CHAPTER **27**

Tibiocalcaneal Arthrodesis as a Limb Salvage Solution for a Patient With Rearfoot Charcot Neuroarthropathy and Avascular Necrosis of the Talus

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INTRODUCTION

Jean-Martin Charcot, referred to by some as the father of neurology, first described Charcot joint disease, also known as Charcot neuroarthropathy (CN), in 1868, as a joint disease affecting patients with tabes dorsalis. Most literature and research described involvement of long bones and their articulations. The involvement of the bones of the foot and ankle was first described in 1881. In 1936, a scientist by the name of William Jordan was the first to recognize the correlation between diabetes mellitus and neuropathic arthropathies (1). Diabetic CN is one of the most debilitating complications that can arise in the diabetic patient. This condition affects 1% of diabetic patients worldwide and is of major concern for clinicians and patients alike (1,2). CN is present in approximately 29% of patients with diabetic neuropathy (2).

Reconstructive surgery for the treatment of chronic CN depends on the opinion of the surgeon. The type of deformity, the compliance and comorbidities of the patient, presence of infection, and pain level of the patient all have to be considered prior to surgical intervention (3). Some documented surgical procedures for the correction, realignment, and stabilization of hindfoot CN include Achilles tendon lengthening, plantar osteotomies, osseous debridement, realignment osteotomies, arthrodesis procedures, open reduction internal fixation, and external fixation (4). Surgical correction and realignment of hindfoot CN is said in the literature, to increase the patient's quality of life, reduce the probability of recurring ulcers, increase joint stability, and reduce painful exostoses. However, recurrent ulceration, nonunion, failure of hardware, and loss of the correction are common postoperative complications. The literature states that the lifelong economic burden on patients who undergo major lower extremity amputations is approximately $510,275 (5). This is approximately 3-times higher than the cost of a patient undergoing CN reconstruction. Post amputation, the 3 most important things to consider in terms of expenses are the prosthesis, level of limb loss, and the functionality of the patient following limb loss.

Internal fixation for CN reconstructive surgery is very challenging when utilized alone. It is becoming increasingly popular currently to perform reconstructive surgery with a combination of internal and external fixation (6). In CN, fusion of the affected joint allows stress shielding at the fusion site and deters inappropriate weight-bearing by securing a more biomechanically stable plantigrade foot. External fixators alone are also useful, however, pin tract infection is a common complication (7,8). Patients and families should be informed that there is always a chance of failure after reconstruction. It is a major surgery and is an attempt at limb salvage, preventing the need for a major lower extremity amputation.

The purpose of this case study is to present our surgical protocol for the treatment of rearfoot CN on a patient with an infected and obliterated talus. Tibiocalcaneal arthrodesis is a procedure seldom performed (9). The functional outcomes are reported to be inferior to that of the standard ankle fusion (10). Note that in this case study, an ankle fusion was not an option considering the completely obliterated talus (Figures 1, 2). It is also important to note that most patients who reach this level of severity of CN, ultimately require below-knee amputations. As a result, medical literature on solutions for dealing with this particular type of hindfoot CN is scarce. The purpose of the tibiocalcaneal arthrodesis is not to preserve functional range of motion, but to preserve the limb and to stabilize what is viably left of the hind foot (11).

LITERATURE REVIEW

With the presence of bone fragility, poor compliance with load-bearing restrictions, susceptibility to infection and peripheral vascular disease, the surgical management of CN has proven to be extremely challenging (8). Various techniques have been performed to correct the deformity such as stabilization via external fixation application and internal fixation with screws, pins, plates, intermedularry nails, and beaming. Many of these, however, render a significant cost to the patient and their family. A promising and cost-efficient solution to hindfoot CN is tibiotalar or tibiocalcaneal arthrodesis.

First described in the literature by Harry C. Blair for the management of talar body fractures, the tibiotalar arthrodesis advocates using a corticocancellous bone graft from the anterior tibia to be fused into the head of the talus. In severe fractures or osteonecrosis of the talar body, the necrotic or loose bone should be excised. A hole is then trephined into the head of the talus and the tibial graft is slid into place. In the original article, Blair did not utilize any means of fixation other than the relatively stable construct of the ankle joint itself (9). In 1982, Lionberger et al found there to be a pseudoarthrosis rate in tibiotalar arthrodesis of 28%. They found that by using a compression screw for fixation, the speed of healing increased and the incidence of pseudoarthrosis decreased. Since then, further additions to the stability of the procedure have been proposed such as the use of an anterior locking plate by Bergeyk et al or Steinmann pins inserted vertically into the calcaneus and through the tibia by Morris et al (10,11).

The tibiocalcaneal arthrodesis is an enticing surgical approach since it allows for some preserved motion in the midfoot, increased hindfoot stability and an overall normal cosmetic appearance of the foot (12-14), however it causes considerable shortening of the limb. Dennison et al performed the tibiocalcaneal arthrodesis procedure with external fixation on 6 patients with avascular necrosis of the talus and found 5 of the 6 to have good to excellent results (15). Each patient in this study was able to achieve solid fusion both clinically and radiographically, however, each patient had minor complications with the external fixation such as pin breakage and pin tract infections. Of the 6 patients, all patients reported having some degree of stiffness to the midfoot but also reported benefit in using rocker bottom sole shoes during extended ambulation (15).

Although a tibiocalcaneal arthrodesis has not been widely described in the literature for the treatment of diabetic CN, it should not be overlooked as a viable surgical intervention option. This can be achieved while maintaining accurate anatomic alignment and securing stability of the neuroarthopathic rearfoot, making tibiocalcaneal arthrodesis a valid option in the surgical management of the CN deformity.

CASE STUDY

The patient is a 54-year-old, Type II diabetic woman with peripheral neuropathy who has had diabetic complications for approximately 20 years. She has a history of smoking, hypertension, obesity, asthma, bronchitis, Cushing syndrome, and CN of the left foot. The patient presented to the Mercy Hospital Miami, FL emergency department on March 3, 2012 with a chief complaint of left foot pain, which was eventually diagnosed via radiographs and computed tomography (CT) as a superior medial avulsion fracture of the left talus. The patient was admitted for acute CN and osteomyelitis.

Surgical intervention was performed on March 5th, and involved a hindfoot triple arthrodesis of the left calcaneocuboid, talonavicular, and subtalar joints with external fixation. Approximately 13 weeks later, on May 30th, the external fixation hardware was removed without incident. However, on October 3rd, the patient again presented to the emergency department for severe pain of the left ankle. Radiographs showed chronic destruction of the left talus with sclerotic changes of the tarsal bones, calcaneus, and distal tibia and fibula, along with a periosteal reaction consistent with chronic osteomyelitis (Figures 1, 2). A CT was performed to be used for preoperative planning and to show the true extent of the damage. The CT revealed extensive destruction of the entire talus (Figure 3). Surgical intervention was then carried out on October 5th via tibiocalcaneal fusion and calcaneocuboid fusion revision with application of a bone and stem-cell allograft, and application of external fixation.

Surgical Procedure

The patient was placed in a supine position in the operating room. The surgical site on the left lower extremity was aseptically scrubbed and draped. After the induction of anesthesia, a thigh tourniquet was applied and set to 350 mm Hg. Using a #15 blade, a 10-cm incision was made along the anterolateral aspect of the left ankle, down to the level of subcutaneous tissue, ensuring that all small neurovascular structures traversing the incision site were either cut, clamped, ligated, or retracted. The incision was then deepened in the same plane, insuring that all larger neurovascular structures, tendons, and muscle bellies were retracted from the incision site and preserved. With aid of live fluoroscopy, the remnants of the obliterated talus were identified. After careful dissection of all attached soft tissue and structures, the remnants of the talus were excised in total with the aid of a bone rongeur.

Figure 1. Preoperative anterior/posterior radiograph of the left ankle.

Figure 2. Preoperative lateral radiograph.

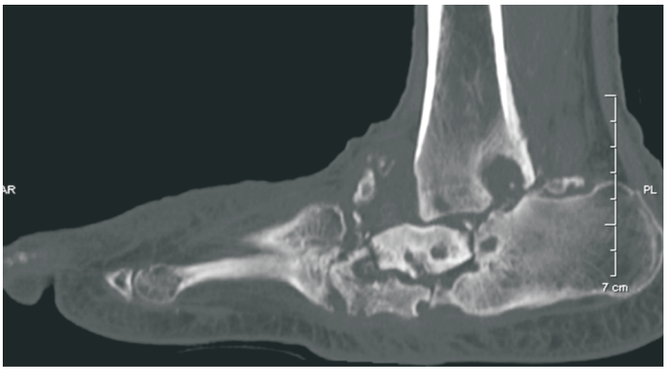

Figure 3. Preoperative sagittal computed tomography image.

Once the entire talus was removed (confirmed with fluoroscopy), the calcaneus and the tibial plafond were inspected. Attention was then directed to the calcaneocuboid joint, which was also cleaned out in total in preparation for the fusion. It was noted that there was a bone cyst measuring approximately 1.5 cm x 1.5 cm, which was removed through careful curettage. Final inspection was done clinically and under fluoroscopy. The intraoperative fluoroscopy showed good anatomic alignment of the tibia onto the calcaneus. Prior to closure, the calcaneus was fixated to the distal aspect of the tibia utilizing a Steinmann pin. A bone and stem-cell autograft was then applied to the fusion areas and into that area of the curetted cyst. All subcutaneous tissue was reapproximated with 4-0 and 3-0 vicryl sutures and skin staples were used for the reapproximation and closure of the skin.

After skin closure, a total of 8 pins were inserted in a cross sectional manner through the mid and proximal tibia, medial malleolus, lateral malleolus, calcaneus, and the forefoot. Once the foot was in a stabilized position, the pre-constructed circular external ring fixator was applied. The wires were tightened, tensioned, and bolted down to the ring fixator. The forefoot plate was applied, which successfully achieved an arch in the patient's midfoot. After the procedure, the tourniquet was deflated and dry sterile dressings were applied over the external fixation. Postoperative radiographs were taken in the post-anesthesia care unit (Figures 4, 5)

Follow-Up

Bone pathology results from the intraoperative bone biopsy showed fragments of trabecular bone with acute and chronic osteomyelitis. The patient was discharged with a 3 week course of oral Augmentin antibiotics. Complete fusion of the tibia to calcaneus was noted 2 months postoperative with the foot in good, plantigrade alignment. The patient reported no subjective symptoms. The patient was placed in a CAM boot and physical therapy was initiated 2 months after the circular external fixator was removed. The patient was placed in a Charcot restraint orthotic walker (CROW) boot 2 months after the initiation of physical therapy. At 9 months postoperative, the patient was able to ambulate without a boot, and with no reported pain.The radiographs at 12 and 49 months postoperative demonstrated a stable rearfoot with a solid fusion of the tibia onto the calcaneus (Figures 6, 7). As expected, the patient was noted to have a postoperative limb length discrepancy, with the left limb being shorter (Figure 8).

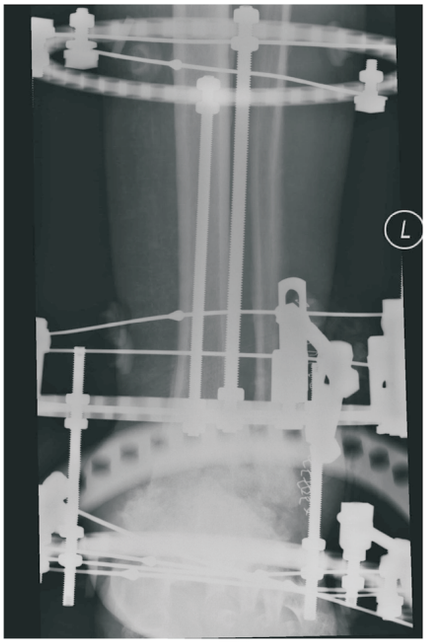

Figure 4. Same day postoperative anterior/posterior radiograph of the left ankle.

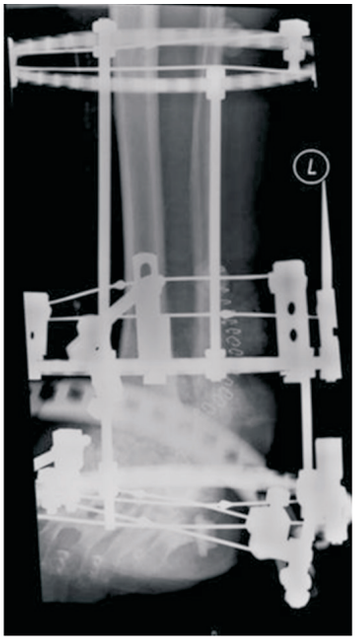

Figure 5. Same day postoperative mortise radiograph.

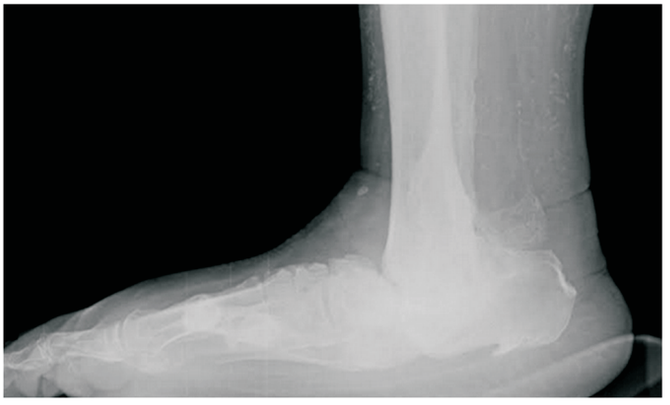

Figure 6. Lateral radiograph, 12 months postoperative.

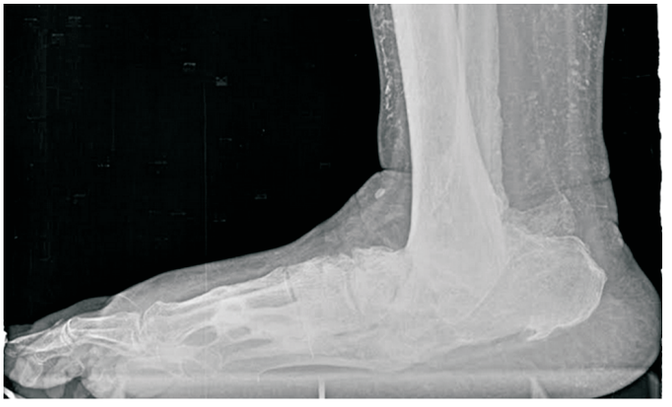

Figure 7. Lateral radiograph, 49 months postoperative.

Figure 8. Clinical view, 3 years postoperative. Note the limb length discrepancy. Customized orthopedic shoe modification to the left shoe is used to to compensate for the shortened left leg.

DISCUSSION

Traditionally, the indications for tibiotalar or tibiocalcaneal arthrodesis are avascular necrosis, talar fractures, osteomyelitis of the talus, intra-articular ankle fractures, and failed total ankle replacements. In this hindfoot CN case study, tibiocalcaneal arthrodesis achieved the primary goals of Charcot foot reconstruction, which are to stabilize the foot and ankle and to salvage the limb. Due to complete obliteration and osteomyelitis of the talus, secondary to complications of CN, the patient's foot and ankle were successfully stabilized surgically via excision of the remains of the infected talus, with tibiocalcaneal arthrodesis, and revision of calcaneocuboid arthrodesis with external fixation.

Although there is a void in the current literature indicating tibiocalcaneal arthrodesis as a viable surgical option for Charcot Foot reconstruction limb salvage, it is a formidable option that achieves the goal of stabilizing the neuroarthropathic hindfoot. There is a need for more research on tibiocalcaneal and tbiotalar arthrodesis for CN rearfoot deformities.

Although many would recommend a below-knee-amputation when the talus is non-viable, a tibiocalcaneal arthrodesis with circular external fixation produces adequate limb salvage. Note that this procedure does considerably compromise the length of the limb, but with advances in customized orthopedic modifications to footwear, the benefits of attained stability of the limb and patient satisfaction all outway the inherent risk of limb length discrepancy.

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