DOI: https://doi.org/10.30795/jfootankle.2025.v19.1875

Case Report

Plantar closing-wedge calcaneal osteotomy for the treatment of plantar ulcers in diabetic foot: a case report

Cláudia Diniz Freitas[1], Felipe Daniel Plata Rosa[1], Martha Lúcia Silva Katayama[1], Daniel Araújo da Silva[1], Eduardo Araújo Pires[1], Eduardo Cezar Silva dos Santos[1]

1. Hospital Alemão Oswaldo Cruz, São Paulo, Brazil.

Abstract

Calcaneal ulcers in the diabetic foot present a complex challenge in limb preservation, as most of the outcomes are calcanectomy or limb amputation. These outcomes can significantly impact the patient, leading to functional limitations and difficulties with orthotic use. We report a case of the adaptation of a technique previously described by Gaenslen in 1931 for the treatment of calcaneal osteomyelitis. A 51-year-old diabetic patient with chronic injury in the calcaneal plantar region. Previous ulcers and debridements made primary closure challenging. A plantar subtraction osteotomy of the calcaneal bone was performed, facilitating primary chronic wound closure. The technique proved to be effective in treating calcaneal ulcer of a diabetic patient, preventing amputation, and promoting rehabilitation, in addition to enabling the early return of the patient to work activities.

Level of Evidence IV, Therapeutic Study; Case Report.

Keywords: Diabetic foot; Osteomyelitis; Osteotomy; Amputation; Ulcer.

Introduction

The prevalence of diabetes mellitus (DM) worldwide will be 783 million people by 2045, and it is estimated that 15% of this population will have diabetic foot ulcers at some point in the disease, and the outcome may be amputation in up to 30% of cases[(1)].

Calcaneal bone involvement in diabetic foot ulcers presents a significant challenge, as factors such as reduced vascularity, loss of the plantar cushion, and reduced protective sensation complicate treatment. In these cases, maintaining hindfoot functionality, securing calcaneal tendon fixation, and achieving primary wound closure are often difficult[(2)].

Currently, the most accepted treatment for calcaneal ulcers is the combination of debridements, calcanectomy, and less invasive procedures to preserve functional structures[(3)]. However, osteotomies are also alternatives to manage diabetic foot ulcers, as described by Gaenslen in 1931, involving a sagittal incision to perform an osteotomy with plantar resection of the affected portion of the calcaneus[(4)].

The objective of this study is to report a case of calcaneal plantar osteotomy in a diabetic foot, performed to treat ulceration in this region. The technique, successfully adapted from the method originally described by Gaenslen, allowed primary wound closure with lower morbidity and early return to usual activities.

Case report

A 51-year-old diabetic patient was diagnosed with type 2 for five years and on insulin for one year. The patient reported a wound in the plantar region of the left calcaneus two months prior, although unable to inform if it originated from a callus or contusion. Despite undergoing dressings and debridements, the wound showed no signs of improvement (Figure 1A). In previous specialized care, surgical procedures were suggested, such as vascularized flaps, calcanectomy, and even amputation. Upon admission to our service, the patient presented pain, hyperemia, and purulent discharge with a foul odor through the wound. Laboratory tests were as

Study performed at the Hospital Alemão Oswaldo Cruz, São Paulo, Brazil.

Correspondence: Eduardo Cezar Silva dos Santos. 1815, Treze de Maio Street, postal code: 01323-903, São Paulo, Brazil. **Email:** eduardocezar.ortopedia@gmail.com. **Conflicts of interest:** None. **Source of funding:** None. **Date received:** January 28, 2024. **Date accepted:** March 16, 2025.

How to cite this article: Freitas CD, Rosa FDP, Katayama MLS, Silva DA, Pires EA, Santos ECS. Plantar closing-wedge calcaneal osteotomy for the treatment of plantar ulcers in diabetic foot: a case report. J Foot Ankle. 2025;19(1):e1875.

follows: Hemoglobin 13.8 g/dL, leukocyte count 11100%/mm3, C-reactive protein 5.53 mg/dL. On imaging tests, both radiography and nuclear magnetic resonance (NMR) of the ankle showed no changes in the calcaneal bone. In the NMR, no signs suggestive of osteomyelitis were found (Figures 1B and 1C). Doppler arterial ultrasound showed significant obstruction of popliteal flow and tibiofibular trunks. Revascularization was performed but was insufficient, with permanence of posterior and anterior tibial artery stenosis, without filling the plantar arch (Figure 2A and 2B). To control soft tissue infection, debridement was performed with material collection for culture, maintained using negative pressure therapy due to plantar area exposure of the calcaneus, concomitant with intravenous antibiotics (Figure 2C and 2D).

In the samples collected for microbiological evaluation, *Enterococcus faecalis* bacteria were growing in soft tissues, but there was no growth in bone fragments. Antimicrobial therapy with Teicoplanin 400 mg/day was maintained for two weeks. After discussing the case with the patient and family members, it was decided to preserve the limb by a plantar subtraction calcaneal osteotomy for primary wound closure.

With the patient in the prone position, devitalized tissues were removed from the plantar wound, and a proximal portion of the plantar aponeurosis was resected. During the procedure, meticulous care was taken to identify and protect the adjacent anatomical structures. Medially, this included the posterior tibial nerve and its branches, the posterior tibial

Figure 1. (A) Clinical photo of the plantar portion of the calcaneus after initial debridement. (B) Magnetic Nuclear Resonance Imaging (MRI) – Sag T1. (C) Magnetic resonance imaging – Sag T2. MRI images show mild edema and liquid slides in the adjacent fat pad but without extension to the deep bone plane or signs of osteomyelitis.

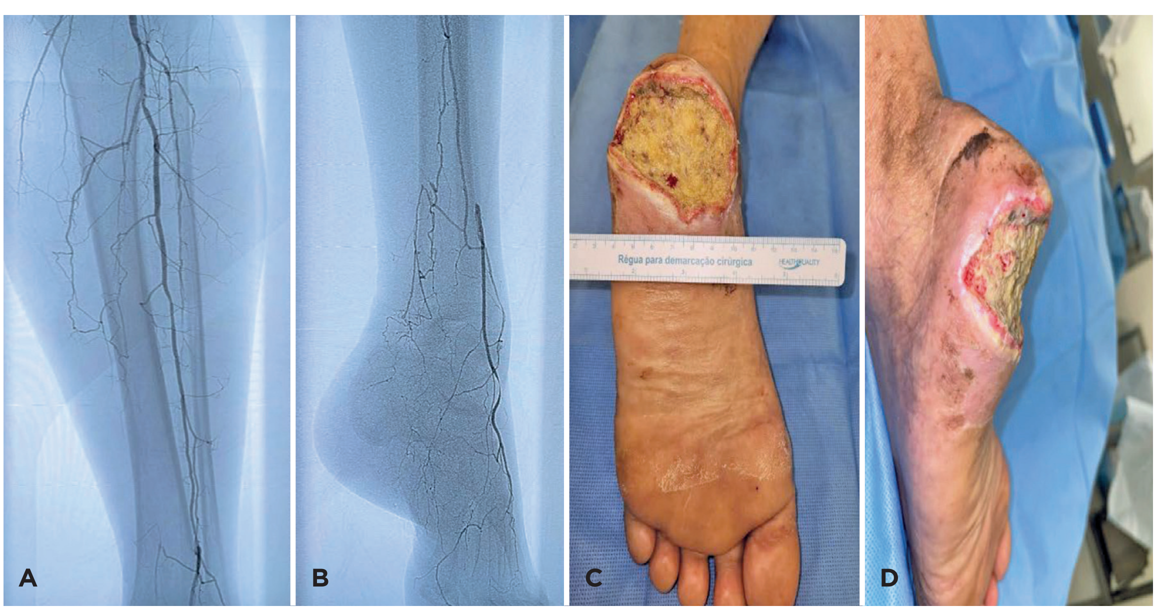

Figure 2. (A and B) Arteriography images after angioplasty, presenting obstruction of the anterior and posterior tibial arteries in the leg, only patent fibular artery. In the foot, the plantar arch is incomplete due to obstruction of the plantar arteries and minimal vascularization in the calcaneous, with only the dorsalis pedis artery remaining patent. (C and D) Clinical photo after surgical approach.

tendon, the flexor hallucis longus, and the flexor digitorum longus. Laterally, the peroneal tendons and the sural nerve were safeguarded. Under radioscopic guidance, the site for the plantar subtraction osteotomy was marked as a triangular region on the calcaneus, with the base at the plantar surface and the apex just below the subtalar joint (Figure 3A).

The marked area was resected using a saw, preserving the superior cortical bone. Radiological control in the sagittal plane was performed, followed by osteotomy closure and provisional fixation with two guidewires (Figure 3B). Final fixation was then completed using two cannulated screws (Figures 3C and 3D). Due to the osteotomy closure, the calcaneal tendon was tensioned. To prevent deformity in equinus positioning of the foot, a percutaneous Hoke-type tendon lengthening was performed. Intraoperative radioscopic control (Figures 3E and 3F) confirmed that the fixed osteotomy allowed wound edge approximation and enabled primary ulcer closure (Figure 4A). A negative pressure incisional dressing was applied, and the limb was immobilized using a suropodalic splint, with the ankle maintained at 90 degrees.

The lesion was reassessed after one week in a sterile environment (Figure 3B). The patient was discharged with a standardized antimicrobial therapy and instructed to maintain immobilization and avoid weight-bearing for three weeks. After this period, a physiotherapy program was initiated to restore the range of motion and muscle strengthening. Stitches and immobilization were removed in the third week. However, in the fourth week, the patient developed wound dehiscence in the medial region of the calcaneal along with the appearance of a fistula at the site of the medial calcaneal screw, which was attributed to screw protrusion (Figures 4D and 4E). An attempt was made to close the wound using silver dressings over two weeks, but without success. Given the persistence of the lesion, a new surgical intervention was performed, involving the removal of the medial cannulated screw and suturing to approximate the wound edges (Figure 4F). Despite the initial difficulty in wound closure, the lesion completely healed with no fistulas or secretion discharge formation. Starting in the tenth week, the patient began progressive physiotherapy focused on gradual muscle strengthening, proprioception, and partial weight-bearing, using insoles and footwear designed for insensitive feet. By the sixth month, the patient had returned to work without walking limitations, showing progressive improvement in mobility. At the one-year follow-up, radiographic exams confirmed osteotomy consolidation (Figures 5A and 5B), and the patient demonstrated a very satisfactory clinical outcome (Figures 5C, 5D, 5E, and 5F).

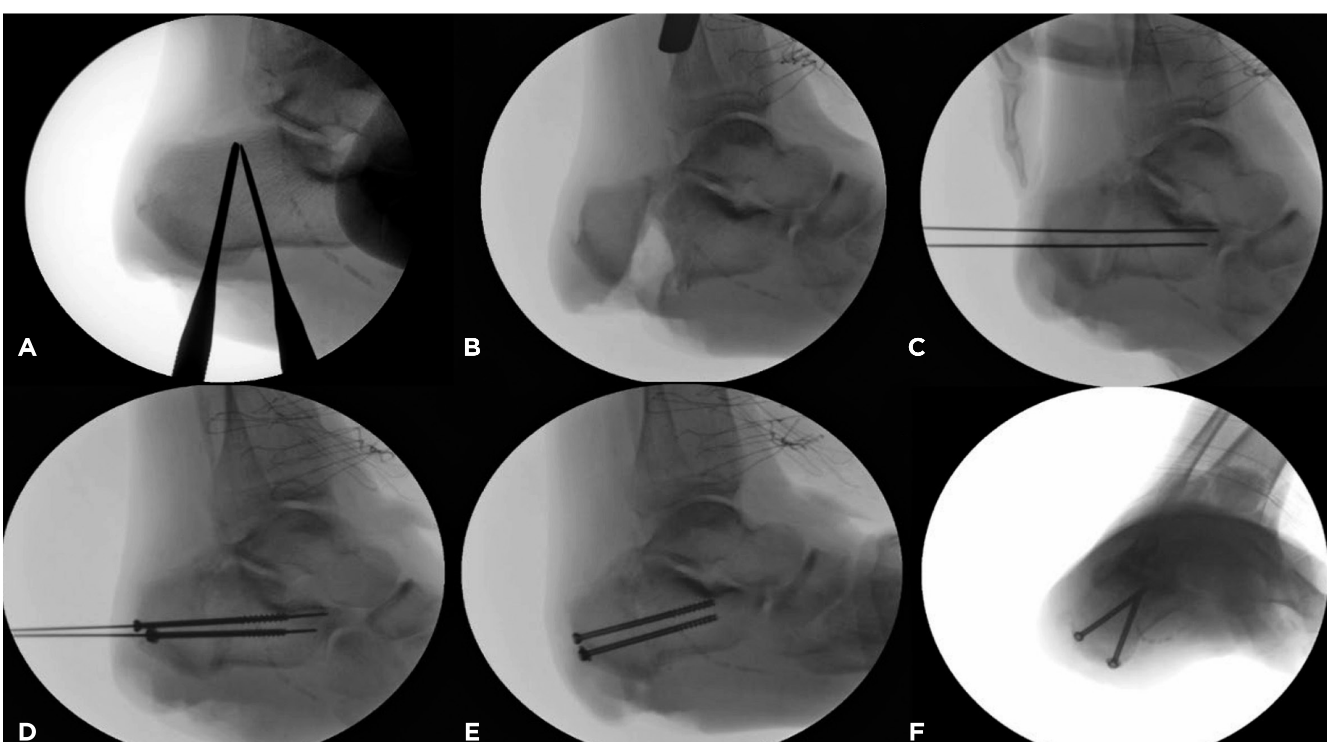

Figure 3. (A) Osteotomy marked area. (B) Plantar resection osteotomy performed. (C) Osteotomy closure and guidewire passage. (D) Osteotomy fixation with cannulated screws. (E and F) Intraoperative control of osteotomy fixation.

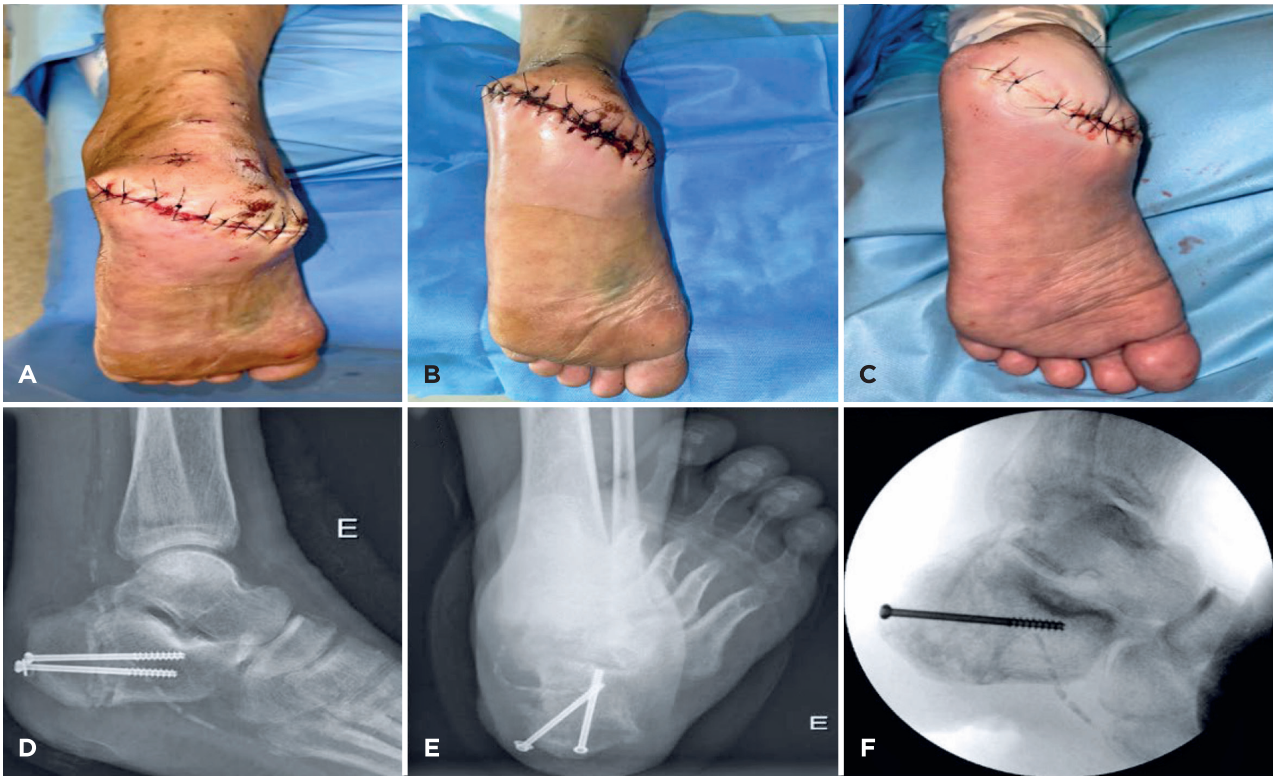

Figure 4. (A) Suture in the immediate postoperative period. (B) One week surgical wound. (C) Suture after revision wound and removal of a cannulated screw after six weeks. (D) Profile calcaneal radiography and (E) Axial calcaneal radiography, observed loosening of one cannulated screw. (F) Intraoperative control of removal of one screw.

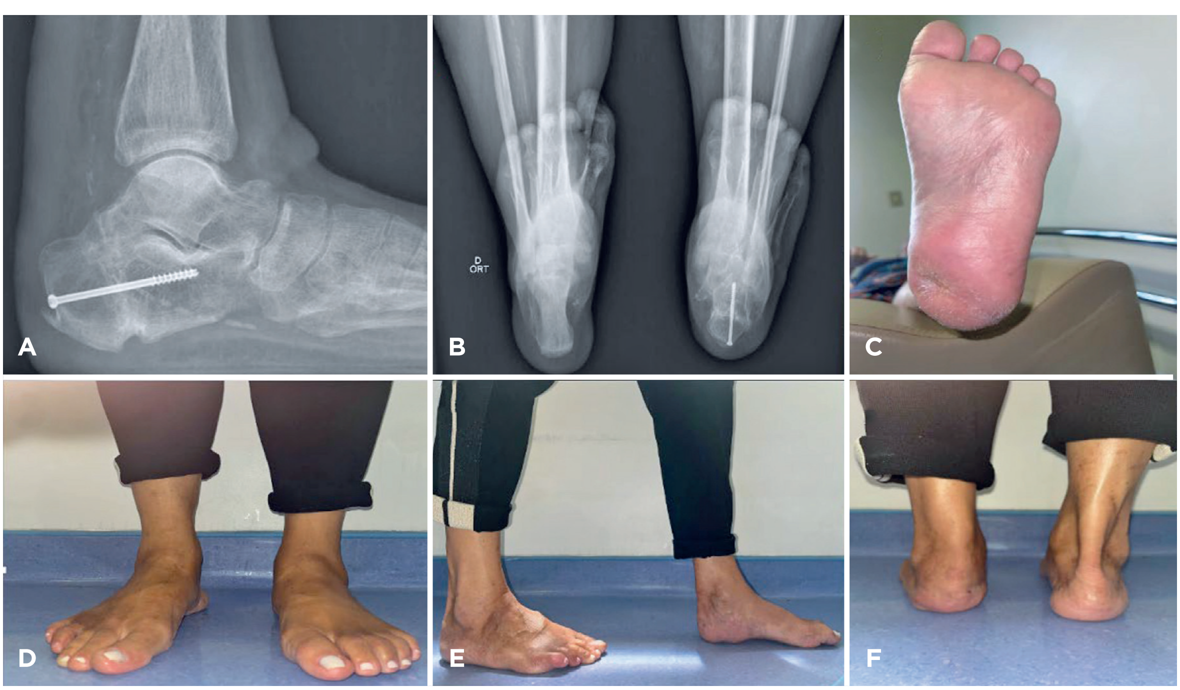

Figure 5. (A) Profile calcaneal radiography after 12 months (B) Bilateral Saltzman radiography after 18 months. (C) Healed wound. (D, E, and F) Clinical photos of the patient's foot, performing weight-bearing.

Discussion

This case report highlights the challenges involved in achieving wound closure in diabetic foot ulcers, emphasizing the importance of choosing treatments that prevent unsatisfactory outcomes for patients. Diabetic foot ulcers represent a significant source of morbidity, mortality, and socioeconomic burden in the Western world. Approximately 60% of these ulcerations are infected with polymicrobial flora, and up to 20% of moderate to severe diabetic foot ulcers may lead to amputation, with associated mortality rates reaching as high as 30% within five years[5].

The synergistic effect of diabetic sensory, motor, and autonomic dysfunctions results in foot deformities and viscoelastic alterations in the skin. Combined with repeated microtrauma, these changes lead to callus formation, which progressively extends deeper into the soft tissues, ultimately involving the bone[5,6].

In diabetic foot, the calcaneus is the second most frequently affected area by ulcerations[6]. Managing ulcers in this location is particularly challenging for limb preservation, as this region experiences significant pressure from body weight and has limited options for vascularized flap coverage[6,7]. Literature indicates that such ulcerations often progress to osteomyelitis, resulting in prolonged antibiotic use, length of hospital stay, and higher overall treatment costs. Therefore, accurate diagnosis is essential for effectively preventing and managing diabetic foot infections[7].

Although the definitive diagnosis of osteomyelitis is microbiological, several tests can increase the predictive accuracy for this condition, including radiographs, MRI, and the probe-to-bone test[2,7]. In our case, the probe-to-bone test was positive despite the absence of clear signs of osteomyelitis or definitive bone involvement on imaging studies. This suggests that the timely intervention performed prevented further progression of the disease.

Calcanectomies have been advocated as procedures aimed at preventing transtibial or transfemoral amputation in patients presenting with contiguous and recurrent infections, as these amputations not only increase morbidity and mortality but also constitute significant risk factors for subsequent amputations[2,8]. A functional limb capable of ambulation with the use of orthoses can be achieved, but the adaptation process for patients is not always straightforward[2].

Alternative limb-preserving surgical treatments for calcaneal ulcerations and osteomyelitis include using muscle flaps to fill bone defects following debridement[9]. However, in our case, stenoses of adjacent vessels made the use of vascularized flaps unfeasible. As a result, a plantar resection osteotomy was chosen as an effective alternative, enabling primary wound closure while preserving the Achilles tendon insertion.

Unlike the original technique described by Gaenslen, whose incision was to plantar sagittal in the midline[9], the approach in our study employed a transverse incision to the midline in the sagittal plane. An important limitation of this study was the fact that the calcaneus was not attached to the bone, which made it possible to fix the osteotomy for early mobility with greater safety and bone consolidation.

Plantar resection osteotomy proved to be an effective alternative for treating calcaneal ulcers, allowing for early rehabilitation, infection control, and primary wound closure. However, future randomized clinical trials are needed to provide a stronger scientific foundation for adapting the Gaenslen technique.

Authors' contributions: Each author contributed individually and significantly to the development of this article: CDF *(https://orcid.org/0000-0002-6649-2066) Interpreted study results, participated in the review process; FDPR *(https://orcid.org/0009-0007-9143-1162) Interpreted study results, participated in the review process; MLSK *(https://orcid.org/0009-0009-9003-0863) Interpreted study results, participated in the review process; DAS *(https://orcid.org/0009-0008-8395-8797) Interpreted study results, participated in the review process; EAP *(https://orcid.org/000-001-60088671) Interpreted study results, participated in the review process. ECSS *(https://orcid.org/0000-0001-5018-3923) Conceived and planned the activities that led to the study, wrote the article, participated in the review process, approved the final version; interpreted study results, participated in the review process; and participated in the review process; All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

References

1. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract. 2022;183:109119. Erratum in: Diabetes Res Clin Pract. 2023;204:110945.
2. Walsh TP, Yates BJ. Calcanectomy: avoiding major amputation in the presence of calcaneal osteomyelitis-A case series. Foot (Edinb). 2013;23(4):130-5.
3. Uzun M, Eralp L. Functional Ankle Reconstruction Technique After Total Calcanectomy. J Am Podiatr Med Assoc. 2024;114(3):21-102.
4. Gaenslen FJ. Split-Heel Approach in osteomyelitis of os calcis. J Bone Joint Surg. 1931;13(4): 759-72.
5. Armstrong DG, Tan TW, Boulton AJM, Bus SA. Diabetic Foot Ulcers: A Review. JAMA. 2023;330(1):62-75.
6. Akkurt MO, Demirkale I, Öznur A. Partial calcanectomy and Ilizarov

external fixation may reduce amputation need in severe diabetic calcaneal ulcers. Diabet Foot Ankle. 2017;8(1):1264699.

7. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and Their Recurrence. N Engl J Med. 2017;376(24):2367-75.
8. Chen SL, Chen TM, Chou TD, Chen SG, Wang HJ. The distally based lesser saphenous venofasciocutaneous flap for ankle and heel reconstruction. Plast Reconstr Surg. 2002;110(7):1664-72.
9. Levine AD, Picard C, Alperson M, Sirhan MF, Ben Lulu O, Liberson A. Tuber Calcanei Osteomyelitis Eradication via Modified Gaenslen's Approach. Foot Ankle Orthop. 2022;7(2):24730114221099023.