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Original Article

# Surgical Treatment of Charcot Ankle Fractures by Primary Tibiotalocalcaneal Nailing

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## Abstract

**Background:** Charcot ankle fractures are a complex injury requiring effective surgical intervention to ensure optimal healing and functional restoration. Primary tibiotalocalcaneal nailing has emerged as a potential fixation technique for these challenging fractures, though the functional outcomes and rates of union require further investigation.

**The aim of the work:** This study aims to evaluate the functional outcomes of primary tibiotalocalcaneal nailing in adults with Charcot ankle fractures and assess the rates of union and non-union following the procedure.

**Patients and Methods:** Twenty adult patients with diagnosed Charcot ankle fractures underwent primary tibiotalocalcaneal nailing. Each patient was followed up for a minimum of six months, with clinical and radiological assessments performed to evaluate the functional outcomes of the fixation. Radiographic evaluations at three months post-operatively were conducted to determine the incidence of union and non-union. The study also examined complications, including post-operative suture removal, wound infection, and weight-bearing status

**Results:** At the three-month follow-up, radiological assessments indicated that 70% of the studied cases achieved union, while 30% experienced non-union. Statistical analysis revealed no significant differences between union and non-union cases concerning post-operative suture removal, incidence of wound infection, and weight-bearing status, with p-values of 0.65, 0.521, and 0.2, respectively.

**Conclusion:** Primary tibiotalocalcaneal nailing shows promise as a surgical treatment for Charcot ankle fractures, with a favorable union rate observed in the majority of patients.

**Keywords:** Diabetes mellitus; Ankle fractures; Charcot Ankle; Tibiotalocalcaneal; Fixation.

## INTRODUCTION

Individuals with diabetes experience a greater rate of fractures in the foot, ankle, and hip compared to those without the condition. Ankle fractures, in particular, are among the most frequently occurring fractures in the lower extremities. Studies have shown that the yearly incidence of ankle fractures in the general population can reach as high as 184 per 100,000 individuals. In contrast, this rate is 1.5 times higher among those living with diabetes [1]. Young men and older women are the usually affected subjects by ankle fractures. It is the commonest in men under the age of 50 and after this age, there is a prominent shift to women [2].

Slippery surface and alcohol drinking are the commonest risk factors for about one third of the ankle fractures. The commonest direct cause of these fractures is the twisting and falls. The third common cause is the sports injuries. Diabetes mellitus, overweight and obesity are significant associations with fractures in middle and old-age adults [3].

Ligament injuries are common associations with ankle fracture. The pattern of fracture is directly related to the magnitude and direction of the deforming force exerted on the ankle joint [2].

In geriatric population, the management of fragility of ankle fractures representing a challenge to orthopedic surgeons. This attributed to instability of the fractures, compromise of the soft tissues and associated comorbid conditions. The treatment options used traditionally are open reduction and internal fixation (ORIF) or conservative management. However, both treatment options are associated with higher complication rates [4]. One in eight of patients treated surgically for rotational ankle fractures are diabetic [1]. The complications of surgical treatment of ankle fractures in diabetic patients are reported to be between 26% and 47% compared to 15.0% of non-diabetic patients [5]. One study demonstrated that, amputation is higher among diabetics than non-diabetics after fixation of ankle fractures. In addition, diabetics are more likely to be submitted to reoperation due to higher rate of infection and different surgical complications [6].

## THE AIM OF THE WORK

This work aimed to assess the value of tibiotalocalcaneal (TTC) nails in the treatment of ankle Charcot fractures on the clinical and radiological basis. We proposed that the primary fixation using TTC nail is a safe and effective surgical treatment option and decreases the overall incidence of perioperative complication.

## PATIENTS AND METHODS

This was an interrupted time series clinical trial (quasi experimental) conducted on patients suffering from Charcot ankle fracture presented to us within two weeks of sustaining injury. The study started in January 2022 for 6 months. Patients were selected from Al-Azhar university hospital (New Damietta) and Damietta specialized hospital. The follow up was performed in the outpatient clinics. An informed written consent was obtained from each patient. In addition the protocol was approved by ethical committee of the institution.

We included adult patients from 30 to 70 years from both genders with recent closed fractures less than two weeks. However, we excluded patients with poly-trauma, patients with open or pathological fracture and patients with neglected fracture for more than two weeks.

The preoperative assessment included personal data (e.g., name, age, sex, occupation, address, and phone number), as well as the patient's complaints and present history, which encompassed the onset, course, and duration of the complaint. The clinical examination involved a general assessment and local examination, which included inspection, palpation, movement assessment, special tests, neurological examination (motor and sensory), and evaluation of vascular status. Routine laboratory investigations included a complete blood count, INR, liver and kidney function tests, RBS, and HbA1c. The radiological workup comprised plain X-rays or a CT scan. A prophylactic preoperative intravenous antibiotic was administered.

**Operative technique:**

All patients were submitted to surgery in prone position and under spinal anesthesia. The primary treatment was performed by the retrograde TTC nailing without preparation of the joint. A closed reduction of the ankle fracture was performed and primary retrograde pinning was performed. The pinning was started from the calcaneus and extended to the tibia and this was routinely performed for all patients. The pin was placed anteriorly or posteriorly to the tract of the definitive nail. This was performed to ensue and prevent difficulties while preparing the tract or insertion of the nail. In a retrograde manner, a starting guidewire was inserted and advanced from the calcaneus into the talus and extended to the tibia. After that, advancement of opening reamer over the wire was performed to reach the distal tibial physeal scar. Then both opening reamer and wire were removed and placement of a ball-tipped guidewire was performed into the tract. This was extended to the tibial mid-diaphyseal level. After that, we performed a minimal reaming as the diameter of the patients canal are large enough to easily pass nail 9 mm or more. However, in an effort to minimize nail incarceration risk, reaming to 1 mm greater than the nail size was performed. Finally, two interlocking screws were inserted proximally in the tibia and one interlocking screw was placed through talus and calcaneus. During the whole procedure, we did not use any tourniquets.

**Post-operative:** Patients were followed up and assessed both clinically and radiologically for at least six months regarding the functional outcomes of the fixation. Major changes in the position of the implant, joint stability and range of motion and function were clinically documented. Major complications (related to fixation), and failure of fixation was recorded. In each evaluation visit. The process was completed by a radiologist, who was blinded to the treatment or clinical outcome.

**Data analysis and interpretation:** A software computer package known as statistical package for social science (SPSS) for windows was used to perform all analyses. The relative frequencies (numbers) and percentages were used to represent the categorical data, while mean and standard deviation (SD) were used as measures to represent the quantitative variables. P value $< 0.05$ was set as the margin of significance. As the union is the primary outcome, we tested variables that could affect it by comparison between union and non-union groups. Groups with categorical data were compared by Chi square, while student test was used to compare continuous quantitative data.

## RESULTS

This study included 20 patients with Charcot ankle fractures. The mean age of the studied cases is 55.55±9.85. Males are 45% of the cases, while females are 55%. 40% of the cases are not working, 25% are manual workers and 35% are employee. The mean Fracture duration (days) of the studied cases is 6.70±1.72. Mean Diabetes duration (years) of the cases is 15.05±3.32. Mean HBA1C % is 6.71±0.337 as shown in Table [1]. The mean post-operative sutures removal of the studied cases is 15.05±1.76. Wound is clear in 90% of the cases. Mean weight bearing (weeks) is 8.45±1.23 as shown in Table [2]. The X-ray of the studied cases at 3months detects union in 70% of cases and non-union in 30%. X-ray at 6 months detects union in 30% of cases as shown in Table [3].

Table [4] shows non- statistically significant difference between union cases and non-union cases as regard age, sex and occupation (P=0.119, 0.49 and 0.79 respectively) and also shows non-statistically significant difference between union cases and non-union cases as regard mean Fracture duration/days, Diabetes duration (years) and HBA1C% (P=0.547, 0.295 and 0.52 respectively). Table [5] shows non-statistically significant difference between union cases and non-union cases as regard post-operative sutures removal, wound infection and weight bearing (weeks) (P=0.65, 0.521 and 0.2 respectively).

Table [1]: Sociodemographic characteristics of the studied cases

| Variables | Measures | Statistics |
|---|---|---|
| Age (years) | Mean±SD | 55.55±9.85 |
| | Min. – Max. | 35-70 |
| Sex (n,%) | Male | 9 (45.0%) |
| | Female | 11 (55.0%) |
| Occupation (n,%) | None | 8 (40.0%) |
| | Manual worker | 5(25.0%) |
| | Employee | 7 (35.0%) |
| Fracture duration b Before fixation | Mean±SD | 6.70±1.72 |
| | Min. – Max. | 3 – 9 |
| Diabetes duration (years) | Mean±SD | 15.05±3.32 |
| | Min. – Max. | 10-22 |
| HbA1C% | Mean±SD | 6.71±0.337 |
| | Min. – Max. | 6- 7 |

Table [2]: Operative characteristics of the studied cases

| Variables | Measures | Statistics |
|---|---|---|
| Duration of removal of sutures after surgery | Mean±SD | 15.05±1.76 |
| | Min. – Max. | 12-18 |
| Wound infection (n,%) | Clear | 18 (90.0%) |
| | Infected | 2 (10.0%) |
| Weight bearing/weeks | Mean±SD | 8.45±1.23 |
| | Min. – Max. | 7-11 |

Table [3]: X-ray findings among studied cases

| | | n=20 | % |
|---|---|---|---|
| X-ray at 3 months | Non union | 6 | 30.0 |
| | Union | 14 | 70.0% |
| X-ray at 6 months | Union | 6 | 30.0 |

Table [4]: Comparison of sociodemographic characteristics, fracture duration, diabetes duration and HBA1c between cases with & without union

| | | Non -union N=6 | Union N=14 | test | P |
|---|---|---|---|---|---|
| Age/years | | 60.83±53.28 | 53.28±9.48 | 0.119 | 0.119 |
| Sex (n,%) | Male | 2(33.3) | 7(50) | 0.471 | 0.492 |
| | Female | 4(66.7) | 7(50) | | |
| Occupation (n,%) | Not working | 3(50) | 5(35.7) | 0.459 | 0.795 |
| | Manual worker | 1 (16.7) | 4(28.6) | | |
| | Employee | 2 (33.3) | 5(35.7) | | |
| Duration before fixation | | 6.33±2.33 | 6.86±1.46 | 0.614 | 0.547 |
| Diabetes duration (years | | 13.83±3.65 | 15.57±3.16 | 1.08 | 0.295 |
| HBA1C% | | 6.63±0.32 | 6.74±0.35 | 0.656 | 0.520 |

Table (5]: Relation between operative post-operative findings and incidence of nonunion among studied cases

| | | Non -union N=6 | Union N=14 | test | P |
|---|---|---|---|---|---|
| Days for suture removal | | 15.33±1.86 | 14.93±1.77 | 0.461 | 0.650 |
| Wound infection | Clear | 5(83.3 | 13(92.9) | 0.423 | 0.521 |
| | Infected | 1(16.7) | 1(7.1) | | |
| Weight bearing/weeks | | 9.0±1.26 | 8.21±1.19 | 1.33 | 0.200 |

## Case Presentations

No 1: Female patient aged 55years with history of diabetes mellitus type II for 10 years (HbA1c=6.5) and the next figures representing pre- and post-operative data (Figures 1, 2, 3).


Figure (1): Shows preoperative X ray AP and lateral view (case I).

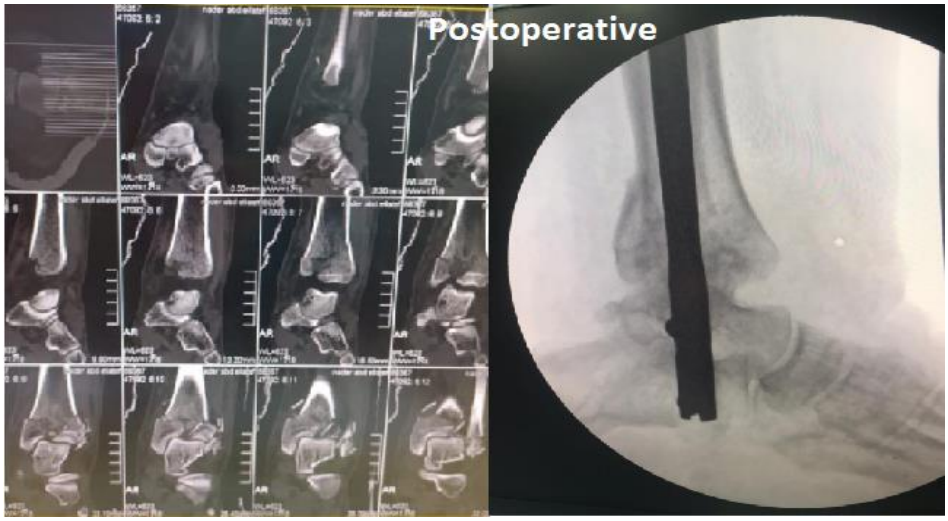


Figure (2): Shows postoperative view (case I).

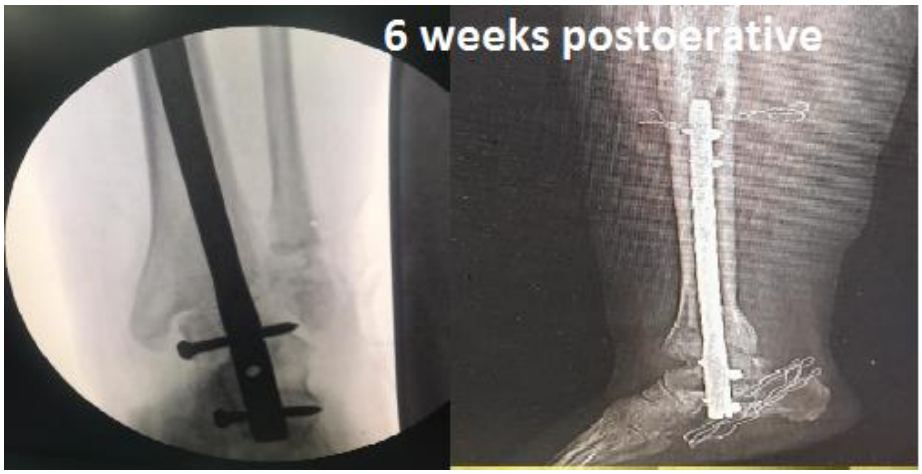


Figure (3): Shows 6 week's postoperative view (case I).

No 2: Female patient aged 56 years old with history of diabetes mellitus type II since 18 years (HbA1c=6.8) complain of fracture dislocation of ankle (Figures 4,5,6)

Figure (4): Preoperative AP and lateral X- ray view (case III).

Figure (5): Shows postoperative AP and lateral X- ray view (case III).

Figure (6): Follow up 2 months (case III).

## DISCUSSION

The fragile ankle fractures showed progressive increase, mainly in older females. These fracture are usually due to low-energy injuries with the resultant disproportionate high level of morbidity [7]. In addition, the advanced age is associated with the development of systemic diseases (e.g., diabetes, peripheral vascular diseases and osteoporosis, among others). The presence of such comorbid diseases affected the wound healing and bone union. In addition, it leads to higher incidence of peri-operative complications, postoperative wound infection and delayed healing [8].

In this age group, the conservative management of ankle fractures is the rule. However, ORIF comes as the second treatment option. However both methods had higher rate of failure and postoperative complications [9]. Thus, the research continuous to reach the optimal treatment option in this age group. However, the topic remains controversial. Intra-medullary Steinmann pins are proposed for indirect fixation of the ankle and showed satisfactory results [10]. Retrograde TTC nails also have been introduced for the management of complex ankle pathology (e.g., pantalar osteoarthritis, Charcot arthropathy and post-traumatic pseudarthrosis). In addition, it is used as a salvage method in the failed ankle replacement [11].

In fragile ankle fractures, TTC nails were described for the failure of other treatment forms. Furthermore, it gained attention as a primary treatment option with reported satisfactory success. However, the previous studies included a small number of patients [12]. Thus the current work was designed to assess the clinical and radiological outcome of TTC nails in the treatment of ankle fragility fractures.

Twenty patients were included with a mean age of 55.55±9.85, and slight increase of females (55%) and 40% of all patient not have a current work. These results are comparable to **Rammelt *et al.*** [13] study. They included an equal number of males and females (19 for each gender). Their mean age was 53 years and about half of them hand no work at the time of inclusion

Our results showed that the mean Fracture duration (days) of the studied cases was 6.70±1.72. The mean duration of DM 15.05±3.32 years, while the mean HBA1C % was 6.71±0.337. **Taylor *et al.*** [14] presented the results of their evaluation of 31 patients, who were primary treated by retrograde TTC nailing. Their patient had a mean HbA1C (%) was (7.6±1.9) and between injury to fixation (days) was 2.4 ± 2.7. It is clear that they started fixation earlier than the current work, while the glycated hemoglobin values were comparable to our study.

The mean post-operative time for sutures removal was 15.05±1.76 days, and the wound was clear in 90%. The mean weight bearing (weeks) was 8.45±1.23. **Lu *et al.*** [15] collected data retrospectively for 20 patients submitted for intramedullary nailing with a TTC nail. Only five cases had diabetes and two of them had superficial wound infection after surgery. This represented 40% of all diabetic patients included in their study, which is higher than the current one. The limited number of diabetic cases in their study could explain this variation.

**Ebaugh *et al.*** [16] included 27 older patients than the current work (the mean age was 66) who were relatively obese. The open fractures were reported for 6 out of 27 fractures and neuropathy was recorded for 20 out of 27 patients. The mean glycated hemoglobin was 7.4 and the average weight of postoperative stay was 6 days (0-22). The values of glycated hemoglobin were comparable to our results. However no cases with neuropathy was reported in the current work.

The current study showed that the X-ray of the studied cases at 3 months detected union in 70% of cases and non-union in 30%, and after the 6 months, the 30 patients with non-union at the end of the third month of follow up showed complete union of their fractures. **Jonas *et al.*** [11] designed a study to investigate the functional outcome for fragile ankle fractures treated by primary TTC nailing. Their results showed that, 30/31 patients had formed radiographic union at the average of one year of follow up, while 8 patients showed no evidence of radiographic union with earlier follow up time (average 2 months). In addition, **Lu *et al.*** [15] reported that none of 20 patients had periprosthetic fractures, breakages of nails, or non-unions at the end of their follow up

Interestingly, the current study showed non- statistically significant difference between union and non-union as regard patient demographics, occupation, mean time between fracture and fixation, duration of diabetes, glycated hemoglobin, the interval for removal of sutures, the rate of wound infection and weight bearing. Thus, we could say that, age, sex, DM duration, HBA1c, post-operative sutures removal, wound infection and weight bearing, might not predict the frequency of union of ankle fracture fixed by the retrograde TTC nail. Conversely, **Liu *et al.*** [17] concluded that HbA1c appear to be a predictor of the risk of postoperative complication after the surgical management of diabetic patients with ankle fractures.

Collectively, our study shows that retrograde TTC nail is a useful option for treatment of ankle fractures in diabetic population. This method is superior to the traditional ORIF in some aspects. These include shorter operative time, reduced blood loss, minimum dissection of soft tissues with permission early mobilization and weight bearing.

**Jordan *et al.*** [18] concluded that TTC nailing is a useful alternative to save the ankle and subtler joints prone to future arthritis in patients with high risk, especially in patients unable to comply with postoperative instructions.

Additionally, **Genovese *et al.*** [19] showed that TTC nailing is an effective and safe treatment option for unstable fractures of the ankle in high-risk diabetic patients. It provides a rigid fixation, minimal dissection of soft tissues and few complications than ORIF.

Several limitations should be acknowledged in this study. First, the follow-up period for this study was relatively short, limiting our ability to assess long-term outcomes and complications associated with the surgical treatment. Finally, the number of patients included in this study was small, which may restrict the generalizability of the findings and reduce the statistical power of the analyses conducted. Future studies with larger cohorts and longer follow-up durations are needed to further elucidate the effectiveness and safety of primary tibiotalocalcaneal nailing in the management of Charcot ankle fractures

**Conclusions:**

TTC nails is a safe and reasonable option to fixate the ankle fracture in diabetic patients. The patient characteristics or data of injury did not predict the postoperative complications. This may be due to small number of patients included in this work, which representing a limiting step of the current work. In addition, the shorter

duration of follow up is the second limitation of the current work. However, this study added evidence supporting the use of a TTC nail in fixation of ankle fractures in diabetic patients.

**Conflict of Interest and Financial Disclosure:** None

## REFERENCES

1. Lavery LA, Lavery DC, Green T, Hunt N, La Fontaine J, Kim PJ, Wukich D. Increased Risk of Nonunion and Charcot Arthropathy After Ankle Fracture in People With Diabetes. J Foot Ankle Surg. 2020 Jul-Aug;59(4):653-656. doi: 10.1053/j.jfas.2019.05.006.

2. Ho B, Ketz J. Primary arthrodesis for tibial pilon fractures. Foot and Ankle Clinics. 2017 Mar 1; 22(1):147-61. DOI: 10.1016/j.fcl.2016.09.010.

3. Bullard KM, Cowie CC, Lessem SE, Saydah SH, Menke A, Geiss LS, et al. Prevalence of diagnosed diabetes in adults by diabetes type—United States, 2016. Morbidity and Mortality Weekly Report. 2018 Mar 3; 67(12):359. DOI: 10.15585/mmwr.mm6712a2

4. Jani MM, Ricci WM, Borrelli J Jr, Barrett SE. A protocol for treatment of unstable ankle fractures using transarticular fixation in patients with diabetes mellitus and loss of protective sensibility. Foot Ankle Int. 2003 Nov; 24(11):838-44. DOI: 10.1177/107110070302401106.

5. Chaudhary SB, Liporace FA, Gandhi A, Donley BG, Pinzur MS, Lin SS. Complications of ankle fracture in patients with diabetes. J Am Acad Orthop Surg. 2008 Mar; 16(3):159-70. DOI: 10.5435/00124635-200803000-00007.

6. Georgiannos D, Lampridis V, Bisbinas I. Fragility fractures of the ankle in the elderly: open reduction and internal fixation versus tibio-talo-calcaneal nailing: short-term results of a prospective randomized-controlled study. Injury. 2017 Feb 1; 48(2):519-24. DOI: 10.1016/j.injury.2016.11.017

7. Migliorini F, Giorgino R, Hildebrand F, Spiezia F, Peretti GM, Alessandri-Bonetti M, Eschweiler J, Maffulli N. Fragility fractures: risk factors and management in the elderly. Medicina. 2021 Oct 17; 57(10):1119. DOI: 10.3390/medicina57101119

8. Rammelt S. Management of ankle fractures in the elderly. EFORT open reviews. 2016 May; 1(5):239. DOI: 10.1302/2058-5241.1.000023

9. Saini R, Shah N, Dholakia A, Shah D, Agrawal K, Patel U. A prospective study on functional outcome of distal tibial fracture fixation with locking compression plate using minimally invasive percutaneous osteosynthesis. International Journal of Orthopaedics. 2021; 7(2):20-4. DOI: 10.22271/ortho.2021.v7.i2a.2608

10. Makwana N, Ismael S. Implantology of Fractures of the Foot. Handbook of Orthopaedic Trauma Implantology. 2022 May 7 (pp. 1-22). Singapore: Springer Nature Singapore.

11. Jonas SC, Young AF, Curwen CH, McCann PA. Functional outcome following tibio-talar-calcaneal nailing for unstable osteoporotic ankle fractures. Injury. 2013 Jul 1; 44(7):994-7. DOI: 10.1016/j.injury.2012.11.008

12. Amirfeyz R, Bacon A, Ling J, Blom A, Hepple S, Winson I, Harries W. Fixation of ankle fragility fractures by tibiotalocalcaneal nail. Archives of Orthopaedic and Trauma Surgery. 2008 Apr; 128:423-8. DOI: 10.1007/s00402-008-0584-z

13. Rammelt S, Pyrc J, Ågren PH, Hartsock LA, Cronier P, Friscia DA, et al. Tibiotalocalcaneal fusion using the hindfoot arthrodesis nail: a multicenter study. Foot & ankle international. 2013 Sep;34(9):1245-55. DOI: 10.1177/1071100713487526

14. Taylor BC, Hansen DC, Harrison R, Lucas DE, Degenova D. Primary Retrograde Tibiotalocalcaneal Nailing For Fragility Ankle Fractures. Iowa Orthop J. 2016; 36:75-8. PMID: 27528840.

15. Lu V, Tennyson M, Zhang J, Thahir A, Zhou A, Krkovic M. Ankle fusion with tibiotalocalcaneal retrograde nail for fragility ankle fractures: outcomes at a major trauma centre. Eur J Orthop Surg Traumatol. 2023 Jan; 33(1):125-133. DOI: 10.1007/s00590-021-03171-1.

16. Ebaugh MP, Umbel B, Goss D, Taylor BC. Outcomes of Primary Tibiotalocalcaneal Nailing for Complicated Diabetic Ankle Fractures. Foot Ankle Int. 2019 Dec; 40(12):1382-1387. DOI: 10.1177/1071100719869639.

17. Liu J, Ludwig T, Ebraheim NA. Effect of the blood HbA1c level on surgical treatment outcomes of diabetics with ankle fractures. Orthopaed Surg 2013 Aug; 5(3):203-8. DOI: 10.1111/os.12047

18. Jordan RW, Chapman AW, Buchanan D, Makrides P. The role of intramedullary fixation in ankle fractures–a systematic review. Foot Ankle Surg. 2018 Feb 1; 24(1):1-0. DOI: 10.1016/j.fas.2016.04.004

19. Genovese N, Patel J, Lin SS, Greendyk J. Primary Tibiotalocalcaneal Fusion for High-risk Complex Ankle Fractures. Journal of Foot and Ankle Surgery (Asia Pacific). 2021 Oct 20; 8(4):188-92. DOI: 10.5005/jp-journals-10040-1180

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