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Ilizarov External Fixator Versus Internal Fixation for Ankle Joint Arthrodesis in Diabetic Charcot Neuroarthropathy

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Abstract

Objective: This study aims to evaluate the patients with Charcot neuropathy and look for differences in fusion rate, limb salvage rate, and complications following external fixation and internal fixation used in tibiotalar/tibiocalcaneal arthrodesis.

Methods: 12 patients were identified and evaluated for the rate of limb salvage, complications, union at arthrodesis site, and clinical results based on the modified American Orthopaedic Foot and Ankle Society scale.

Results: After an average follow-up of 70.9 months, we found 100% limb salvage rate; of the 12 patients, 8 had an osseous union at the arthrodesis site. Using the modified American Orthopaedic Foot and Ankle Society scale, we calculated a mean score of 79.4 (range, 75-84) points in the external fixation group and 79.2 (range, 71-85) points in the internal fixation group ($P > .05$). The results were excellent in 5 patients (100%) in the external fixation group and were excellent in 5 patients (71.4%) and good in 2 patients (28.6%) in the internal fixation group.

Three patients in the external fixation group had pin tract infection that resolved with appropriate treatment. On the other hand, 1 patient in the internal fixation group experienced a tibial stress fracture that required revision nailing.

Conclusion: It is possible to obtain 100% limb salvage regardless of the fixation method with an individualized treatment plan in patients with Charcot neuropathy-related ankle involvement.

Keywords: Arthrodesis, arthropathy, neuropathic, limb salvage

Introduction

Charcot neuroarthropathy (CN) is a progressive, non-infectious condition that is related to osteolysis-induced bone and joint destruction, and patients with peripheral neuropathy are at risk for experiencing CN.[1] Several diseases that cause neuropathy are related to the development of CN, but, nowadays, diabetes is the leading cause of this disease.[1,2]

Although the midfoot is the most common site of involvement, hindfoot and ankle are the most common sites that require major surgical intervention.[3] Joint destruction, the collapse of the talar body and related instability, increases the risk of ulceration around the ankle in patients with CN, and without appropriate treatment, osteomyelitis may further complicate the pathology. Patients who have accompanying osteomyelitis are at increased risk for future amputation.[1,4] But limp salvage is especially important in diabetic patients, because mortality rates are 39%-68% higher after amputation when compared with the non-diabetic matches.[5,6] To achieve a stable, weight-bearing extremity and to prevent the patient from future amputations, arthrodesis is indicated for CN of the ankle joint to improve alignment, decrease the risk of ulceration and/or heal the previous ulcerations, and mobilize the patients with a stable and plantigrade weight-bearing extremity.[2,7] Although there is not any clear consensus regarding the type of fixation in reconstruction procedures, either internal (IF) or external fixation (EF) can be used to achieve an ulcer-free, stabile, and plantigrade extremity.[7]

Therefore, this retrospective study aims to evaluate the patients with CN and look for significant differences in terms of fusion rate, limb salvage rate, and complications following EF and IF techniques for tibiotalocalcaneal or tibiocalcaneal arthrodesis.

Methods

We identified 14 consecutive patients (6 females and 8 males) with CN involving the ankle and hindfoot between November 2008 and February 2019. All patients were operated on by the senior author. After approval from the institutional review board, all patients provided informed consent and were evaluated for the rate of limb salvage, rate of complications related to the surgeries, osseous or fibrous union along with the arthrodesis site, and clinical results based on the modified American Orthopaedic Foot and Ankle Society (AOFAS) Ankle hindfoot scale.

Inclusion criteria were Eichenholtz stage III CN, the involvement of talus, and intact vascularity which were evaluated either with palpation of distal pulses or in the absence of palpable pulses, with Doppler ultrasonography of the affected extremity. Patients who have less than 2 years of follow-up, patients who are unable to follow the postoperative instructions, and patients with missing pre/postoperative records were excluded from the study group. Therefore, 12 available patients were included in the study group. All 12 patients were diabetic. Their age averaged 55.2 years (range, 30-66) and had diabetes for an average of 23.4 years (range, 10-47 years). Of the 12 patients, 5 had previous surgeries related to the involved foot (3 patients in the EF group and 2 patients in the IF group). Among the 12 patients, IF was used in 7 patients (58.3%) and 5 patients (41.6%) had EF with an Ilizarov frame.

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After ethics commitee approval (Bakırkoy Dr. Sadi Konuk Eğitim ve Araştırma Hastanesi (April 13, 2018; approval number: 2018-08.12); records of all patients were inspected to evaluate preoperative examination findings and radiological evaluations (standing radiographies as well as in cases with suspected osteomyelitis additional magnetic resonance imaging). Among the 12 patients, 3 had preoperative ulcerations around the ankle and all 3 of them were treated with EF.

Under general/spinal anesthesia, lateral approach to ankle was used for all patients. Fibulae were excised approximately 10 cm proximal from the tip of the malleolus, and further in the surgery, fibulae were used as autograft. The articular surfaces were freed of any remaining cartilage and all necrotic bony fragments were excised. Talus or calcaneus was matched with the distal tibia, provisionally stabilized with K-wires and the remaining defects were filled with the excised fibula. After this stage, fixation was done either internally (intramedullary nail, plate constructs, or cannulated screws) or externally (with an Ilizarov frame — 2 rings were placed in the distal tibia and these were connected to a foot ring). For the patients with existing ulceration, ulcer debridement was also performed (Figure 1).

Postoperatively, the patients in the IF group were kept within a posterior splint for 2 weeks, and after this period, they were followed with a removable walking boot for another 10 weeks without weight-bearing, and then they were allowed to weight bear as tolerated after 12 weeks. Patients with EF did not have any splint but similarly, they did not allow to bear weight for 4 weeks postoperatively and weight-bearing as tolerated was permitted afterward. Implants were typically removed at the end of 3 or 4 months in the EF group.

At the final follow-up, patients were analyzed with respect to limb salvage, complications, union around the arthrodesis site, functional scores, and postoperative complications. Limb salvage was defined as the patient not requiring amputation below the knee. Non-union was defined as the failure to obtain solid union by 40 weeks postoperatively and requiring surgical revision. The clinical results were determined using the modified AOFAS ankle hindfoot scale.[8] The AOFAS score is calculated from a total of 100 points, but 14 points related to ankle and subtalar motion are excluded, thus the maximum points possible with this modified scale were 86 points. A score of 74-86 was considered excellent, 64-73 as good, 54-63 as fair, and <54 as poor score.

Figure 1. 60 years old male with an ulcer around lateral malleolus. (a) Preoperative radiographies and clinical photo. (b) Radiological evaluation at his final follow-up.

Statistical Analysis

The Mann–Whitney U test was used to compare both groups. Statistical significance was defined as $P \leq .05$

Results

After an average follow-up of 70.9 ± 44.7 months, all the patients underwent clinical and radiological assessments. We found 100% limb salvage rate; of the 12 patients, 8 had an osseous union at the arthrodesis site. Two patients in the IF and 2 patients in the EF group had fibrous union but all patients had stable and plantigrade weight-bearing extremities and did not necessitate to use any kind of brace or orthosis.

Using the modified AOFAS ankle hindfoot scale, we achieved a mean score of 79.4 (range, 75-84) points in the EF group and 79.2 (range, 71-85) points in the IF group ($P > .05$). The results were excellent in 5 patients (100%) in the Ilizarov group and were excellent in 5 patients (71.4%) and good in 2 patients (28.6%) in the IF group.

The incidence of complications was higher in the EF group, but one major complication that required surgical intervention was encountered in the IF group. This patient experienced tibial stress fracture just proximal to the nail at the 14th week postoperation. Revision surgery was performed with a custom-made intramedullary nail and bony union at arthrodesis site and fracture site achieved at the final follow-up. In the EF group, there were no cases of pin failures, but 3 patients (60%) developed pin tract infection that resolved with daily dressing and oral antibiotics Figure 2.

Discussion

Ankle involvement in the CN is usually treated with surgery but because of the bony destruction and diminished bone quality, patients with CN require specific attention to get a satisfactory

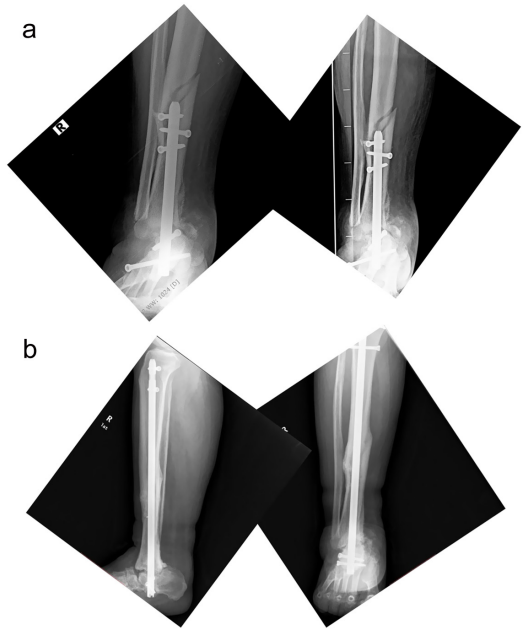

Figure 2. 58 years old male; (a) His preoperative radiographies revealing stress fracture and (b) 1 year after revision with a custom-made intramedullary nail.

result. Diminished wound healing, peripheral neuropathy, accompanying osteomyelitis, and poor patient cooperation can also complicate the postoperative outcomes in these patients. In this challenging situation, there is not any golden standard regarding the most successful and reproducible surgical method. In this retrospective study, we aimed to compare the results of IF and EF in achieving limb salvage and union along with the arthrodesis site and found 100% limb salvage with no significant difference in the rate of union.

We performed the surgery in the consolidation stage to limit the risk of soft tissue infection and wound dehiscence as preferred in the literature as well.[1] If we detected the patients in the earlier stages of disease, we preferred to follow them in a total contact cast without weight-bearing to limit the bony destruction and to prevent the development of ulceration as a consequence of instability. Once the disease reached its consolidation phase, surgical planning can be done accordingly.

Limb salvage is the ultimate goal of CN surgery. Although we did not have any amputations in both groups, a systematic review by Dayton et al.[7] which compares complications of IF and EF, reported an amputation rate of 8.6% after IF and 5.9% after EF, respectively.[7] Similarly, Richman et al[5] reported more frequent failures after retrograde nailing of the ankle. Although EF is more commonly preferred in complicated cases such as the ones that have osteomyelitis or open wounds, higher salvage rates may be related with the inadequacy of the bone density and difficulty to obtain a solid fixation with standard techniques that had developed to use in normal bones.[1] Once the stability of the fixation diminished, resultant instability could end up with the development of ulcerations, and subsequent infection further complicates the treatment, thus ends up with worse results.

Non-union is another potential complication of CN and inability to obtain a solid fixation may also be related to the increased rates of non-union. We did not encounter a significant difference in union rates between the groups. This may be related to the small study groups, but the literature reports mixed results concerning the fusion rates.[4] Eylon et al[9] reported a fusion rate of 100% with Ilizarov fixation, while Myerson et al[10] reported 92.3% union rate with the use of blade plates for ankle arthrodesis. Contrary to these preferable results, Caravaggi et al[11] reported 92.8% salvage rate with 71.4% solid fusion rate with an intramedullary nail. Recently, ElAlfy et al[8] compared the results of ankle arthrodesis with IF and EF in CN. They reported a non-union rate of 14% in EF group and 23.1% in IF group, respectively. In our opinion, relatively higher union rate with EF can be related to the ability to adjust the frame (increased compression along with the arthrodesis site) during the follow-up period.

The number of complications was higher in EF group (pin tract infection in 3 patients), but all these complications were considered minor because they did not require further surgery and they were all treated with daily wound care and oral antibiotics. On the other end, the only complication encountered in the IF group was tibial stress fracture and required revision surgery with a custom-made intramedullary nail. This complication occurred 14 weeks after surgery, once the patient started to weight bear on the affected extremity. The used nail was 150 mm in length and similar to the findings of Wukich et al,[12] we experienced a fracture at the tip of the nail. Although they reported the routine use of 300 mm nails both to treat and to prevent this complication, we decided to use a custom-made intramedullary nail to fix both the arthrodesis site and fracture site with a single implant and to limit the soft tissue dissection.

The limitations of the present study were the small sample size in each group, retrospective nature of the study, and lack of randomization of patients between the treatment groups.

In conclusion, both IF and EF yielded 100% limb salvage, but to achieve a satisfactory outcome and avoid complications, every patient should be assessed individually and a surgical plan must be done accordingly.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Bakırköy Dr. Sadi Konuk Eğitim ve Araştırma Hastanesi (Date: April 13, 2018; approval number: 2018-08.12).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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