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Ilizarov External Fixator Versus Retrograde Intramedullary Nailing for Ankle Joint Arthrodesis in Diabetic Charcot Neuroarthropathy

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ABSTRACT

Charcot neuroarthropathy of the ankle joint is a destructive process that leads to instability and significant morbidity that can end with amputation. Surgical arthrodesis in Charcot neuroarthropathy has a high failure rate. The aim of the present prospective study was to compare the outcomes of an Ilizarov external fixator and retrograde intramedullary nailing (IMN) for tibiotalar arthrodesis in Charcot neuroarthropathy. From February 2010 to October 2013, 27 patients (16 males and 11 females) with Charcot neuropathy of the ankle joint were treated in our department. Their ages ranged from 32 to 75 (average 54) years. Of the 27 patients, 14 received an Ilizarov external fixator and 13 underwent IMN. A preoperative clinical and radiologic assessment of all patients was performed. The outcomes were measured for bone union, development of complications, and clinical follow-up. The mean score of modified American Orthopaedic Foot and Ankle Society ankle hindfoot scale was 80 ± 2.7 points in the Ilizarov group and 75 ± 1.9 points in the IMN group. In the Ilizarov group, 12 of 14 patients achieved union, and in the IMN group, 10 of 13 patients achieved union. The complication rate was significantly greater in the external fixator group than in the IMN group. The complications in the Ilizarov group included nonunion in 2 patients (14%), pin tract infection in 8 (57%), pin tract loosening in 3 (21%), surgical wound infection in 3 (21%), and wound breakdown in 1 patient (7%). In the IMN group, nonunion occurred in 3 patients (23.1%), back-out of a distal locking bolt in 2 (15.4 %), and a superficial wound infection that resolved with antibiotics in 1 patient (7.7%). In conclusion, retrograde IMN and the Ilizarov external fixator both yielded better union for tibiotalar arthrodesis in Charcot neuroarthropathy. The Ilizarov external fixator resulted in a greater union rate than IMN but the complications with external fixation were significantly greater than those with IMN.

Charcot neuroarthropathy is a progressive, degenerative condition that affects the joints in the foot and other parts of the body. It occurs in the presence of peripheral neuropathy due to diabetes mellitus or other neurologic disorders. The incidence of Charcot neuroarthropathy in patients with diabetes ranges from 0.2% to 29% (1). Abnormal nociception and proprioception at the ankle region leads to destruction of the joint, collapse of the ankle mortise, and instability, with significant morbidity that can require amputation (2–6). The philosophy of surgical management of the Charcot joint has changed from amputation to limb salvage. Reconstructive surgery on the chronic deformed, unstable quiescent Charcot foot has become common in recent years. The aim of reconstructive procedures is arthrodesis with realignment and stabilization of the severely deformed foot or ankle to avoid ulcers and amputation (7).

External fixation and internal fixation have been used to obtain a stable arthrodesis for Charcot neuroarthropathy of the ankle joint (8–10). However, controversies remain regarding the most successful and reproducible method.

The aim of the present study was to compare the results of Ilizarov external fixation and retrograde intramedullary nailing (IMN) in ankle arthrodesis for patients with Charcot neuroarthropathy of the ankle joint.

Patients and Methods

The present prospective study was conducted from February 2010 to October 2013. The study included 27 consecutive patients (16 males and 11 females) with Charcot neuropathy of ankle joint due to diabetes mellitus who had been treated in our department. Of the 27 patients, 17 came directly to our clinic and 10 had been referred to us from the diabetic foot clinic. Their age ranged from 32 to 75 (average 54) years. All the patients were diabetic and had had the condition for an average of 13.8 (range 7 to 20) years. Of the 27 patients, 14 received the Ilizarov external fixator and 13 underwent

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IMN. The type of surgical procedure, whether Ilizarov external fixator or retrograde IMN, was chosen randomly, irrespective of the stage or condition of the bone. The Ilizarov external fixator group was treated by the first author (A.M.A.), the IMN group was treated by the second (B.E.), and the third (S.I.F.) was the assistant to both.

The inclusion criteria were a quiescent phase of the disease in stage II/III Charcot neuropathy using the Eichenholz radiographic classification (11) and satisfactory distal circulation. The exclusion criteria included active infection, stage 1 Charcot neuropathy, no diabetes, the presence of peripheral obstructive vascular disease, dementia, or psychiatric problems, and clinical or radiologic evidence of osteomyelitis.

All the patients underwent preoperative clinical and radiologic assessment. All 27 patients were confirmed to have neuropathy by clinical examination and positive findings on the monofilament test (an inability to identify 3 of 10 points) (12,13). The blood glucose levels and hemoglobin A1c (HbA1c) values were monitored to ensure the proper control of the diabetes. Of the 27 patients, 11 had skin ulcers (7 over the lateral aspect and 4 over the medial aspect of the ankle).

With the patient under general or spinal anesthesia, the ankle joint was approached laterally. Any ulcer over the lateral aspect was excised en bloc with the skin incision. Any implants from previous surgeries were removed. The lateral malleolus was excised and kept for further use as a graft. The dense fibrous tissues and synovium were excised. The articular surfaces of the distal tibia and the dome of the talus were excised to allow good co-optation between the distal tibia and the talus in proper alignment. The talus was reduced to the distal tibia and fixed by Kirchner wires inserted from the plantar aspect of the calcaneus to the tibia. The Ilizarov frame was then applied, with 2 rings for the distal tibia and 1 oval frame for the foot. The cancellous bone of the lateral malleolus was extracted, fragmented into small pieces, and placed between the distal tibia and the talus. The foot frame was then connected to the leg frame, and compression was applied at the ankle site.

For IMN, the distal tibia and the dome of the talus were prepared the same as for Ilizarov fixation. Next, a small incision was made over the plantar aspect of the heel, and blunt dissection was carried down to the bone. The guide wire was inserted in a retrograde manner from the calcaneus to the tibia. Reaming was performed, and a nail of an appropriate diameter was inserted and locked distally and proximally. The soft tissues were closed in layers. Ulcers over the medial aspect of the ankle were debrided and dressings were applied.

Postoperatively, the patients with IMN were further supported in a posterior below-the-knee slab for 12 weeks and patients with Ilizarov fixation were allowed partial weightbearing. The patients were discharged after an average of 5 days and returned for follow-up visits every 2 weeks for the first month and monthly subsequently. At every visit, the patients were examined clinically for wound healing, the neurovascular state of the limb, and evidence of pin tract infection. They were also examined radiologically for bone healing and alignment at the ankle region.

Measurement of the blood glucose levels was performed postoperatively to ensure good control. The HbA1c levels were measured every 3 months during the follow-up period. The patients were analyzed with respect to wound healing, wound condition, union, pin loosening, pin tract infection, stability of the construct, and loosening of the screws.

Delayed union was defined as failure to obtain union by 30 weeks, with, however, eventual achievement of union by 40 weeks without surgical interference. Nonunion was defined as failure to obtain sound union by 40 weeks postoperatively and requiring surgical interference (14).

The clinical results were determined using the modified American Orthopaedic Foot and Ankle Society ankle hindfoot scale (15–17). The American Orthopaedic Foot and Ankle Society scale score is calculated from a total of 100 points. However, the maximum points possible with this modified scale were 86 points, because 14 points were excluded. The 14 excluded points referred to the ankle and subtalar movements, which had been eliminated by the arthrodesis. A score of 74 to 86 was considered an excellent result, 64 to 73 a good result, 54 to 63 a fair result, and <54 a poor result. The Wilcoxon rank sum test was used to compare both groups. Statistical significance was defined as $p \leq .05$.

Results

The median average hospital stay was 5 (range 2 to 9) days. The median average follow-up period was 31 (range 26 to 45) months. The mean HbA1c value was 6.8% ± 1.540%.

The patients were mobilized to full weightbearing within a mean period of 14 ± 1.2 weeks in the external fixator group and 18 ± 1.5 weeks in the interlocking group. The difference was statistically significant ($p < .05$). The mean time for ulcer healing was 7 ± 2.4 weeks in both groups. In those patients with union, radiologic union was achieved within a median average of 16 ± 1.8 (range 14 to 18) weeks in the external fixator group and 20 ± 1.3 (range 15 to 34) weeks in the interlocking group, with a statistically significant difference ($p = .03$).

Using the modified American Orthopaedic Foot and Ankle Society ankle hindfoot scale (15), we achieved a mean score of 80 ± 2.7 (range 30 to 86) points in the Ilizarov group and 75 ± 1.9 (range 35 to 86) points in the IMN group. The results were excellent in 5 patients (35.7%), good in 7 (50%), and poor in 2 patients (14.3%) in the Ilizarov group. The results were excellent in 4 patients (30.7%), good in 5 (38.5%), fair in 3 (23.1%), and poor in 1 patient (7.7%) in the IMN group. When the results were compared regarding the bony union rate, 12 of 14 patients in the Ilizarov group had achieved union and 10 of 13 patients of the IMN group had achieved union (Figs. 1 and 2).

The incidence of complications was significantly greater among the external fixator group than in the IMN group ($p = .03$). Two patients (14%) in the external fixator group experienced nonunion. One was a fibrous nonunion, allowing the patient to walk with a brace. The second nonunion resulted from early removal of the fixator owing to noncompliance of the patient with the frame. Another 8 patients (57%) developed pin tract infection, and 3 patients (21%) experienced pin tract loosening, 2 of whom required revision of the loose pins. Surgical wound infection developed in 3 patients (21%), and 1 patient (7.7%) experienced wound breakdown. IN the IMN group, 3 patients (23.1%) experienced nonunion. One of these patients underwent regrafting and eventually achieved union and the other 2 patients refused another surgery. Another 2 patients (15.4%) experienced back-out of the distal locking bolt, which was removed and replaced with another, and 1 patient (7.7%) developed a superficial wound infection that resolved with dressing and systemic antibiotics. One patient with fusion had a 5° of equinus deformity that was compensated for with footwear. The limb length discrepancies were insignificant (0.5 to 1.5 cm) in both groups ($p = .75$).

Discussion

Charcot arthropathy of the ankle is a challenging problem in orthopedics, because it is a destructive process that can affect patients with peripheral neuropathy of any etiology. It can lead to significant long-term complications such as collapse of the bony architecture, ulcers, foot deformity, infection, and amputation. In diabetic patients, the risk of amputation can reach ≤15%. Early diagnosis and proper management are crucial to avoid catastrophic outcomes (18–21).

Reconstructive surgery is indicated for unstable Charcot neuroarthropathy with deformity. The surgical goal is to restore stability and alignment and achieve a plantigrade, weightbearing surface free of ulceration. Arthrodesis can achieve this goal and can be achieved with either external fixation or internal fixation methods (8–10). However, controversies remain regarding the most successful and reproducible method. To the best of our knowledge, no comparative study of locked IMN and the Ilizarov external fixator in the management of Charcot ankle has been previously published.

In the present study, we compared the results of the Ilizarov external fixator and IMN in achieving ankle arthrodesis in diabetic patients with Charcot arthropathy.

The timing of surgical intervention for Charcot arthropathy is very crucial. Most investigators (1,22,23) have advocated surgical intervention in the coalescent or consolidative stages (stage II/III) according to the classification of Eichenholz (11). In the acute phase (stage I), the lower extremity will be erythematous and edematous and can be predisposed to soft tissue infection. We performed surgical intervention when the patient's deformity is resistant to appropriate conservative treatment and when the deformity endangers the condition of the skin.

The high incidence of nonunion of arthrodesis after fixation in patients with Charcot neuroarthropathy has been well documented (24). Nonunion results from the poor bone quality and difficulty in