International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

Results of Pantalar Fusion in Charcot Ankle Using Retrograde Interlocking Nail

Ahmed Shaaban Hassan[1], *Ahmed Mahmoud Kholeif*[2], *Hatem Mohamed Abdul Ghani Mohamed*[2*]

[1]*Department of Orthopedic Surgery, Faculty of Medicine, Helwan University.*

[2]*Department of Orthopedic Surgery, Faculty of Medicine, Cairo University.*

Abstract

Foot and ankle are the most commonly affected sites between diabetes and Charcot neuroarthropathy. To evaluate the efficacy, advantages and disadvantages of pantalar fusion in charcot ankle using retrograde interlocking nail. This prospective study performed on 20 patients with Charcot osteoarthropathy of the ankle using retrograde interlocking nail at Helwan University hospital, Al Helal hospital, Boulak El Dakror general hospital and Kasr Al Ainy hospital during the period between January 2021 and January 2022. Preoperative grading according to Eichenholtz classification showed that: 9 patients were of type 2 (45%) and 11 were of type 3 (55%). The mean preoperative score percentage was 35.75% (range twenty percent – fifty-four percent). The mean score percentage at 6 months after surgery was 75.88% (range 64.0% - 93.0%). There was further improvement in score at end of the study. The mean final score percentage at the end of study was 89.12% (range 81.0% - 97.0%). Retrograde interlocking nail showed satisfactory results in corrective fusion of severe abnormalities of ankle and hind foot in Charcot neuroarthropathy since it was able to achieve our goals which related to painless ankle, limb salvage, ulcer healing, deformity correction & return to independent activities of daily living.

Keywords: Pantalar fusion, Charcot ankle, Retrograde interlocking nail.

Full length article **Corresponding Author*, e-mail: ptrservices2022@gmail.com

1. Introduction

Charcot first noted that individuals with tabes dorsalis can have Charcot neuroarthropathy in 1883. The foot & ankle are the most typical locations of Charcot neuroarthropathy, which Jordan first identified in 1936 as being associated with diabetes [1]. Among the many complex clinical issues encountered by foot & ankle surgeons, the Charcot foot stands out. Patients with diabetic neuropathy are at increased risk for developing the debilitating foot & ankle deformity known as neuropathy arthropathy. It sneaks up on people & leaves a crippling aftermath. There is a substantial probability that individuals with diabetic Charcot neuroarthropathy of the foot and ankle may need amputation of the lower extremities [2]. The aetiology of Charcot ankle is unclear and may be due to a combination of factors [3]. There has been ample description of the clinical presentation, categorization, & evaluation of Charcot arthropathy [4]. From a radiological perspective, Eichenholtz outlined the phases of neuropathic joint development in 1966.

Radiographs show debris production, bone fragmentation, subluxation, or dislocation during period I, the developing period. In Stage II, which is also known as the coalescence stage, the sclerosis of bony ends, debris absorption, & bone fragment coalescence are seen. During Stage III, which is also referred to as the "reconstruction phase," the foot & ankle undergo partial reformation, remodeling of bone fragments, & a decrease in sclerosis. Physical manifestations are distinct across the three phases. The first stage is characterized by severe swelling & a heated foot. Swelling & redness diminish during stage II, & they return to normal during stage III, when the temperature returns to normal [5]. Management of Charcot neuroarthropathy is based on many factors Including site, stage of the disease, presence of deformity, infection, and co-morbidities. Investigations include plain X-ray, CT, MRI and isotope scanning but still diagnosis is primarily clinical [6]. Treatment can vary from basic shoe modification to major amputation [7].

Surgical management include, arthrodesis using intramedullary nailing, plates, screws, stables, Illizarov fixator or a combination of more than one of these methods [8-9]. This research aims to assess how well, advantages & disadvantages of pantalar fusion in charcot ankle using retrograde interlocking nail.

2. Patients and methods

This prospective study performed on twenty patients with Charcot osteoarthropathy of the ankle using retrograde interlocking nail at Helwan University hospital, Al Helal hospital, Boulak El Dakror general hospital and Kasr Al Ainy hospital during the period between January 2021 and January 2022.

2.1. Inclusion criteria

Patients of both sexes, patients with or without fractures, patients with deformed foot and ankle and active patients with failed conservative methods of treatment.

2.2. Exclusion criteria

Patients experiencing active infection, critical skin & soft tissue diseases, significant tibial malalignment (often due to trauma), severe vascular illness, severe deformities of the tibial medullary canal, & patient bed rest.

2.3. Ethical Consideration

The research ethics committee of Helwan University's Faculty of Medicine gave its stamp of approval to the study. Before they could take part in the research, all the participants had to complete an informed consent form. Preoperative Assessment of all patients by the AOFAS. It consisted of 9 questions covering 3 categories: Pain (forty points), function (fifty points) & alignment (ten points). These are all scored together for a total of one hundred points, (ninety to one hundred points) was considered excellent score, (eighty to eighty-nine points) referred as good score, fair (seventy to seventy-nine points), & poor (lower than points).

2.4. Surgical procedures

According to the classifications of Eichenholtz & Charles C., which defined the quiescent phase of the illness, the surgical treatment was usually done when there was no evidence of infection, edema, or change in skin temperature among both feet [5]. Lay on your back with your heel touching the edge of the operation table. The patient's ipsilateral back was raised until their whole lower extremity was brought into a strictly upward posture. The thigh was inflated with a tourniquet at a pressure of 350 mm of mercury in case it is necessary. Procedure was done under general or spinal anesthesia. Pre-operative and post-operative prophylactic antibiotics were given. Complete antiseptic technique to minimize risk of infection. Sterilization of the whole leg, ankle and foot by povidone iodine. In order to reach the ankle and subtalar joints, surgeons use either an antero-medial or antero-lateral approach. This allows for decrease, drilling, & cartilage removal, as well as curettage of subchondral bone. In rare situations, the procedure is performed percutaneously with just an incision on the entrance side & incisions for locking screws. Before reaming, the ankle should be in a neutral posture, which means it should be at a 90-degree angle of dorsiflexion, 5-degree angle of external rotation, & 5-degree angle of hind foot valgus.

2.6. Entry point

Finding the right spot to start is essential for nail insertion processes in general. The entry point was determined under anteroposterior and lateral ankle views under C-arm. It is at the point of transection of the longitudinal axis of the calcaneus and the bimalleolar axis of the tibia anterior to subcalcaneal fat pad. Line in sagittal plane drawn from tip of the second toe to center of heel and another line drawn in coronal plane bisecting both malleoli. Small calcaneal incision done over the plantar aspect and a guide wire was advanced proximally from calcaneus to tibia with guidance of the fluoroscopy through talus

2.7. Reaming

Reamer was introduced over the guide wire and advanced through calcaneus, talus and tibial shaft. Flexible reamers were inserted in a sequential fashion.

2.8. Nail insertion

The tibial medullary canal was reamed 1 to two millimeters wider than the nail diameter that had been utilized which was between 10 to 12 mm. The nail was inserted over the guide wire. The preferred depth was achieved when the distal locking screw is in the calcaneus and the proximal hole in the talus. The nails used ranged in length from eighteen to twenty-four centimeters. At the very tip of the nail were inserted the two biocortical screws. The distal ends of the nails were then threaded with the talar, calcaneal, & distal tibial locking screws. Wounds were irrigated and closed in layers and incisions were covered with a sterile dressing and application of below knee slab. The procedure took from 60 to 110 minutes with a mean time of 85 minutes which varied according to complexity of the case.

2.9. Postoperative management

A postoperative X-ray of the ankle taken in both the anterior & posterior planes to verify the alignment of the joint, the nail's size & length, & the locking screws. After twenty-four hours of non-weight bearing rehabilitation after surgery, all patients were cleared for release.

2.10. Methods of evaluation

After a successful operation, you shouldn't put any weight on your feet for at least twenty-four hours. Foot was transferred to a lower leg cast for a further four to eight weeks after two to three weeks of follow-up, after which the slab & sutures were removed. The patients had clinical examinations at each visit to check for signs of infection, limb neurovascular status, & wound healing. Radiographs were taken of the ankle area to check for bone healing & alignment. After radiographically obvious osseous consolidation had occurred, the patient was permitted to progressively advance to full weight bearing in a walking orthosis for six to ten weeks as tolerated. Complications were monitored every three months throughout this time. Gait training, lower leg muscle strengthening, & localized edema reduction were all part of the physical therapy-based rehabilitation program.

At the a six-month & 18-24-month follow-ups, the American Orthopedic Foot & Ankle Society ankle & hind foot score (AOFAS A/H) was used. In postoperative follow up we use the modified AOFAS score which its maximum is 86 because hind motion and sagittal motion excluded because of arthrodesis.

3. Results and Discussion

3.1. Case presentation

3.1.1. History

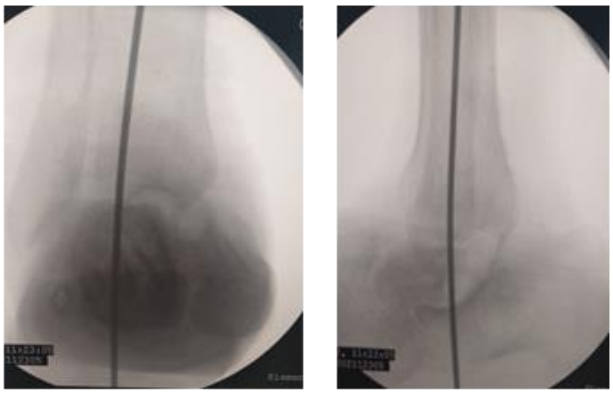
Female patient 60 years old presented with failed fixation of trimalleolar fracture of the left ankle which done about 7 months ago she was diabetic and having Charcot neuroarthropathy and presented with valgus deformity of the ankle.

3.1.2. Procedure

Removal of plate & screws. Retrograde arthrodesis by IMN. Our results showed that there was no statistically significant variance amongst complicated & non-complicated cases as regard age, sex, occupation, side (right or left) and technique (open or closed). Also, our results showed that 6 (30%) patients were having previous ankle surgeries as following: 3 failed previous ankle fracture fixations with plates and screws and, patient had Ankle debridement and external fixator application due to severe infection and 2 previous surgeries for skin ulcers over bony prominences. Preoperative grading according to Eichenholtz classification showed that: 9 patients were of type 2 (45%) and 11 were of type 3 (55%). The mean preoperative score percentage was 35.75% (range twenty to fifty four percent). The mean score percentage at 6 months after surgery was 75.88% (range 64.0% - 93.0%) [5]. There was further improvement in score at end of the study. The mean final score percentage at the end of study was 89.12% (range 81.0% - 97.0%). The complications occurred in (35%) patients as following: (5%) of patients had intraoperative distal tibial crack during nail introduction, (10%) of patients had loosening of proximal screws and infection, (15%) of patients had skin infection at the site of distal screws and (5%) of patients had deep infection improved with parenteral antibiotics. In a prospective study that ran from February 2010 to October 2013, ElAlfy et al., (2017) looked at how well the Ilizarov external fixator & IMN worked at repairing ankle arthroscopies in diabetics with Charcot arthropathy [10]. The study looked at twenty-seven cases in a row, 16 men & 11 women. They were thirty-two to seventy-five years old, with fifty-four being the average age. All of the patients had diabetes. Out of the twenty-seven cases, fourteen were given the Ilizarov external fixator & thirteen were given IMN. The type of surgery was selected at random, without taking into account the bone's state or health. Eleven of the 27 cases had skin sores, 7 on the outside & four on the inside of the ankle. A mean score of eighty points, with a range of thirty to eighty-six points for the Ilizarov group & seventy-five points, with a range of thirty-five to eighty-six points for the IMN group. It was great for five patients (35.7 percent), good for seven patients (50%), & bad for 2 patients (14.3 percent) in the Ilizarov group. Four patients (30.7%) in the IMN group had great results, five (38.5%) had good results, three (23.1 percent) had fair results, & one (7.7 percent) had bad results. Twelve of the fourteen patients in the Ilizarov group had their bones fused together, while ten of the thirteen patients in the IMN group had theirs fused together. There were a lot more problems in the group that used an external fixator than in the group that used an IMN (p =.03). In the external fixator group, two patients (fourteen percent) didn't recover properly, eight patients (57 percent) got an infection in the pin tract, three patients (21 percent) had the pin tract loosen, three patients (21 percent of the group) got an infection in the surgical wound, & one patient (7.7 percent of the group) had the wound break. In the IMN group, 3 patients (23.1 percent) did not heal, two patients (15.4 percent) had the distal locking bolt come loose, & one patient (7.7 percent) got an infection on the surface of the cut. One person who had fusion had a 5º equinus abnormality that could be fixed with shoes. There were small differences in leg length (0.5 to 1.5 centimeters) among the two groups (p =.75). The results of this study showed that both the backward IMN & the Ilizarov external fixator worked better for tibiotalar arthrodesis in Charcot neuroarthropathy. There were more unions with the Ilizarov external fixator than with the IMN. It was much more difficult to deal with problems with outward focus than with IMN [10]. A total of twenty-one ankle fusions were evaluated by Pinzur and Kelikian (1997). They discovered that 20 out of 21 ankles, or 95.2 percent of the total, could be salvaged. Major revisions were necessary for three patients (14.3percent), wound problems occurred in six patients (28.5 percent), & three patients (14.3 percent) needed their nails removed [11]. In their study of fourteen patients with Charcot ankle arthropathy, Caravaggi et al., (2006) investigated compressive retrograde IMN arthrodesis. The authors discovered that a solid ankle fusion was accomplished by ten patients (71.4 percent), whereas a stable fibrous union that enabled ambulation in a brace was established by three patients (21.4 percent). The removal of hardware was necessary in three individuals (21.4percent), & a transtibial amputation was subsequently necessary in one patient (7.2 percent) due to postoperative osteomyelitis [12]. Twenty individuals (ten diabetic & ten non-diabetic) were studied by Mendicino RW et al. to compare locked IMN with tibiocalcaneal arthrodesis. While Five out of ten diabetic patients experienced serious problems, nineteen patients nevertheless had good outcomes with limb salvage [13].

(A): The skin incision (Intra operative Image).

(B): The skin incisions for locking screws (Intra operative Image).



(C): Passage of guide wire with guidance of the fluoroscopy (Intra operative Image).

(D): Application of proximal locking screws with guidance of the fluoroscopy (Intra operative Image).

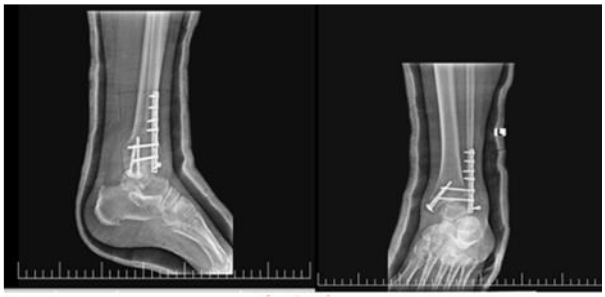
(E): Application of distal locking screws with guidance of the fluoroscopy (Intra operative Image).

Figure 1: Operative procedure.

(A): Skin condition before the first fixation surgery.

(B): X ray preoperative before the first fixation surgery

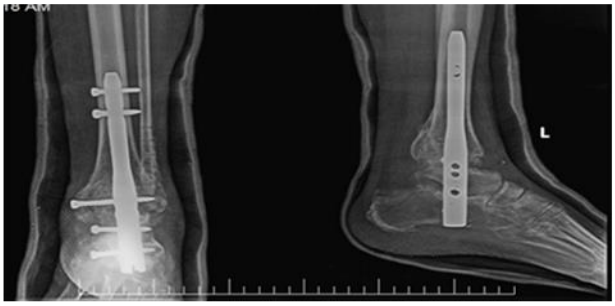
(C): X ray postoperative after the first fixation surgery



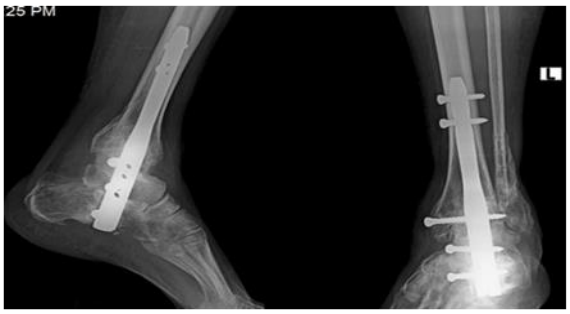
(D) X ray after 1.5 months postoperative after first fixation surgery

(E):X ray 7 months postoperative after the first fixation surgery.

(F): X ray immediate postoperative after arthrodesis.



(G) X ray 2 months postoperative after arthrodesis.



(H): X ray after arthrodesis at the end of follow up period.

(I): Clinical photo at the end of follow up.

Figure 2: Photos of case presentation**.**

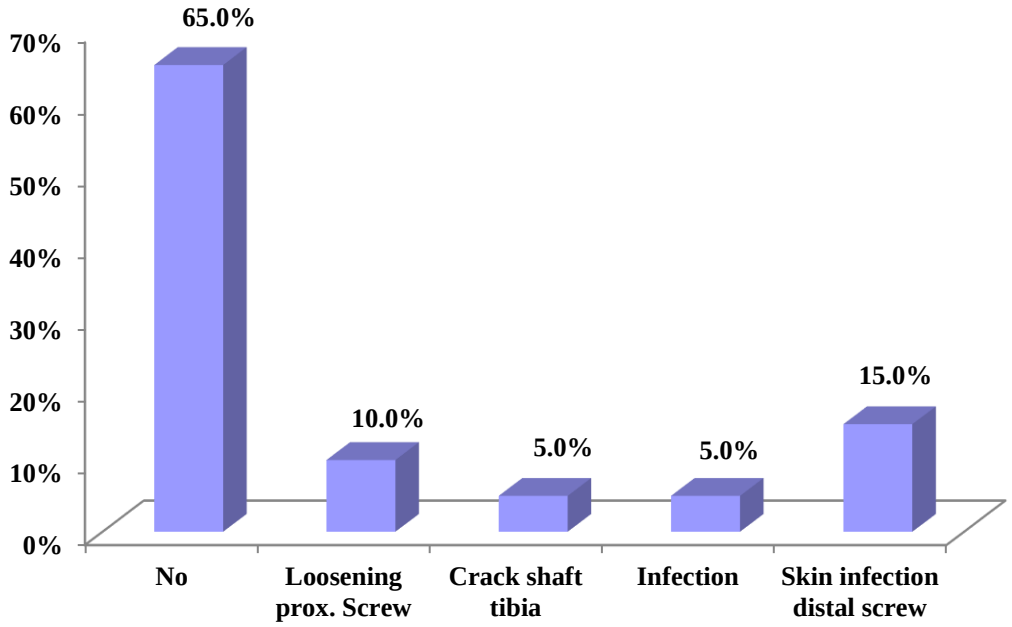


Figure 3: Type of postoperative complication among the studied patients.

The complications occurred in (35%) patients as following: (5%) of patients had intraoperative distal tibial crack during nail introduction, (10%) of patients had loosening of proximal screws and infection, (15%) of patients had skin infection at the site of distal screws and (5%) of patients had deep infection improved with parenteral antibiotics.

Table 1: Comparison among complicated & non-complicated cases as regard demographic data & characteristics of the studied patients.

		Non complicated	Complicated	Test-value	P-value	Sig.
		No.=13	No.=7			
Occupation	Office worker	4 (30.8%)	2 (28.6%)	4.615*	0.329	NS
	House wife	6 (46.2%)	2 (28.6%)			
	Manual worker	2 (15.4%)	0 (0%)			
	Retired	1 (7.7%)	2 (28.6%)			
	Teacher	0 (0%)	1 (14.3%)			
Age	Mean±SD	59.69 ± 3.43	60.57 ± 6.08	-0.418•	0.681	NS
	Range	53 – 64	50 – 68			
Sex	Female	8 (61.5%)	3 (42.9%)	0.642*	0.423	NS
	Male	5 (38.5%)	4 (57.1%)			

P-value > 0.05: Non-significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant. *: Chi-square test; •: Independent t-test. There was no statistically significant variance among complicated & non-complicated cases regarding age, sex & occupation (Table 1).

Table 2: Comparison among complicated & non-complicated cases regarding side and technique of the studied patients.

		Non complicated	Complicated	Test-value	P-value	Sig.
		No.=13	No.=7			
Side	Right	9 (69.2%)	4 (57.1%)	0.292*	0.589	NS
	Left	4 (30.8%)	3 (42.9%)			
Technique	Open	4 (33.3%)	2 (28.6%)	0.046*	0.829	NS
	Closed	8 (66.7%)	5 (71.4%)			
Post-operative x ray	Done	13 (100%)	7 (100%)	–	–	–

P-value > 0.05: Non-significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant. *: Chi-square test; •: Independent t-test. There was none statistically significant distinction amongst complicated & non-complicated cases as regard side (right or left) and technique (open or closed) (Table 2).

Table 3: Distribution according to previous ankle foot surgery.

Previous ankle and foot surgery	**Number**	**Percentage%**
No	14	70.0
Yes	6	30.0

Table 3 showed that 6 (30%) patients were having previous ankle surgeries as following: 3 failed previous ankle fracture fixations with plates and screws and, patient had Ankle debridement and external fixator application due to severe infection and 2 previous surgeries for skin ulcers over bony prominences.

Table 4: Distribution of cases according to Eichenholtz classification.

	Type 2	Type 3	Total
No.	9	11	20
Percentage	45%	55%	100%

Preoperative grading according to Eichenholtz classification showed that 9 patients were of type 2 (45%) and 11 were of type 3 (55%) (Table 4).

Table 5: X-ray and AOFAS score at different times among the studied patients.

		Total no.=20
1 month x ray	Done	20 (100%)
2month X ray	Done	20 (100%)
3 months x ray	Done	20 (100%)
AOFAS Score pre	Median (IQR) Mean Range	0.34 (0.27 – 0.45) 35.75 0.2 – 0.54
AOFAS Score 6m	Median (IQR) Mean Range	0.76 (0.72 – -0.78) 75.88 0.64 – 0.93
AOFAS Score end	Median (IQR) Mean Range	0.91 (0.82 – 0.95) 89.12 0.81 – 0.97

The mean preoperative score percentage was 35.75% (range twenty to fifty four percent). The mean score percentage at 6 months after surgery was 75.88% (range 64.0% - 93.0%). There was further improvement in score at end of the study. The mean final score percentage at the end of study was 89.12% (range 81.0% - 97.0%) (Table 5).

4. Conclusions

Retrograde interlocking nail showed satisfactory results in corrective fusion of severe abnormalities of ankle and hind foot in Charcot neuroarthropathy since it was able to achieve our goals which related to ulcer healing, painless ankle, deformity correction limb salvage, & return to independent activities of daily living.

References

[1] A. H. YOuSrY, A. M. ABDAlHADY. (2010). Management of diabetic neuropathic ankle arthropathy by arthrodesis using an Ilizarov frame. Acta Orthopædica Belgica. 76 (6): e821-e826.

[2] B. Baravarian, C. C. Van Gils. (2004). Arthrodesis of the Charcot foot and ankle. Clinics in Podiatric Medicine and Surgery. 21 (2): e271-e289.

[3] S. G. Dellenbaugh, J. A. DiPreta, R. L. Uhl. (2011). Treatment of ankle fractures in patients with diabetes. Orthopedics. 34 (5): e383-e388.

[4] C. Holmes, B. Schmidt, M. Munson, J. S. Wrobel. (2015). Charcot stage 0: A review and consideratons for making the correct diagnosis early. Clinical Diabetes and Endocrinology. 1 (1): e1-e12.

[5] S. N. Eichenholtz. (1966). Charcot Joints. Springfield, IL, USA: Charles C. Thomas.

[6] C. Gooday. (2022). Monitoring of Charcot neuroarthropathy. A mixed method, feasibility study (Doctoral dissertation, University of East Anglia).

[7] M. F. Green, Z. Aliabadi, B. T. Green. (2002). Diabetic foot: evaluation and management. Southern medical journal. 95 (1): e95-e102.

[8] N. J. Lowery, J. B. Woods, D. G. Armstrong, D. K. Wukich. (2012). Surgical management of Charcot neuroarthropathy of the foot and ankle: a systematic review. Foot & ankle international. 33 (2): e113-e121.

[9] D. K. Wukich, V. Kavarthapu. (2023). Charcot Foot: Surgical Management and Reconstruction. In Functional Limb Salvage: The Multidisciplinary Team Approach. Cham: Springer International Publishing. e237-e250.

[10] B. ElAlfy, A. M. Ali, S. I. Fawzy. (2017). Ilizarov external fixator versus retrograde intramedullary nailing for ankle joint arthrodesis in diabetic Charcot neuroarthropathy. The Journal of Foot and Ankle Surgery. 56 (2): e309-e313.

[11] M. S. Pinzur, A. Kelikian. (1997). Charcot ankle fusion with a retrograde locked intramedullary nail. Foot & ankle international. 18 (11): e699-e704.

[12] C. Caravaggi, M. Cimmino, S. Caruso, S. Dalla Noce. (2006). Intramedullary compressive nail fixation for the treatment of severe Charcot deformity of the ankle and rear foot. The Journal of foot and ankle surgery. 45 (1): e20-e24.

[13] R. W. Mendicino, A. R. Catanzariti, K. R. Saltrick, M. F. Dombek, B. L. Tullis, T. K. Statler, B. M. Johnson. (2004). Tibiotalocalcaneal arthrodesis with retrograde intramedullary nailing. The Journal of foot and ankle surgery. 43 (2): e82-e86.