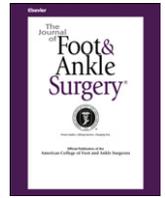




Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org



Limb Salvage: Revision of Failed Intramedullary Nail in Hindfoot and Ankle Surgery in the Diabetic Neuropathic Patient

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ARTICLE INFO

Keywords:

blade plate
Charcot arthropathy
fibula
surgery
T-plate
talus
tibia

ABSTRACT

Herein, we illustrate an operative technique to attain limb salvage after a failed intramedullary nail in the diabetic Charcot neuropathic patient. The use of the blade plate, or T-plate, in combination with external fixation, fastened into the body of the calcaneus allows for greater bone capture. Our experience has shown that this provides for a stable, long-lasting construct.

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Ankle and subtalar joint arthrodesis via an intramedullary nail has been used for decades as an effective surgical procedure in hindfoot conditions involving subtalar and ankle joints (1). Kile et al were considered to be pioneers in spearheading the use of retrograde intramedullary nailing for tibiotalar calcaneal arthrodesis (2). This fixation technique soon proved to be effective and internally stiffer when compared with any other fixation device (3).

The main indication for intramedullary arthrodesis includes severe posttraumatic arthrosis of the subtalar and ankle joint (4). Complications with such procedures involve nonunion, malunion, implant failure, persistent pain and fracture, malalignment, and deep infection with reports as high as 60% (4–6). As indications for intramedullary nailing have expanded, complication rates may increase.

In 2010, according to the American Diabetes Association, 1.9 million new cases of diabetes are diagnosed each year. The American Diabetes Association also reports the incidence of diabetes in the United States to be prevalent amongst 25.8 million people, accounting for 8.3% of the population (7). Charcot arthropathy (CA), due to diabetes mellitus, has been known to affect the foot and ankle region anywhere from 1% to 16% of the time (2,8–11). Despite the above-mentioned incidence, other authors believe that the incidence is much higher than reported because of misdiagnosis (12). The major causative factor in the development of CA is the presence of sensory

peripheral neuropathy (13). Additionally, increased plantar pressure, ulceration, age, obesity, trauma, and joint instability are among the risk factors for development of CA. Pinzur et al noted obesity to be present in at least two thirds of the patients presenting with CA (14). Armstrong et al reported increased plantar pressures present in the limb with CA compared with those without neuropathy, or feet with neuropathy but without ulcers (15). CA involving the midfoot or hindfoot has 8.5 times greater midfoot peak pressure than non-Charcot patients (16). Of the reported 53% of Charcot patients, 43% are noted to have ulceration present on the affected limb (14,17). Trauma has also been known to play a role in the formation of CA as noted by various authors ranging from as minor as a ligament sprain to a fracture (13). A history of trauma was noted to be present 22% to 53% of the time in patients presenting with CA, regardless of the location (9,13,14,18).

The review of the literature demonstrated one treatment option that offers a limb salvage technique when removal of the intramedullary nails is warranted (19). Advancements in techniques and implant technology should yield outcomes in revision arthrodesis comparable with those of a primary procedure. We report on a salvage technique using a blade plate and/or a T-plate (locking and nonlocking plates) in combination with external fixation to treat 3 revisional failed intramedullary nails.

Surgical Technique

The patient is placed in a supine position on a radiolucent operating table with the entire extremity exposed and in a vaguely elevated position subsequent to the administration of general or

Financial Disclosure: None reported.

Conflict of Interest: None reported.

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Fig. 1. Oblique view presenting fractured calcaneus, hardware, and inferior migration of the intramedullary nail.

spinal anesthesia. A well-padded thigh tourniquet is used for hemostasis. Attention is directed toward the plantar aspect of the foot using the original plantar incision. Fluoroscopy is used to assist in the location of the locking end cap. The end cap is removed, and if infection is suspected, a deep culture is taken and a jig is hooked to the nail for removal. In cases where interlocking screws were used, these screws are removed with fluoroscopic assistance before removing the nail. If the plantar site appears to be infected, after removal of the nail, the intramedullary canal is progressively reamed until the contents are noted to be mostly fresh bone. Pulse irrigation followed by placement of antibiotic beads in the canal and temporary fixation of 2 Steinman pins and/or external fixation is performed. The standard infectious disease course of treatment is then used until clinical and laboratory signs of infection are resolved. If the wound is not infected,



Fig. 2. Lateral view of the right ankle demonstrating a pseudarthrosis with fractured screws and collapse of the arthrodesis.



Fig. 3. Postoperative oblique radiograph after application of AO technique and a lateral T-plate.

a primary closure of the plantar incision is performed and the procedure continues.

Attention is directed to the lateral aspect of the ankle by means of a transfibular approach. All soft tissues are freed from the remaining fibula and tibia. The diseased section of the ankle joint and/or subtalar joints are resected, ensuring there is healthy, bleeding bone. Aggressive debridement of surrounding soft tissue and disease joints is performed with a combination of rongeurs, osteotomes/mallet, and curettes until well-vascularized bone surfaces are visualized. The distal lateral malleolus is resected proximally and is prepared to be used for an inlay or onlay graft. The presence or absence of abnormality/malalignment is recognized preoperatively to amend the operative method accordingly. An in situ arthrodesis is performed on



Fig. 4. Postoperative lateral radiograph after application of AO technique and a lateral T-plate.



Fig. 5. A 58-year-old obese woman presented with a pseudarthrosis subsequent to an attempted tibiotalocalcaneal arthrodesis. Note the failure of arthrodesis and the “backing out of the screw.”

the patient who presents without an angular or rotational deformity. If these deformities exist, a corrective wedge osteotomy or an interpositional bone graft is required. In either situation, the hindfoot is adjusted in neutral dorsiflexion position, 0° to 5° of hindfoot valgus and the foot externally rotated approximately 5° to 10° or similar to the contralateral side. A posterior translation of the hindfoot on the tibia is performed. All bony voids are then packed with autogenous or allogenic graft followed by a standard Arbeitsgemeinschaft für



Fig. 6. Oblique radiograph demonstrating failure of arthrodesis, “backing out of screw,” and inferior migration of nail.



Fig. 7. Intraoperative anteroposterior ankle with screw fixation and application of lateral T-plating.

Osteosynthesefragen (AO) technique of a blade plate or a T-plate (locking and/or nonlocking plates) from lateral to medial. A large, fully threaded cancellous screw is inserted either from the posterior/inferior aspect of the calcaneus into the anterior/distal aspect of the tibia, or vice versa. The blade position of a blade plate is anchored into the body of the calcaneus. If a T-plate is used, it is inverted, allowing for the wide component of the “T” to be fastened to the body of the calcaneus. Typical soft tissue closure is performed followed by an application of an external multilevel circular frame. If an ulcer is present, a technique involving complete elliptical excision and closure of the ulcer is performed in conjunction with an exostectomy as discussed by Leventen in 1986 (20).

Discussion

Numerous surgical techniques using intramedullary nails have been reported to achieve bony fusion in the hindfoot and ankle. The advancements have shown promising surgical results with increased healing rates. Oftentimes when intramedullary nailing failure exists, below-the-knee amputation tends to be the solution (21). Herein, we offer a technique using a blade-T-plate coupled with external fixation to be an effective revisional surgical procedure. To date there has been

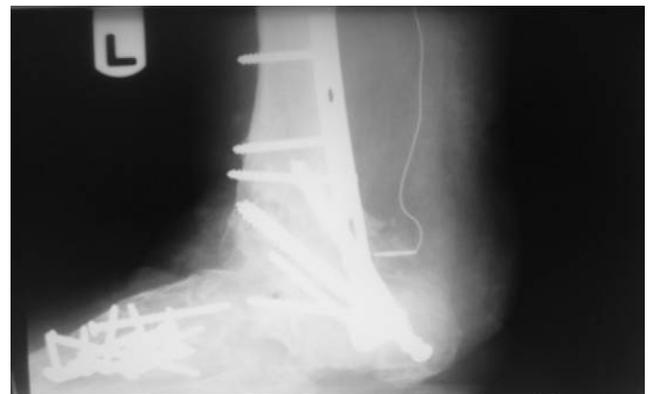


Fig. 8. Postoperative view of a successful arthrodesis with screw fixation and application of a lateral T-plate.



Fig. 9. Postoperative view of a successful arthrodesis with screw fixation and application of a lateral T-plate.

a single published article that discusses a revisional surgical technique for tibiotalocalcaneal arthrodesis due to failure of an intramedullary nail. In this case report, a healthy 44-year-old man presents with a painful pseudoarthrosis after a tibiotalocalcaneal arthrodesis. The choice of fixation was an intramedullary fibula with a laterally placed blade plate (19). Our experience with the 3 patients outlined herein has proven successful with long-term follow-up. The first patient, a 52-year-old obese woman, presented with a pseudarthrosis, a fractured calcaneus, and broken hardware subsequent to an attempted intramedullary nail tibiotalocalcaneal arthrodesis (Figs. 1 and 2). Oblique and lateral radiographs show fixation with the lateral T-plate (Figs. 3 and 4). She continues to be followed up a decade later and has had no further problems since the repair. The second female patient is now 64 years old and at her 6-year follow-up continues to enjoy a lasting joint construct. She presented with pseudarthrosis



Fig. 10. A 79-year-old moderately obese man presented with an infected pseudoarthrosis and fractured calcaneus after an attempted tibiotalocalcaneal arthrodesis. Note the inferior migration of the posterior-anterior calcaneal screw with inferior migration of the nail.

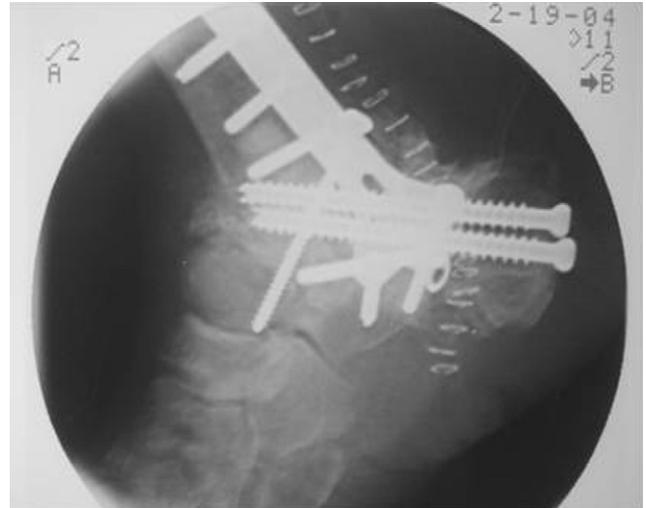


Fig. 11. Intraoperative view of internal fixation with an application of a laterally applied blade plate.

subsequent to a failed tibiotalocalcaneal arthrodesis (Figs. 5 and 6). Fixation was again achieved with a screw fixation and application of a lateral T-plate (Figs. 7–9). The third case was a moderately obese man who presented with an infected pseudoarthrosis and fractured calcaneus (Fig. 10). An intraoperative view shows the internal fixation with application of a laterally applied blade plate (Fig. 11). The successful arthrodesis is demonstrated in Fig. 12. The patient was 79 years old at the time of his surgery and died at age 85. He did not experience any adverse events in the 6 years after the repair.

In conclusion, the main goal of surgical correction of the hindfoot and ankle intramedullary nailing is to restore stability and alignment, prevent further destruction, and facilitate functional ambulation (22). Arthrodesis of the ankle and subtalar joint via an intramedullary nail is known to be an effective surgical procedure in severe hindfoot and ankle deformities. The review of the literature fails to adequately demonstrate a treatment option that offers a limb salvage technique when removal of an intramedullary nail is warranted. We have demonstrated that a transfibular approach, using a blade/T-plate in



Fig. 12. Postoperative oblique view demonstrating a successful arthrodesis using a laterally applied blade plate.

combination with a multilevel circular frame, in the style of Ilizarov, proves to be an effective means of limb salvage.

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