ankle joint, a section of the fibula is removed to allow mobility of the fibula. This will allow it to be compressed against the lateral aspect of the tibia and the talus, acting as a lateral strut. The joint surfaces are then resected and temporarily stabilized with two crossed 5/64" Steinmann pins. Intra-operative x-rays are obtained, followed by closure of the wounds. At this time, under direct visualization of intra-operative fluoroscopy, the Ilizarov external frame is applied.

Tibio-talar fusion, in the absence of segmental bone loss or hindfoot deformity, can be performed with a simple four ring construct. It can be applied to create compression between the tibia and talus, tibia and calcaneus, or in combination creating tibio-talar and subtalar compression. The frame consists of two appropriately sized rings placed around the distal portion of the leg, and fixated to the tibia with two stainless steel wires per ring. The most proximal wires fixate the tibia to the frame. One of the distal wires passes just through the tibia, while the other is driven through both bones of the leg, and placed in such a manner as to compress the fibula against the lateral aspect of the tibia.

The third ring is positioned at the level of the talus and fixated with two pins. The first pin is directed from anterior-medial to posterior-lateral across the talus, while the second pin is directed from anterior-lateral to posterior-medial, being careful to avoid the neuro-vascular bundle and the Achilles tendon. The fourth ring is a half-ring surrounding the calcaneus with extensions paralleling the borders of the forefoot. Two pins connect the calcaneus to the frame, and three to four wires attach the midfoot and forefoot to the frame. The two distal rings act as a unit to compress the talus against the tibia, with the use of threaded rods connecting the distal unit to the proximal rings. The subtalar joint is protected from compression by maintaining a fixed distance between the two distal rings.

If a tibiotalar fusion is to be performed following a triple arthrodesis, a three ring frame can be used. The design is the same as the four-ring construct with the exception that the ring at the level of the talus is not used. The distal ring provides stability at the previous fusion site, and fully stabilizes the forefoot and rearfoot. The forefoot cannot be allowed to plantarflex as it may allow the ankle to plantarflex.

If a significantly short extremity or segmental bone loss is present, bone transport can be accomplished to restore length. A metaphyseal corticotomy is performed in the proximal tibia, followed by distraction osteogenesis. The defect between the tibia and talus is closed by compression.

CASE PRESENTATION 1

A 64-year-old white male presented with a failed ankle fusion performed with the use of internal fixation. The ankle was laterally and anteriorly displaced. After removal of the previously placed screws, an Ilizarov frame was applied. It was used to correct the angular displacement and to compress the resected tibio-talar surfaces. The patient's medical history was significant for coronary disease requiring previous by-pass surgery. He was taking oral anti-coagulant and anti-hypertensive medications. He was a poor candidate for cast immobilization, due to his medical conditions and a history of non-compliance relative to his weight-bearing status.

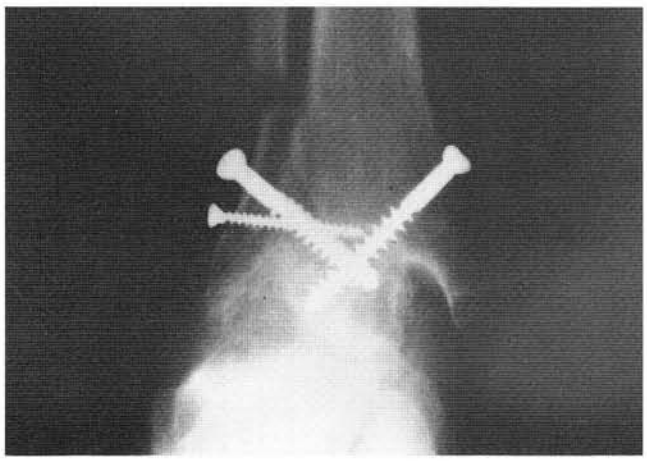

Figure 4A. Preoperative AP radiograph demonstrating malposition /nonunion of the ankle.

Figure 4B. Preoperative lateral radiograph.

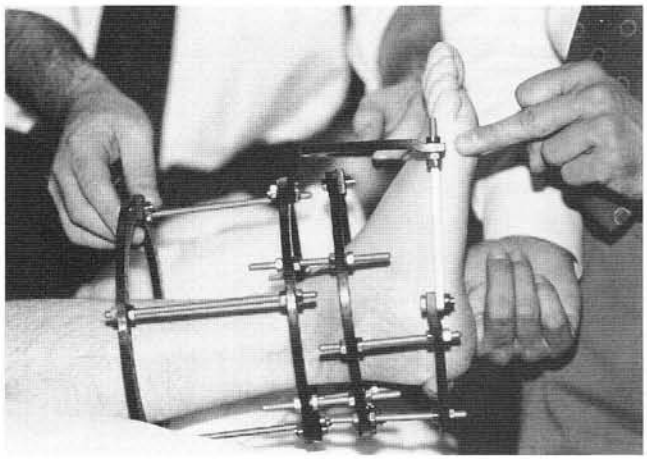

Figure 5. The Ilizarov frame is pre-constructed prior to surgery to diminish the amount of time spent intra-operatively.

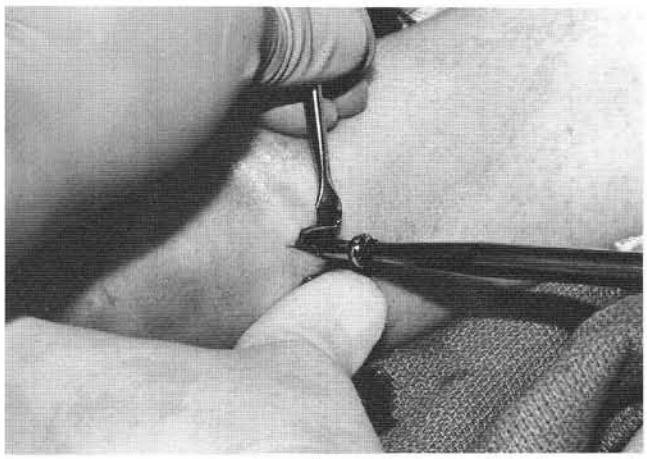

Figure 6. Removal of a retained internal fixation compression screw.

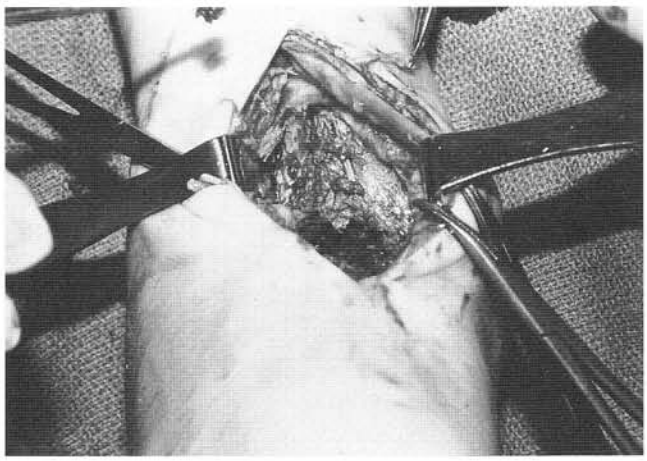

Figure 7. Visualization of the tibiotalar nonunion.

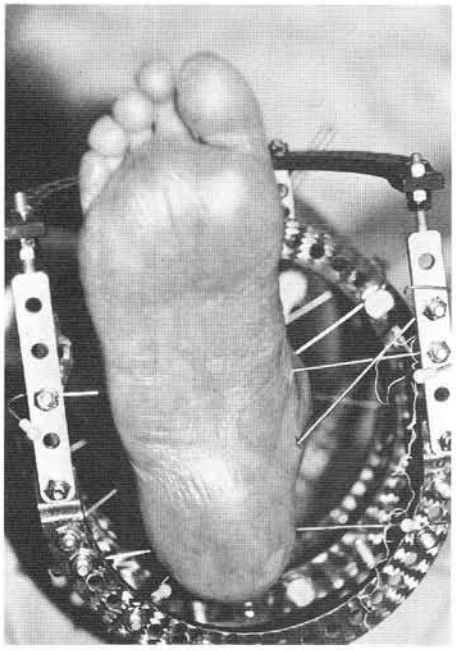

Figure 8A. Postoperative view of the plantar aspect of the foot, showing multiple pins used for fixation of the foot to the frame.

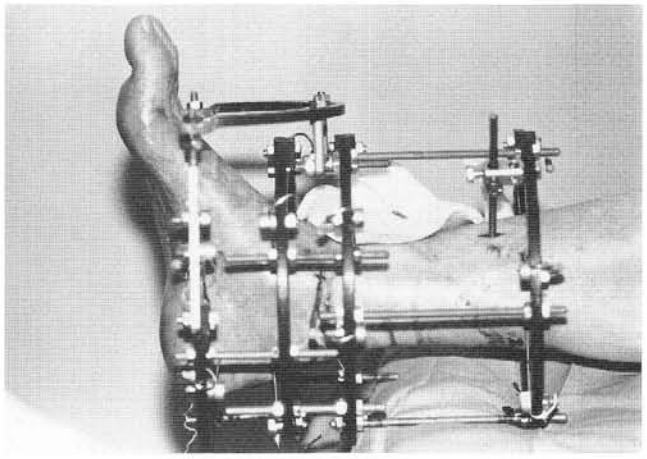

Figure 8B. Postostoperative view of the medial aspect of the foot and leg. Note the appropriate position of the ankle in relation to the leg.

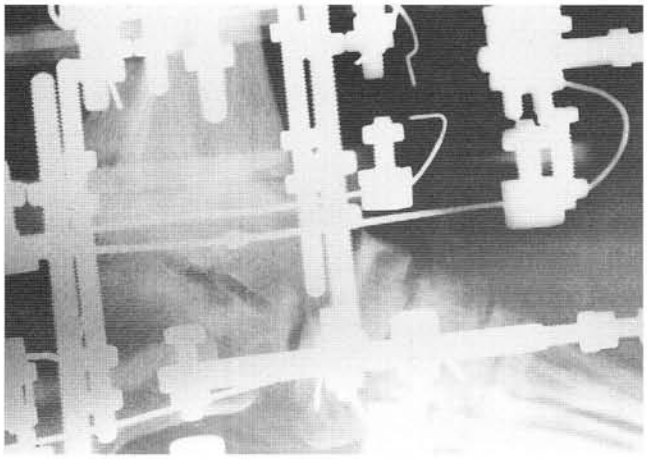

Figure 9A. Postoperative lateral radiograph with the Ilizarov frame in place.

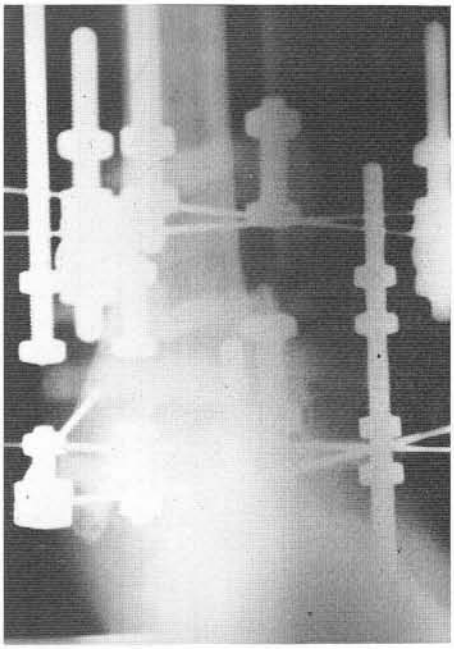

Figure 9B. Postoperative AP radiograph.

Figure 10. Patients are allowed full-weight bearing on postoperative day one.

Figure 11A. One year postoperative AP radiograph.

Figure 11B. One year postoperative lateral radiograph.

The patient had a complete fusion of the ankle at twelve weeks after application of the Ilizarov frame. He was full-weight bearing with crutch assistance on postoperative day one. Four weeks after surgery, he no longer required the use of crutches and was full-weight bearing.

CASE PRESENTATION 2

A 52-year-old male with insulin-dependent diabetes mellitus and multiple left foot surgeries, presented with a fixed varus position of the ankle and a severe equinus. His previous surgeries were bone resection for recurrent osteomyelitis and an attempted subtalar fusion. The patient had minimal sensation distal to the ankle. Realizing that a common complication of a Charcot foot deformity is breakdown of the contralateral side, an Ilizarov frame was chosen so that the patient could be full weight-bearing immediately, with equal stress placed on both extremities.

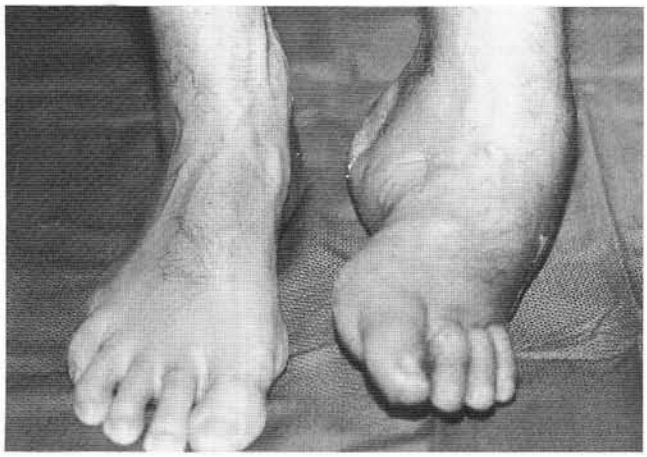

Figure 12. Clinical comparison of the patient's right and left (preoperative) feet.

Figure 13. Clinical appearance of the left foot. Notice the ulceration at the lateral malleolus.

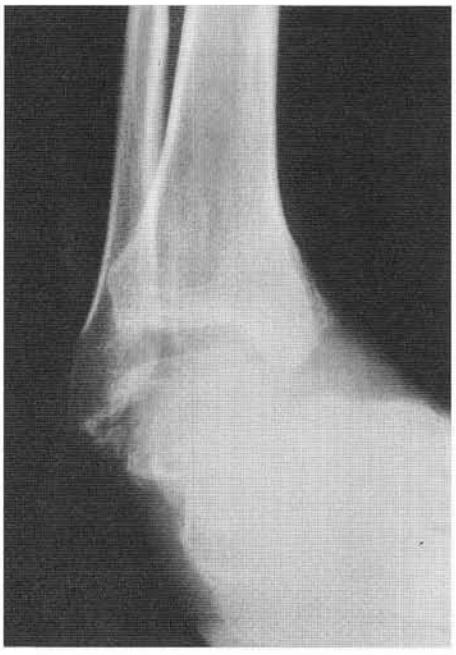

Figure 14A. AP radiograph of the left ankle.

Figure 14B. Lateral radiograph of the left foot.

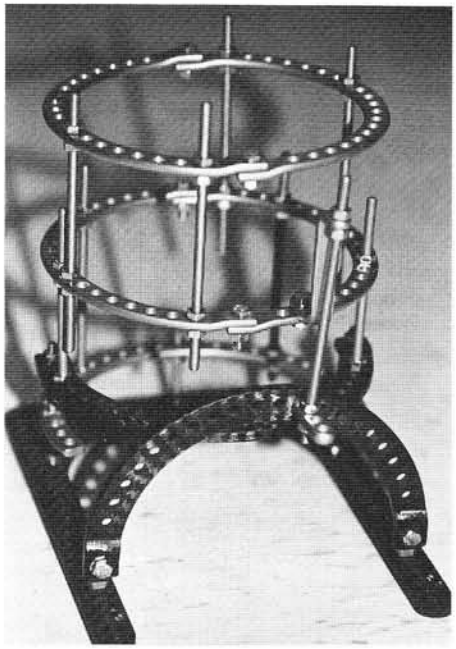

Figure 15. Preoperatively the Ilizarov frame is constructed.

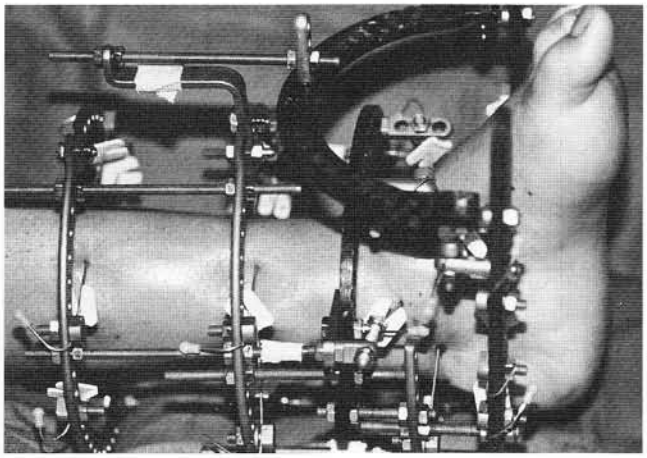

Figure 16. Postoperative view of the frame after application.

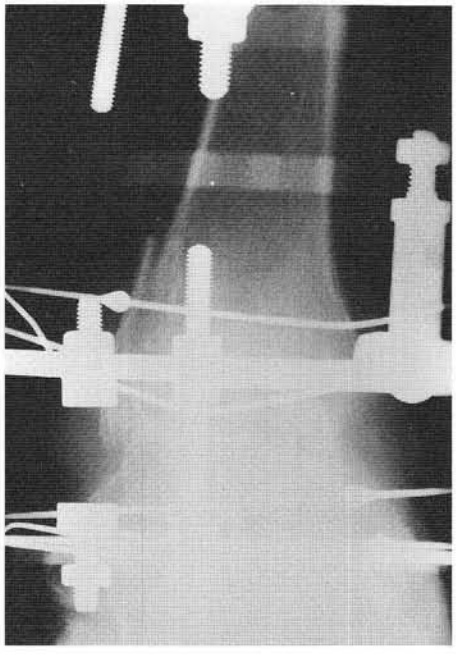

Figure 17. AP radiograph of the left ankle demonstrating the fusion site after application of the frame.

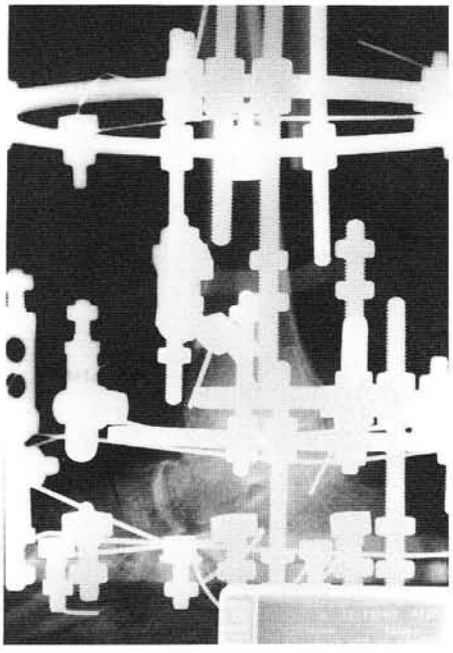

Figure 18. Lateral radiograph of the left ankle.

Figure 19A. Preoperative radiograph of the left ankle.

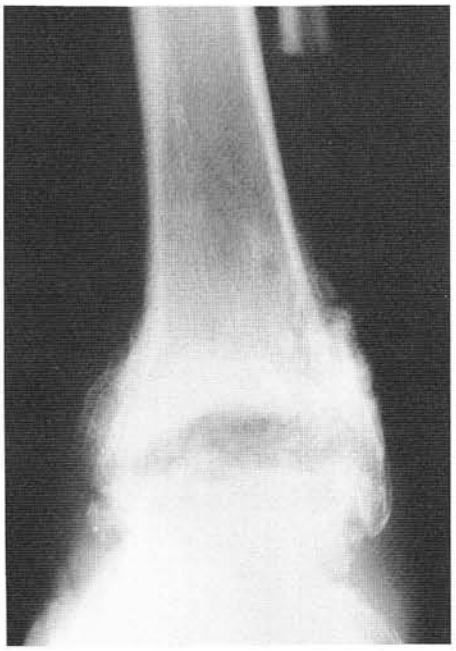

Figure 19B. Six month postoperative AP radiograph.

Figure 20A. Preoperative lateral radiograph of the left ankle.

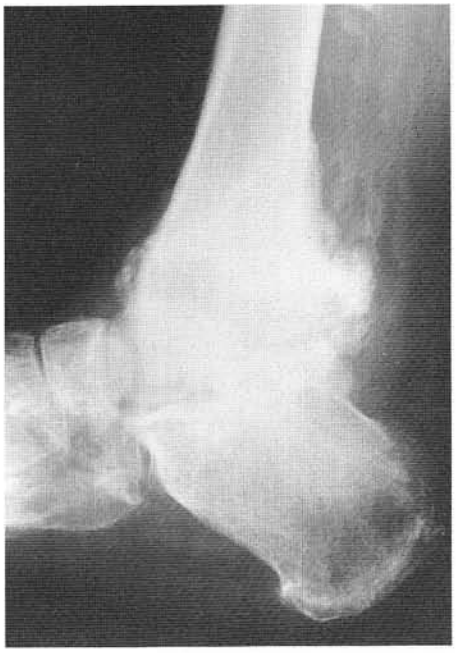

Figure 20B. Six month postoperative lateral radiograph of the left ankle.

The previous case describes arthrodesis of an ankle with Charcot deformity. The patient was full-weight bearing on the affected extremity on postoperative day one, and was working full-time for fifteen weeks with his frame applied, since postoperative week one.

CASE PRESENTATION 3

A 33-year-old obese female presented with a chief complaint of right ankle pain. She was in an automobile accident sixteen months prior to presentation. She was diagnosed as having a right ankle fracture and was casted non-weight bearing for eight weeks. Her right ankle was then placed in an aircast for an additional four weeks. After several months of conservative care, pain was still present, so the surgeon elected to perform an ankle arthroscopy. However, no pathology was found at the time of surgery. After no relief of symptoms, the patient presented with persistent pain to a second surgeon who also elected to perform an ankle arthroscopy. Again the operative reports suggested a normal ankle. The patient then presented to the author with significant pain of the right ankle with range of motion and weight bearing secondary to a varus position.

Figure 21A. AP radiograph demonstrating a normal appearing joint with an old fracture of the distal fibular malleolus.

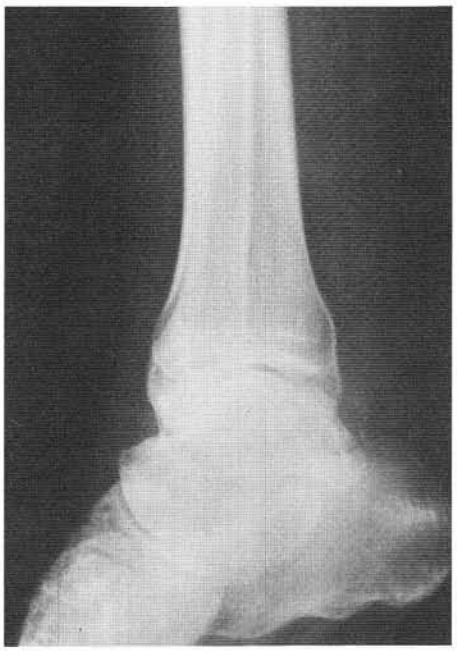

Figure 21B. Lateral radiograph.

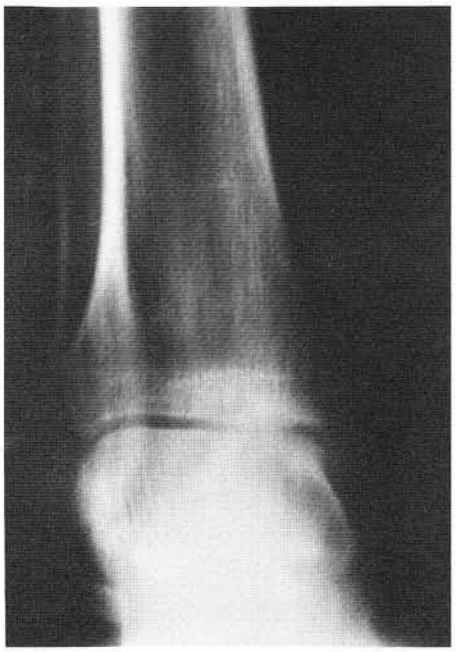

Figure 22A. Tomograms were performed and were essentially normal

Figure 22B. Normal Tomogram

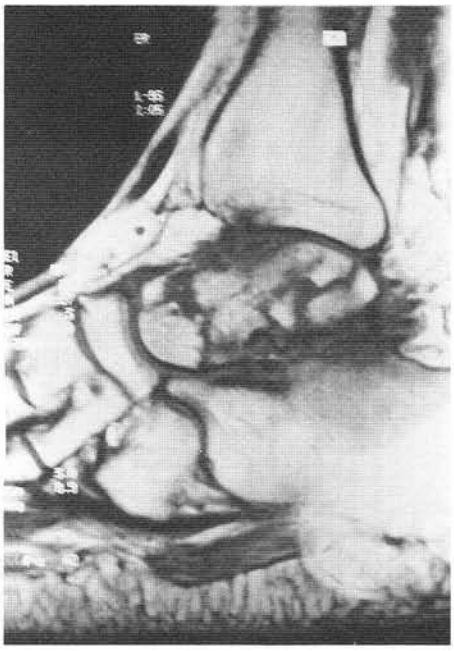

Figure 23A. A CT scan was performed, and demonstrated a comminuted intra-articular fracture of the talus. It was decided that arthrodesis of the patient's right ankle was the most reasonable option for treatment at that point. However, if an ankle fusion was performed using internal fixation, the potential for failure would be quite high due to the significant fragmentation of the talus.

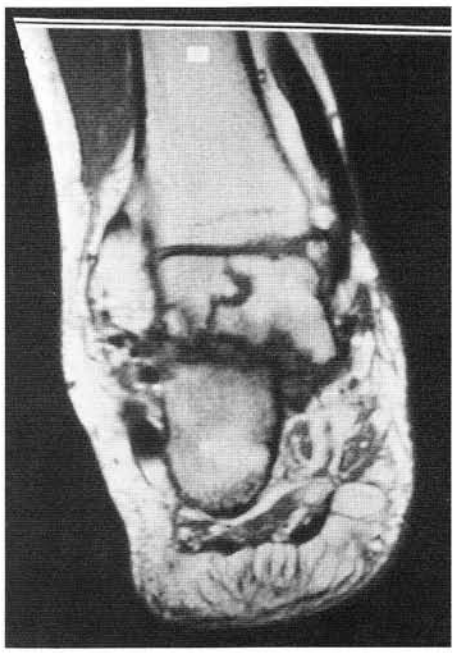

Figure 23B. CT scan demonstrating a sagittal plane fracture of the talus.

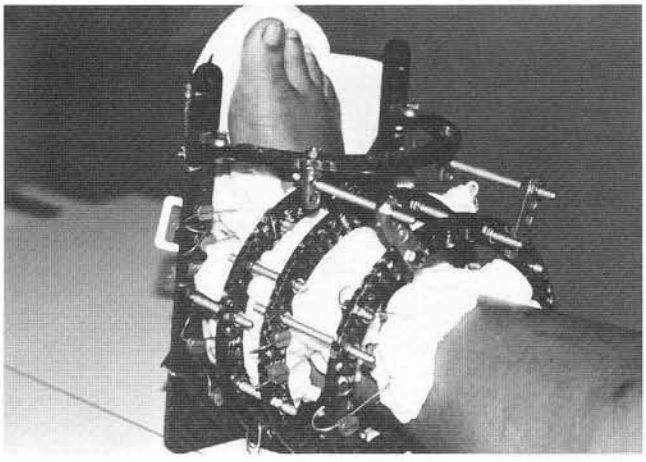

Figure 24A. Due to the status of the talus, in addition to the weight of the patient, external fixation utilizing an Ilizarov frame was chosen.

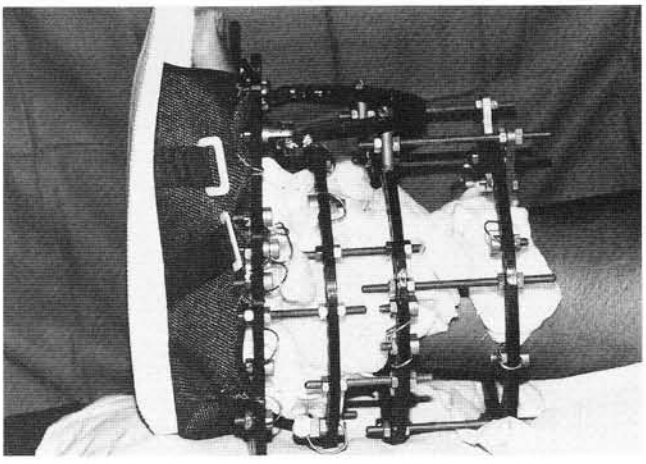

Figure 24B. Lateral view.

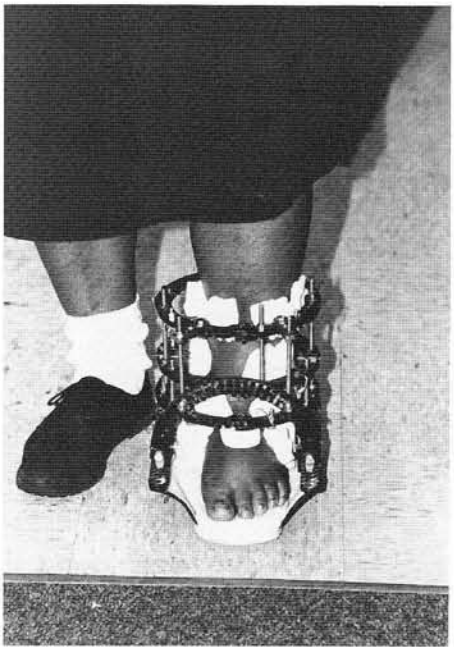

Figure 25. View of the patient full-weight bearing postoperative week one.

Figure 26A. Eight month postoperative AP radiograph with excellent fusion noted.

Figure 26B. Eight months postoperative lateral radiograph.

The patient remained full weight bearing with the frame for approximately ten weeks. She is pain free and back to work full-time using a rocker-bottom sneaker.

The Ilizarov frame can be used in complex ankle fusions when failure of previous procedures resulted in destruction of the talus or demineralization of the tibia or calcaneus. Full-weight bearing can be achieved immediately, a benefit to the diabetic patient with Charcot degeneration. With patient non-compliance or those who would not be expected to do well with non-weight bearing status, the Ilizarov frame is an excellent option for fixation purposes.