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End-Stage Hindfoot Arthrosis: Outcomes of Tibiocalcaneal Fusion Using Internal and Ilizarov Fixation

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ABSTRACT

End-stage post-traumatic pantalar arthrosis from ankle, pilon, and talus fractures has often been complicated by infection, bone loss, and a soft tissue deficit. Patients can present with neuropathy, diabetes, tobacco use, and previously failed arthrodesis. Fusion in this population has been challenging, with nonunion rates up to 30%, often leading to amputation. We reviewed the results of a standardized protocol that combined simultaneous internal fixation with the Ilizarov technique to achieve fusion in high-risk patients. With institutional review board approval, a retrospective review of the patients treated with simultaneous internal fixation and an Ilizarov frame was undertaken. The records and radiographs allowed identification of the comorbidities and the presence or absence of successful fusion. Complications were acknowledged and treated. Fifteen patients had undergone the procedure. The mean follow-up period was 27.9 (range 9 to 67) months. Thirteen patients (86.67%) had had previous fusion failure. Twelve patients (80%) had developed post-traumatic arthrosis, 5 (33.33%) of whom had open injuries. All patients had 1 comorbidity, and 10 (66.67%) had multiple, including rheumatoid arthritis, diabetes (types 1 and 2), and smoking. Four patients (26.67%) presented with deep infection and bone loss. Union was achieved in 11 (73.33%), with 12 (80%) patients experiencing profound pain relief. Seven patients (46.67%) required symptomatic hardware removal. Three patients (20%) eventually underwent below-the-knee amputation for recalcitrant nonunion. Statistically significant correlations were found between smoking and wound infection and revision and between nonunion and amputation. Our results have indicated that combined internal fixation with Ilizarov application can provide a strong surgical option for the management of end-stage, pantalar arthritis. More studies are needed to compare the cohort outcomes and gait analysis in these patients with those who have chosen below-the-knee amputation.

Hindfoot and ankle arthritis has a diverse etiology. For advanced cases, the reference standard of treatment has been arthrodesis of the involved joints. In ideal patient populations, for example, gait analysis of patients with ankle fusion has shown a shortened stride but near normal velocity and cadence and union rates of up to 90% with internal compression (1). A 2007 meta-analysis of more than 1000 ankle fusions confirmed the effectiveness of the procedure, with an incidence of revision of 9%, with 65% of the revisions required for nonunion (2). However, in patients who smoke, drink alcohol, have diabetes mellitus, or have experienced open trauma with soft tissue loss and those with psychiatric disorders, the nonunion rates can be substantial, up to 19% in a study by Perlman and Thordason (3). When a previous fusion has failed in such at-risk patients, the malunion rate for revision has been reported to be as great as 30% (4). However, this is also the patient population with the most severe pathologic features, and, in many cases, their only other satisfactory alternative is below-the-knee amputation (or a more proximal amputation in some cases). However, patients are not eager to part with their limbs, even when facing the greater rates of failure and the potential for several more procedures with arthrodesis. Also, it has been shown by MacKenzie et al (5) that in terms of healthcare costs, limb salvage—including complications and everything—will be about $10,000 less than the costs of amputation at 2 years when including the cost of

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Table 1
Statistical description of case series (n = 15 patients with unilateral tibiocalcaneal fusion)

Exposure (risk factor) or Outcome	Value
Age (yr)	46.33 (21 to 68)
Female gender	10 (66.67)
Left ankle involved	5 (33.33)
Traumatic etiology	12 (80.00)
≥1 Comorbidity	9 (60.00)
Diabetes mellitus	1 (6.67)
Active cigarette smoker	7 (46.67)
Previous surgeries (n)	2.93 (0 to 10)
Iliac crest bone graft used	11 (73.33)
Hospital stay (d)	4.93 (2 to 10)
External fixation duration (d)	85.93 (53 to 156)
Pin tract infection	5 (33.33)
Pin revision	1 (6.67)
Incision infection	4 (26.67)
Incision revision	3 (20.00)
Deep vein thrombophlebitis	0
Successful arthrodesis	11 (73.33)
Pain relief	12 (80.00)
Additional surgery required	9 (60.00)
Hardware removal	7 (46.67)
Total follow-up duration (mo)	27.86 (9 to 67)

Data presented as mean and percentage n (%).

prosthetics. The lifetime healthcare costs for amputation have been approximately 3 times as much as salvage (5). Keeping the affected extremity, therefore, becomes worth it, not only for the patient's desires, but also economically.

In patients with risk factors, who choose to undergo arthrodesis as a limb salvage procedure for end-stage hindfoot and ankle arthrosis, and for those patients whose fusion has failed, the challenge becomes finding a method to maximize the incidence of fusion and minimize the complications. At our institution, for the past 9 years, surgeons have developed a technique of tibiocalcaneal arthrodesis, coupled with Ilizarov external fixation, to increase compression across the fusion sites. In the present report, we have retrospectively described the outcomes we observed in a series of patients who had undergone tibiocalcaneal arthrodesis using Ilizarov external fixation.

Patients and Methods

The present study included consecutive patients treated from July 2003 to May 2010 who had undergone tibiocalcaneal arthrodesis with Ilizarov application at St. Louis University Hospital (St. Louis, MO). The data were abstracted from the medical records by one of us (B.C.). The indications for the Ilizarov technique included impaired healing potential owing to diabetes mellitus, cigarette smoking, previous nonunion of the fusion site, a history of infection at the fusion site, and/or soft tissue deficits localized to the ankle and hindfoot. The operations were performed using the same techniques by the same surgeons (J.T.W., J.J., D.E.K.). Each arthrodesis was performed using a transfibular and anteromedial arthrotomy, as needed. Sagittal plane fibular osteotomy with corresponding removal of the medial half of the distal 8 cm of the lateral malleolus was followed by removal of the articular cartilage and necrotic bone of the ankle and subtalar joints through both incisions. Ankle alignment was restored before application of the hardware and bone graft to achieve fusion. The surgeon applied the Ilizarov fixator in compression across the fusion site. Two tibial rings, rigidly placed above the fusion site, were attached to a foot frame using tensioned thin wires and half pins (Fig. 5). In all cases, we attempted to preserve as much bone as possible during this procedure and used the talus denuded of its cartilage and additional autogenous and allogeneic bone grafts at the surgeon's discretion. The ring fixators remained on the extremity for approximately 10 to 12 weeks, and patients were allowed to bear weight in the frame as tolerated. At the time of fixator removal, pin tracts were irrigated and debrided, and after all wounds were healed, patients were advanced to weightbearing as tolerated, at approximately 2 weeks. The foot and ankle frames were left on the extremity for approximately 10 to 12 weeks, and the patients were allowed to bear weight on the frame as tolerated. All pin tracts were irrigated and debrided at external fixation removal, and the patients were allowed to advance to weightbearing when the pin sites had healed, at approximately 2 weeks.

The exposure and outcome measurements we focused on included age, the reason for fusion (etiology), previous ankle surgeries, medical comorbidities, smoking status, fusion type, the use of an iliac crest bone graft, the length of hospital stay, pin tract infection, period the Ilizarov frame was on the patient, clinical and radiographic union, pain relief, and the need for additional surgery after fusion. The data were analyzed using Microsoft Excel (Microsoft Excel 2007, Microsoft, Redmond, WA). Initially, descriptive numbers, such as age and duration of Ilizarov retention, were averaged. The collected information was then transformed to nominal data, with 1 indicating "yes" and 0, "no" for all variables, except age, length of stay, and the reason for fusion. Once this was completed, the information was used to calculate the percentages and to run Pearson's correlation matrix to show any significant relationships between the variables. Using below-the-knee amputation as the major outcome in our study, each variable was then run against below-the-knee amputation in a phi coefficient analysis to determine whether an association was present between any predisposing measure and amputation. This analysis was done using SPSS, version 15.0 for Windows (IBM, Somers, NY). The statistical analyses were performed

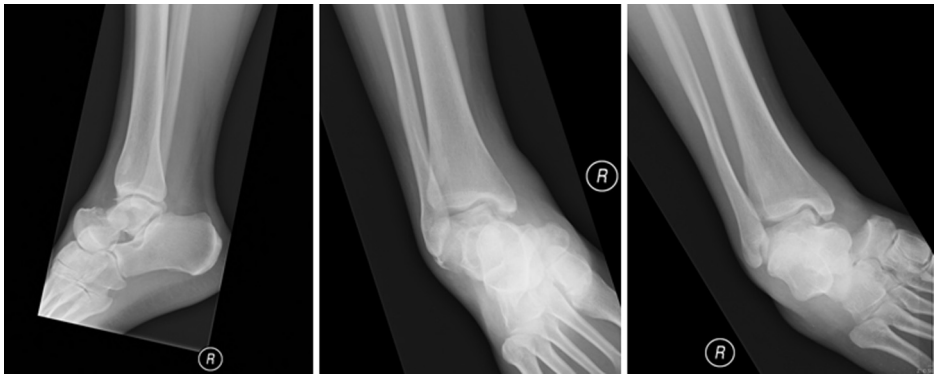

Fig. 1. Anteroposterior, lateral, and oblique radiographic views of the right ankle showing a talar neck fracture dislocation.