Single-Stage Tibiocalcaneal Retrograde Intramedullary Nail Arthrodesis and Distal Tibial Lengthening Utilizing External Fixation in Diabetic Charcot

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Statement of Purpose

Rearfoot Charcot reconstruction is fraught with complications, which often includes severe bone loss, subsequent altered gait, and symptomatic misalignment of the pelvis and spine. The purpose of this case is to present a surgical protocol to simultaneously realign and fuse the rearfoot and ankle using a retrograded nail and external fixator, while lengthening the distal tibia to reestablish pathologic limb length.

Literature Review

Many patients that require ankle arthrodesis as a result of severe bone loss from trauma, removal of infected bone or AVN have a significant degree of limb-length discrepancy. Greater LLD is associated with a higher risk of ankle nonunion [1]. To date, high risk LLD patients have been addressed in literature with proximal tibial osteotomies and simultaneous ankle fusions with external fixation showing excellent results. Katsenis et al [2] studied 16 limbs, and were able to successfully lengthen to 1.5cm shorter than the contralateral limb. 11 patients underwent simultaneous tibial lengthening with satisfactory outcomes. Similarly, in Rochman et al [3] eight patients underwent proximal tibial distraction osteogenesis in the Ilizarov frame to achieve equal limb length. External fixation gives good protection against torsional rotation but lacks good stability against plantarflexion and dorsiflexion movements at the fusion gap [4]. Rozbruch et al performed a 2-step hybrid technique lengthening first and then inserted an intramedullary nail once fused finding this technique more expedient with a quicker recovery decreasing the risk for refracture as previously found as a complication in literature [5]. Studies have also demonstrated 2-3 fold increase in blood flow in the bone segment under distraction arthrodesis as compared to the contralateral side, though to accelerate bone healing [1].

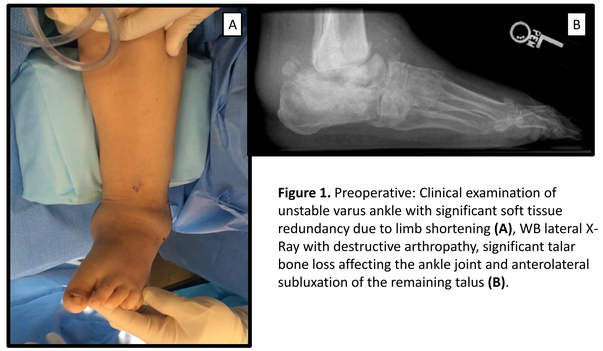


Figure 1. Preoperative: Clinical examination of unstable varus ankle with significant soft tissue redundancy due to limb shortening **(A)**, WB lateral X-Ray with destructive arthropathy, significant talar bone loss affecting the ankle joint and anterolateral subluxation of the remaining talus **(B)**.

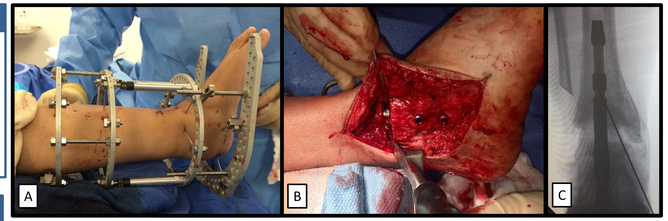


Figure 2. Intraoperative: External fixation construct **(A)**, tibial osteotomy site for lengthening **(B)**, unlocked proximal retrograde nail **(C)**.

Case Study

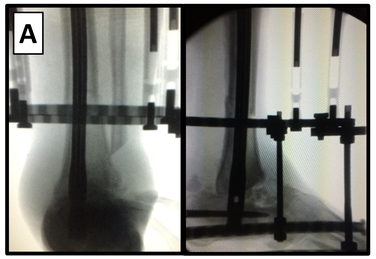
A 32-year-old female with Type I Diabetic Charcot Neuroarthropathy and chronic kidney disease, had a prior 2 month history of a traumatic injury to the left ankle prior to consultation. Films revealed a compression fracture and total destruction of the talus resulting in 3 cm of limb shortening (Fig. 1B). Physical examination revealed significant diffuse edema, erythema and warmth to the left ankle and hindfoot. Sensory neuropathy present to bilateral foot and ankles. Weightbearing exam revealed a varus tilt and slide of the ankle (Fig. 1A), with an antalgic gait favoring the right side with significant drop at the left hip. She subsequently underwent 3 months of non-weightbearing in a CAM boot, then AFO, which failed developing progressive instability and deformity. She then underwent a single-stage tibiocalcaneal arthrodesis via retrograde intramedullary nail with simultaneous distal tibial lengthening utilizing a circular external fixator.

Case Study and Surgical Procedure

The patient was brought to the operating room and placed on the operating table in supine position. General LMA anesthesia was administered. The left extremity was prepped and draped in the usual sterile manner and technique. Attention was directed to the left lateral ankle where a linear incision was made over the distal lateral malleolus and resected with a sagittal saw exposing the remaining ankle joint. A total talectomy was performed removing all remaining degenerated talus. After joint preparation, mesenchymal stem cell allograft was packed into the defect to augment the fusion site. Tibiocalcaneal arthrodesis was performed using a retrograded 200 mm intramedullary nail in a standard manner. It is important to note, to not lock the nail proximally, locking only the nail distally (Fig. 2C) so tibial lengthening via external fixator can be achieved. At the level of the distal tibial flare, approximately 6 cm proximal to the ankle joint, a complete tibial osteotomy was made with an osteotome (Fig. 2B) and then a circular external fixator in a compressive and lengthening Ilizarov construct was applied (Fig. 2A).

Results

Following application of the external fixator, a latency phase of 7-10 days begins. The tibia is then lengthened 1mm/day (0.25mm 4x/day) until lengthening goal is reached with goals of the limb to be 0-1 cm shorter than the normal limb, allowing toe clearance during the swing phase of gate. The fixator is maintained for an additional month to allow for consolidation, or when tibial cortices are sufficiently healed maintaining strict non-weightbearing. At approximately 3 months the frame is removed and the proximal tibial screw can be locked into the nail freehanded with C-arm guidance. Patient is then placed in a walking cast for 3-4 weeks and transitioned to a CAM-boot for 3-4 weeks with physical therapy. We recommend sport AFO or orthopedic shoes for long-term support. Plain films revealed stable internal fixation with approximately 3 cm of bone lengthening and bridging the distal tibial osteotomy site with corrected malalignment (Fig. 3B-C). After a period of protected weightbearing, she reported being pain free with steady ambulation in a plantigrade, braceable, stable foot (Fig. 3C, 4A-B). There has not been a recurrence in deformity or hardware complications at 60 months postoperatively ambulating in an Arizona brace and a custom molded accommodative shoe.



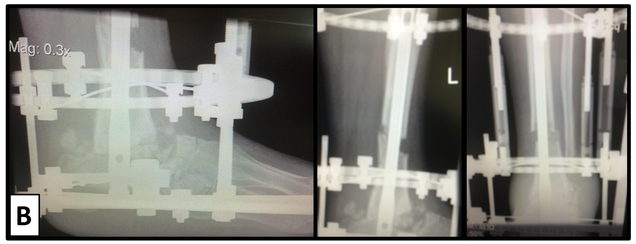


Figure 3. Intraoperative X-Ray Lateral/AP **(A)**, 3 weeks post-op X-Ray Lateral/AP **(B)**, 1-year post-op X-Ray Lateral/AP **(C)**

Figure 4. Gait posterior **(A)** and anterior **(B)** 1-year post-operative left tibiocalcaneal arthrodesis with simultaneous 3 cm lengthening of tibia.

Analysis and Discussion

Rearfoot fusion in the Diabetic Charcot is often a heroic salvage attempt to save the limb, and is often complicated by bone loss, osteomyelitis, and poor soft tissue envelope. Most of these patients had failed multiple previous surgeries, sometimes with total loss of the talus. Although structural allografts have been advocated to reestablish length, the high rate of graft collapse, infection and non-union begs for an improved technique. Ideal candidates have been found to be nonsmokers, young adults, with a strong family support system, who has greater than 3 cm of shortening [6]. Non-union complications can be addressed with external fixation compression of the tibial osteotomy and packed with autogenous vs allogenic bone graft. With this technique combining distal tibial lengthening with simultaneous rearfoot and ankle fusion, it obviates the need to implant devitalized bone graft at a compromised healing site, while maintaining length of the limb with early mobilization, reduced visits to operating room with angular stability and reduction in refracture rate as reported in literature.

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