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Case Report

A Case of Chronic Limb-Threatening Ischemia with Heel Ulcers Cured by Revascularization and Partial Calcanectomy

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Ischemic limbs with infected heel ulcers are often difficult to salvage. We present a case of an 82-year-old woman who had bilateral heel ulcers owing to chronic limb-threatening ischemia. She underwent right femoral-terminal posterior tibial artery bypass surgery, but right calcaneus osteomyelitis occurred and inhibited wound healing. She underwent partial calcanectomy (PC), and her right heel healed six months after the bypass surgery. The ulcer on her left foot also healed after distal bypass and PC. We describe our experience with a patient who needed PC to cure her heel ulcers.

Keywords: peripheral artery disease, heel ulcer, calcaneus osteomyelitis

Introduction

Heel ulcers and gangrene of the ischemic foot are difficult to treat, even among patients with successful revascularization who achieve normal ankle-brachial index (ABI) or skin perfusion pressure (SPP) values.[1–3] Osteomyelitis (OM) is a clinically important inhibitory factor in wound healing. In particular, foot infections, a category of the Wound, Ischemia, and foot Infection (WIfI) classification, are significantly associated with OM and cause delayed wound healing.[4] We present a patient that developed bilateral heel ulcers and calcaneus OM owing to chronic limb-threatening ischemia (CLTI) treated with surgical revascularization and partial calcanectomy (PC).

Case Presentation

An 82-year-old woman with CLTI had a right heel ulcer. She was obese (body mass index 32.6) and had diabetes mellitus (DM). The heel ulcer developed redness, indicating an infected ulcer (**Fig. 1A**). Her white blood cell count was 8,700/mm^3, with a C-reactive protein level of 8.02 mg/dl. Her right ABI was 0.59, and her SPP was 20 mmHg in the dorsum and 25 mmHg in the plantar surface of the right foot. The limb was categorized as stage 4 (wound 2, ischemia 3, and foot infection 2) based on the WIfI classification. Preoperative magnetic resonance imaging (MRI) showed no OM at the foot bones (**Fig. 2A**). Computed tomography angiography demonstrated multiple stenoses at the right superficial femoral artery (SFA) and chronic total occlusion in the anterior tibial artery and peroneal artery, but the posterior tibial artery (PTA) was partially patent via collateral circulation. Preoperative ultrasound vein mapping indicated that her right great saphenous vein (GSV) was available for bypass grafting. The patient underwent bypass surgery from the SFA to the terminal PTA using the GSV in situ. Complete angiography showed a well-visualized wound blush in the right heel (**Fig. 3A**). Post the surgery, the SPP in her right foot improved to 72 mmHg in the dorsum and 64 mmHg in the plantar surface. We used antibiotics on the basis of the results of the wound culture. In this case, we used meropenem and vancomycin until the inflammation re-

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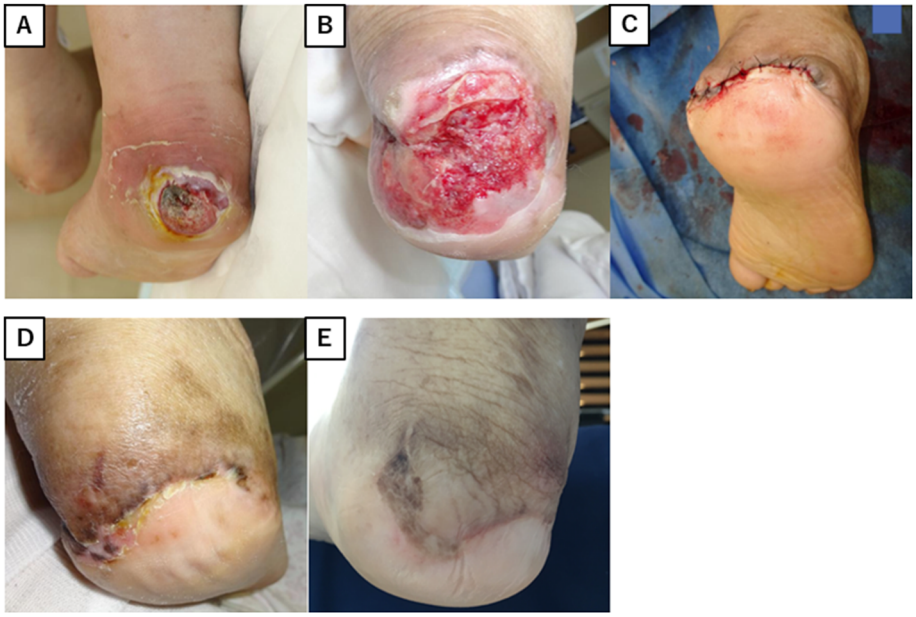

Fig. 1 The right heel ulcer was infected at admission (**A**). The ulcer did not heal for three months despite distal bypass surgery (**B**). Then, partial calcanectomy (PC) was performed (**C**). The wound healed two and a half months after the PC (**D**). The patient did not develop ulcer recurrence or osteomyelitis (**E**).

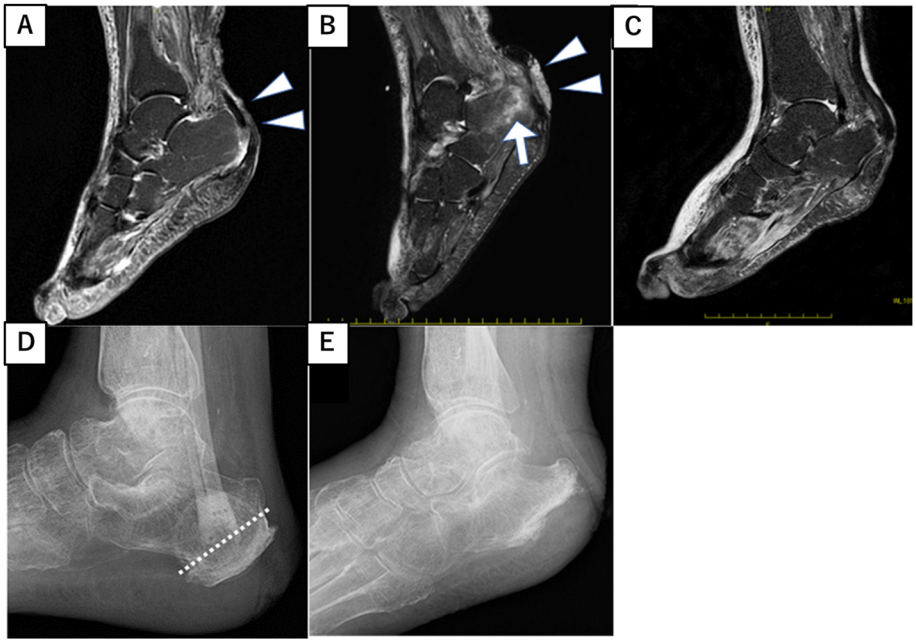

Fig. 2 Magnetic resonance imaging findings of the right foot (T2-STIR images). No osteomyelitis was observed at admission (**A**). Right calcaneal osteomyelitis developed (arrow) three months after the bypass surgery (**B**). Arrowheads indicate the location of the heel ulcer. After partial calcanectomy, no osteomyelitis was observed after wound healing (**C**). Foot radiography before (**D**) and after (**E**) partial calcanectomy. The dotted line indicates the cutting line of the heel bone.

solved. Then, *Proteus mirabilis*, *Enterococcus faecalis*, and *Streptococcus equisimilis* were detected from the wound culture, and we switched to a trimethoprim-sulfamethoxazole combination for de-escalation. Although the heel wound gradually granulated, the wound did not heal for three months after the surgery (**Fig. 1B**). An MRI examina-

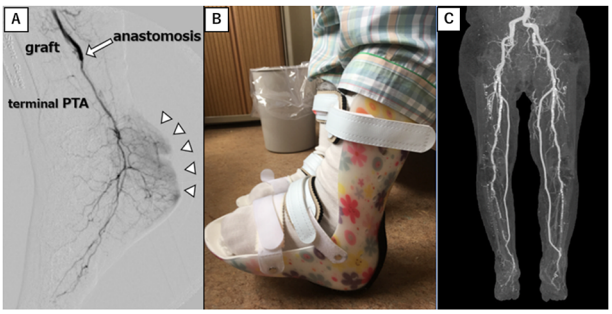

Fig. 3 Complete angiography showed a well-visualized wound blush in the right heel (**A**: arrowheads). Heel covering devices provide heel pressure relief by creating a space between the heel and the devices, and the devices can reduce the incidence of pressure injuries (**B**). Multidetector row computed tomography showed that the bilateral bypass grafts were both patent, and no stenosis occurred (**C**).

tion was performed again to check for the presence of OM because of the possibility of deep infection corresponding to the foot infection grade of 2 in the preoperative WIfI classification. The MRI showed calcaneal OM in the right heel (**Fig. 2B**), and we speculated that OM inhibited wound healing in the heel. After consulting orthopedists, we decided to proceed with PC for the following reasons: the wound was not cured with conventional treatment for over three months and became increasingly wider, and PC can preserve the calcaneus to some extent and maintain her standing function. Then, the patient underwent a PC procedure performed by orthopedists to close the wound and maintain her walking ability (**Figs. 2D** and **2E**). Although the wound for PC was closed directly (**Fig. 1C**), a part of the wound was not primarily healed, so negative pressure wound therapy was performed. Two and a half months after PC, complete wound healing was achieved (**Fig. 1D**). During the treatment of the right foot, another ulcer occurred on the patient's left heel and seemed to be associated with ischemia combined with compression. She underwent left distal bypass from the SFA to the dorsal planter artery (DPA) in an in situ manner. However, OM also occurred at the left calcaneus, and PC was performed as for the right calcaneus. The wound in the left heel completely healed a month and a half after the PC. Her HbA1c was 7.9% at admission, so strict DM control was performed. Then, her HbA1c finally improved to within the normal limit. Because the main cause of the heel wounds in this case was thought to be ischemia with compression and friction from the bed, we ordered custom-made heel offloading devices (**Fig. 3B**). The patient was able to stand with assistance when she was transferred to rehabilitation. The total hospitalization period was approximately seven months. The bilateral bypass grafts were both patent without significant stenosis proven by duplex graft surveillance (**Fig. 3C**), and the heel wounds and OM did not recur (**Figs. 1E** and **2C**). However, unfortunately, her standing and walking ability remained impaired owing to the progression of spondylosis.

Discussion

The development of ulcers in the heel overlaying the calcaneus is a serious problem for patients with ischemic foot. The wound sometimes grows increasingly worse, and cellulitis and local infection, gangrene, or calcaneal OM can subsequently develop.[1] There are many risk factors for healing disorders that can affect heel wounds after revascularization. According to Treiman, heel ulcers and gangrene require up to six months for complete wound healing. Successful revascularization and patency of the PTA are important, and cigarette use and renal dysfunction may be risk factors. Treiman's study also showed no relations between wound healing and ABI, infection, DM, or hyperlipidemia. Our group also reported DM, end-stage renal failure, low albuminemia, and heel ulcer/gangrene as risk factors for unhealed ulcers after revascularization.[3] Conversely, the EURODIALE study suggests that wound infection negatively affects wound healing in peripheral artery disease patients.[5] When treating patients with deep wound infections, it is important to evaluate the presence of OM, use appropriate antibiotics according to the culture results, and perform appropriate debridement surgery.

The selection of bypass target arteries remains controversial in terms of the angiosome concept. However, recent studies have suggested that bypass surgery is less dependent on the angiosome concept than on endovascular revascularization.[3,6] As shown by Azuma et al., surgical revascularization by distal bypass grafting is effective for wound healing regardless of the angiosomes, especially in nondialysis patients, such as in the current case. The PTA is an important blood source to perfuse heels. However, it is not always possible to revascularize the PTA. For such cases, bypass to the DPA may potentially improve the blood supply to the heel. More importantly, the status of the bones, located under the wounds, is significantly associated with wound healing. An evaluation of OM by MRI is informative in treating infected foot wounds, especially infections of heel wounds.

Patients with extensive tissue loss are forced to be on bed rest longer than patients with minimal tissue loss. The increase in bed rest time decreases the physical status and is associated with the onset of sarcopenia.[7] Therefore, PC can be useful not only for salvaging the limb with minimal deformity of the foot but also for maintaining the physical status of the patient, especially the lower limb functions. PC can be an alternative to major amputation for patients

with large heel ulcers and calcaneus OM.[8] In fact, it has also been reported that proper revascularization and PC are effective.[9] We could minimize the deterioration of our patient's quality of life by treating her with PC and rehabilitation.

The heel is the second most prone area to pressure ulcers. To prevent ulcerations, pressure ulcer guidelines suggest that the most important aspect of heel ulcer prevention is pressure relief.[10] In this regard, we used heel covering devices, as shown in **Fig. 3B**. We made this device primarily to use on the bed because the heel wound sustained contact forces when the patient moved on the bed. The device can relieve pressure by creating space between the device and the heel.

In addition to the above factor, we need to make efforts to prevent wound recurrence with multimodal therapy, such as strict infection control with antibiotics: we use proper antibiotics for a long period even after the inflammation subsided. Strict diabetes control and nutrition management have a positive impact on wound healing.[2] We usually use nutrition products, including 3-hydroxy 3-methylbutyrate, arginine, and glutamine, for patients with malnutrition. Elderly patients receive rehabilitation to maintain their physical status and become more independent in their daily lives.

Conclusion

The ischemic foot with heel ulcerations is difficult to treat. Moreover, the development of OM has a negative impact. We experienced a case of bilateral ischemic heel ulcers with infections that we were able to cure by multimodal therapy, successful revascularization, and proper orthopedic surgery intervention including PC, infection control, wound care techniques, rehabilitation, and decompression after the operations.

Disclosure Statement

All authors have no conflict of interest.

Author Contributions

Surgical procedures: TT, SK, AT, SO, DU, SA, NA
Wound management: RH
Adjusting heel offloading devices: TO
Writing: TT, SK, NA
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

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