Combined circular external fixation and open reduction internal fixation with pro-syndesmotic screws for repair of a diabetic ankle fracture

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The surgical management of ankle fractures among the diabetic population is associated with higher complication rates compared to the general population. Efforts toward development of better methods in prevention and treatment are continuously evolving for these injuries. The presence of peripheral neuropathy and the possible development of Charcot neuroarthropathy in this high risk patient population have stimulated much surgical interest to create more stable osseous constructs when open reduction of an ankle fracture/dislocation is required. The utilization of multiple syndesmotic screws (pro-syndesmotic screws) to further stabilize the ankle mortise has been reported by many foot and ankle surgeons. In addition, transarticular Steinmann pins have been described as an adjunct to traditional open reduction with internal fixation (ORIF) of the ankle to better stabilize the talus, thus minimizing risk of further displacement, malunion, and Charcot neuroarthropathy. The authors present a unique technique of ORIF with pro-syndesmotic screws and the application of a multi-plane circular external fixator for management of a neglected diabetic ankle fracture that prevented further deformity while allowing a weight-bearing status. This technique may be utilized for the management of complex diabetic ankle fractures that are prone to future complications and possible limb loss.

Keywords: revisional foot and ankle surgery; diabetes; Charcot neuroarthropathy; trauma-external fixation; complications

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Due to the increasing prevalence of diabetes combined with longer life expectancies of the population, foot and ankle surgeons are frequently faced with the challenge of treating ankle fractures among patients with multiple comorbidities (1–8). Increased complication rates exist for both non-operative and operative management of diabetic ankle fractures; therefore, patients treated for such injuries should be informed of the risks. Wound healing problems, malunion, delayed or non-union, infection, and Charcot neuroarthropathy are among the most common sequelae. In an effort to reduce complications by increasing rigidity of fixation for operatively indicated fractures, several techniques have been reported including longer plates (9), supplementary Kirschner wires in plated fibulas (10), multiple fibula–tibia syndesmotic screws (11–15), locked plating (16), transcalcaneal-tibia pin fixation (17), and circular external fixation (7, 15). The authors present a case demonstrating a novel surgical approach combining ORIF with pro-syndesmotic screws and circular external fixation for a diabetic ankle fracture. This technique can provide surgeons with a viable option when faced with treating certain complicated diabetic ankle fractures.
Case presentation

A 67-year-old male presented to the outpatient clinic with a chief complaint of ambulatory difficulty and a history of an ankle fracture and deformity. The patient’s daughter reported that her father sustained an ankle fracture 6 weeks ago and was hospitalized. The history revealed that the patient was placed in a short-leg cast and surgery was considered but not performed since the ankle mortise was reduced at that time and the patient’s ankle displayed multiple fracture blisters. The patient was discharged to a rehabilitation facility during which time the cast was removed secondary to non-compliance and skin compromise. The patient’s daughter stated that her father was fully ambulatory at 2 weeks after the initial injury despite medical advice. Unfortunately, he was unaware of his ankle fracture since he suffered from dementia and Alzheimer’s disease. His medical history was also significant for poorly controlled diabetes mellitus, peripheral neuropathy, peripheral vascular disease, prior alcohol abuse, seizures, aortic stenosis, meningioma, and hypertension. A physical examination revealed a well-nourished individual who was in no acute distress and was alert but not oriented to time, person, or place. His vital signs were stable. The left lower extremity was edematous with a non-infected necrotic wound over the medial malleolus. The ankle and rearfoot displayed severe valgus deformity with the medial malleolus causing pressure necrosis to the overlying soft tissue. He had weakly palpable pulses and loss of protective sensation when examined with a 5.07 Semmes-Weinstein monofilament. Radiographic evaluation revealed a displaced fibular fracture with significant ankle joint subluxation and widening of the medial clear space (Fig. 1). The patient was admitted to the hospital and stratified as moderate risk for surgical intervention after optimized by both internal medicine and cardiology.

Non-invasive vascular studies that consisted of ankle-brachial index, toe-brachial index, and pulse volume recordings demonstrated moderate arterial occlusive disease with a falsely elevated ankle-brachial index secondary to calcified vessels. The patient was then evaluated by vascular surgery and after angiography was performed, adequate collateral circulation was present and their recommendation was to proceed with appropriate surgical intervention. The patient was brought to the operating room after obtaining informed consent from his daughter, as he was deemed not competent to make his own medical decisions. The patient underwent operative intervention that consisted of ORIF of his fibular fracture with placement of multiple pro-syndesmotic screws and application of a multi-plane circular external fixator. Postoperatively, the patient was permitted to fully weight-bear with the external fixator and discharged to a rehabilitation facility. The patient developed a postoperative infection that was evident 3 weeks after surgery, as wound dehiscence and drainage were apparent. The patient was readmitted to the hospital for inpatient care. The patient was brought back to the operating theater during this admission for an incision and drainage of the ankle wound with collection of deep intra-operative soft tissue cultures and reclosure of the wound over a drain. The drain was removed at 72 h and then wet to dry dressings were applied daily until the wound was healed. Deep intra-operative cultures grew methicillin-resistant *Staphylococcus aureus*. The patient was initially placed on parenteral administration of Vancomycin but was switched to oral administration of Zyvox after the first week as the patient continued to remove his peripherally inserted central catheter line. His antibiotic regimen was continued 6 weeks for treatment of deep infection with retained hardware. The patient healed his wound at 6 weeks postoperatively and was full weight-bearing with the external fixator for 12 weeks total time.

The external fixator was removed and the patient was placed into a walking total contact cast for a total of 6 weeks with cast changes performed at 2 week intervals. The patient was able to resume full ambulatory status with prefabricated extra-depth diabetic shoes with soft inlays at 18 weeks postoperatively. The patient continued to maintain an ambulatory status with no further complications at his 8-month follow-up (Fig. 2).

Technical considerations

An ORIF of the fibula with placement of multiple pro-syndesmotic screws was first performed in routine fashion. The external fixation construct consisted of two tibia rings, a talus ring, and a foot plate. The construct was pre-built and positioned to the lower leg and foot by placing surgical towels on the posterior aspect of the lower leg and heel. The tibia segment was secured with a frontal plane and medial face smooth wires that were tensioned to 130 kgf, generating an estimated force of 1275 N. Two opposing olive wires were utilized to stabilize the calcaneus and tensioned to 90 kgf, generating an estimated force of 887 N, after being attached to the foot plate. A smooth wire was also placed into the midfoot and forefoot and tensioned by hand after being attached to the foot plate. The next step consisted of the placement of three olive wires that were placed to prevent further valgus forces across the ankle joint. Two olive wires were placed in the tibia from medial to lateral, approximately 10 and 15 cm, respectively, from the ankle joint and tensioned to 90 kgf after being attached to two straight plates that extended from the tibia segment.

An additional olive wire was placed from lateral to medial across the body of the talus and tensioned to 90 kgf after being fastened to the talus ring. The authors believe the technique consisting of these last three olive wires offered tremendous stability and control of the talus.
while preventing medial displacement of the tibia as the patient resumed a weight-bearing status. The remaining construct of the proximal tibia block and foot plate offered static osseous stabilization of the foot and leg. A full circular ring and a shoe were attached to the foot plate to allow the patient the ability to walk safely with the external fixation device.

**Discussion**
Successful ORIF of ankle fractures among diabetic patients with peripheral neuropathy can be challenging (1–5, 18). The authors’ combination of ORIF with pro-syndesmotic screws and circular external fixation provides a stable, rigid construct that is capable of maintaining fracture reduction while also allowing weight-bearing through the postoperative healing course. Long-term outcomes including complication rates, functional evaluation, and limb survivability must be assessed amidst these new techniques for management of diabetic ankle fractures to determine if they are truly worthwhile and advantageous. Minimally invasive fracture reduction and stabilization with internal fixation...
combined with external fixation is often utilized in lower extremity fracture patterns that have high risk of soft tissue complications (19, 20).

**Conclusion**
Early recognition and a treatment plan that considers the anticipation of potential complications are paramount to the peri-operative management of diabetic ankle fractures. This article presents a novel technique that may be beneficial for the management of select ‘high risk’ diabetic ankle fractures.

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The authors have not received any funding or benefits from industry or elsewhere to conduct this study.

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