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Case Report

Treatment for Calcaneal Osteomyelitis with Pseudoarthrosis with a Vascularized Fibula Bone Graft and Autologous Cancellous Bone Graft: A Case Report

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Abstract

Calcaneal osteomyelitis with pseudarthrosis after calcaneal fracture is rare, and its treatment is challenging. We describe the use of a free fibular osteocutaneous flap to treat a 52-year-old man who presented with calcaneal osteomyelitis and pseudarthrosis after an operation for a closed comminuted fracture. The patient was previously treated with multiple surgeries and antibiotics for 8 months, but he was not cured. We performed radical osteomyelitis bone debridement and reconstruction with a free fibular osteocutaneous flap and autotrabecular bone grafting from the iliac crest. The skin flap survived, and rehabilitation was initiated early. At 2 years postoperatively, his pain and ambulatory function had markedly improved, and he could walk without problems in daily life. Free fibular osteocutaneous flap and autogenous cancellous bone grafting are considered practical options for the treatment of calcaneal osteomyelitis with pseudarthrosis.

Keywords

osteomyelitis, calcaneus fracture, pseudarthrosis, free fibular osteocutaneous flap, reconstruction

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Introduction

Calcaneal fractures are the most common foot fractures. These are more common in young and pre-retiree men and older women[1]. The incidence of wound infection after open reduction and internal fixation of closed calcaneal fractures ranges from 2% to 15%, and that of osteomyelitis ranges from 0.4% to 4%[2-5]. Treatment of calcaneal osteomyelitis is challenging and can result in partial or total resection of the calcaneus or even amputation of the lower extremity, which carries a high risk of postoperative problems with ambulation[6-8].

We report the case of a difficult-to-treat patient who developed calcaneal osteomyelitis with pseudarthrosis after open treatment of a closed calcaneal fracture, in which a free fibular osteocutaneous flap was used to preserve the calcaneus and achieve good functional recovery.

Case Report

A 52-year-old man fell from a height of 2.5 m while working and sustained a closed crush fracture of the right calcaneus. On the same day, he underwent repair and fixation with an internal fixation plate and artificial bone insertion at the Orthopedic Surgery Department of a local hospital. Osteomyelitis of the calcaneus with pseudarthrosis and a skin ulcer on the lateral side of the heel were then observed. Persistent discharge of pus from the skin ulcer was observed, and antibiotics were administered for 6 months, but the infection did not subside. He was referred to our hospital's Orthopedic Surgery Department and underwent two artificial bone removal procedures that did not result in healing. He was then referred to our department.

Initial findings (**Figure 1A**): The patient had redness, swelling, and tenderness in the right foot. Two skin ulcers with partial exposure of the calcaneus and persistent pus discharge were noted. The visual analog scale was 4 points, the Ankle-Hindfoot Scale was 20 points, and the Maryland Foot Score was 15 points.

X-p: A calcaneal fracture with pseudarthrosis was observed. The Essex-Lopresti classification showed an intra-articular fracture involving the posterior talocalcaneal joint (depressed joint type) (**Figure 1B**).

CT and contrast-enhanced MRI (**Figure 2**): Bone defects

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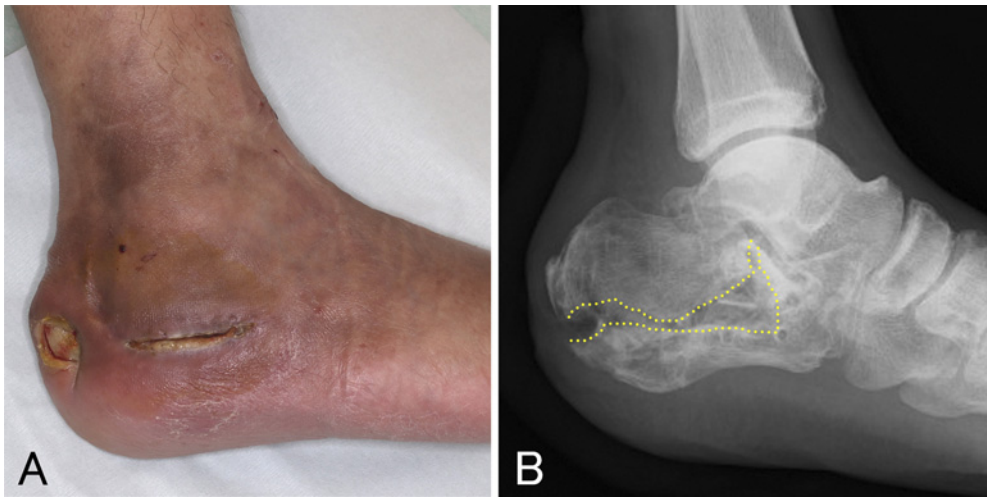

Figure 1. Preoperative clinical (A) and radiographic appearance (B) of the complex calcaneal defect. A yellow dotted line indicated pseudo articulation.

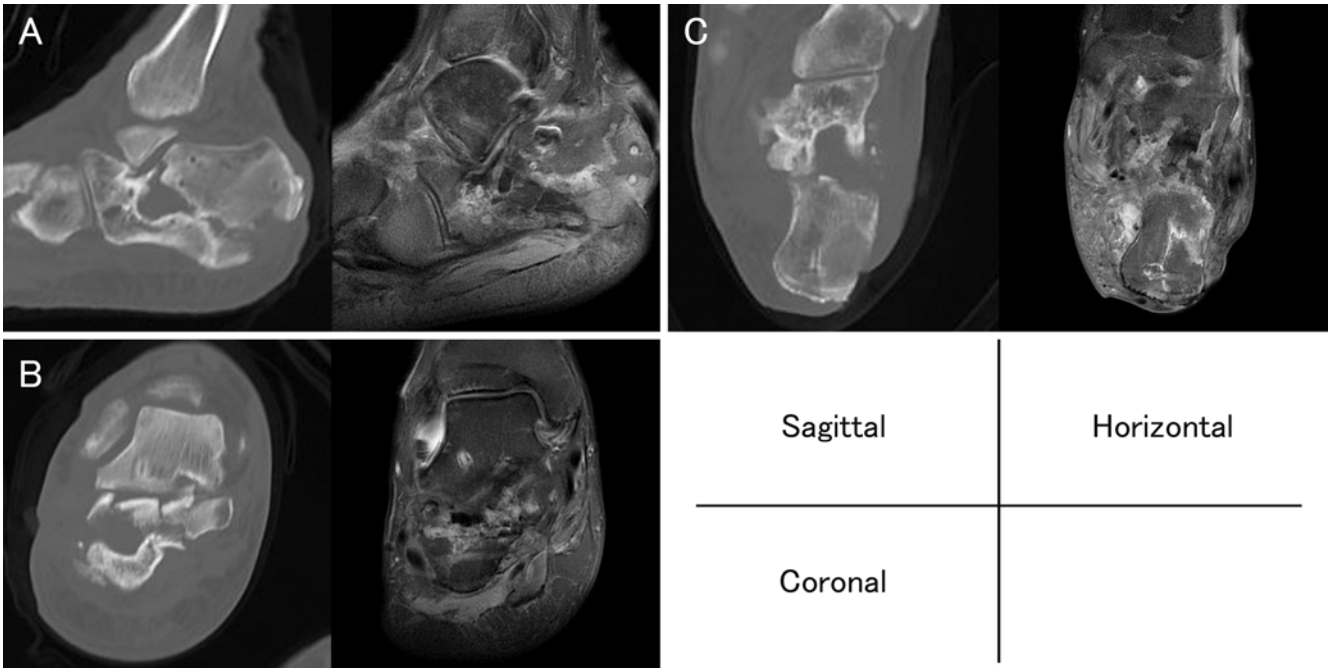

Figure 2. Preoperative CT (left) and contrast-enhanced T2-weighted MRI findings (right) of the calcaneum. (A) Sagittal section; (B) horizontal section; and (C) coronal section.

and comminuted bone fragments of the calcaneus were observed, accompanied by pseudarthrosis. A T2 image showed high osteomyelitis in the calcaneus around the pseudarthrosis site.

Blood tests revealed a white blood cell count and C-reactive protein of 11700 (/μl) and 7.0 (mg/dl), respectively.

Culture results: *Pseudomonas aeruginosa*

Drug allergy: penicillin and cephem antibiotics

Operative findings: The skin of the right foot was incised so the two skin ulcers were contiguous and the calcaneus bone was exposed (**Figure 3A**). The infected lesions, including the residual artificial and decayed bones, were entirely removed until good bleeding was observed. Trabecular bone (6.8 g) was harvested from the iliac bone and filled into the calcaneus defect (**Figure 3B**). A vascularized fibular bone (17 cm in length) with a skin flap (22 × 5 cm skin island) was elevated in the right lower leg (**Figure 3C**). The fibula was excised, leaving ～4 cm of bone, and grafted into the bone defect, and 35 and 45 mm compression screws (SCS Self-Compression Screws®, 4.5/4.7 tapered screws, Homs Giken, Japan) were used to fix the grafted bone and calcaneus (**Figure 3D**). The skin incision was extended below the medial malleolus and the posterior tibial artery was identified. The peroneal artery was anastomosed end-to-side to the posterior tibial artery using a 9-0 nylon. Two companion veins of the peroneal artery and two posterior tibial veins were end-to-end anastomosed using a 3 mm automated vascular anastomosis device (GEM™ Microvascular Anastomosis Device, Wonderworks Inc., Japan) (**Figure 3E**). The donor area was closed and sutured (**Figure 3F**). Immediately

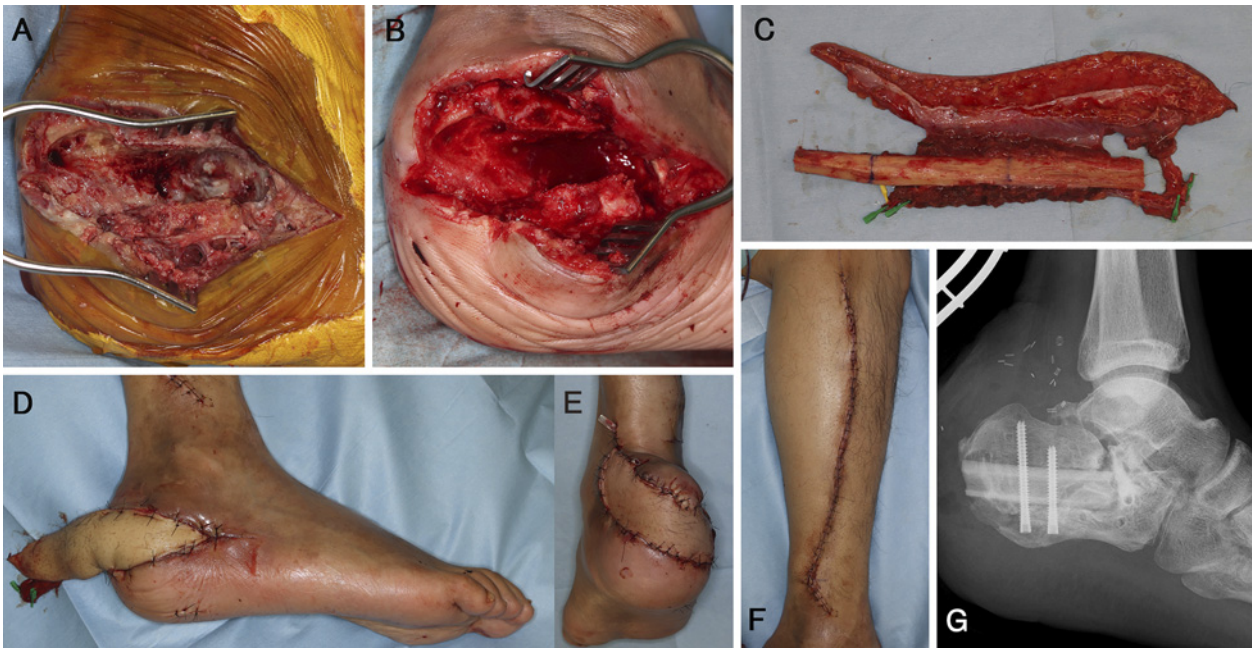

Figure 3. Intraoperative views. (A) After residual artificial and decayed bone were removed entirely; (B) after trabecular bone (the weight was 9.8 g) was filled into the resulting defect; (C) the elevated free fibular osteocutaneous flap; (D) the vascularized bone (the length was 4 cm) fixed by two compression screws and the flap sutured on the lateral side of the heel; (E) after vascular anastomosis was finished and the flap was fixed; (F) the donor site was sutured and closed; and (G) radiographic finding immediately after the operation.

after surgery, bone fixation was confirmed by radiography (**Figure 3G**). The operative time was 11 h and 8 min, and the blood loss was 248 ml.

Postoperative course: The patient was treated with levofloxacin for 1 week postoperatively. The skin flap completely survived, and closed kinetic chain exercise of the right lower extremity was started 1 week postoperatively. A 1 cm ulcer was observed on the heel, but the wound was entirely closed 8 weeks after the surgery with conservative treatment. Ankle joint range of motion training was started 4 weeks postoperatively, and full-load rehabilitation was activated 8 weeks postoperatively. Subsequently, the patient underwent two surgeries to reduce the size of the skin flap. At 2 years postoperatively, the appearance of the donor area and the transplant area was satisfactory (**Figure 4A**). There were no bony problems in the harvested fibular area or tibia (**Figure 4B**, left). The grafted bone was ultimately osteosynthesized in the calcaneus (**Figure 4B**, right). The patient had a visual analog scale score of 0, an Ankle-Hindfott scale score of 86, and a Maryland Foot Score of 86. Currently, his ankle joint range of motion is 15° dorsiflexion and 35° plantar flexion. He was able to walk without problems in daily life (Video. 1).

Discussion

Osteomyelitis can often be treated with systemic administration of antibiotics for acute osteomyelitis. However, surgical therapy is required for chronic osteomyelitis or when the disease is resistant to conservative treatment[9]. Calcaneal osteomyelitis in children is primarily treated nonsurgically, while surgical treatment is more common in adults[10]. Since the calcaneus is rich in trabecular bone, fractures heal well. However, once infected, the infection spreads to the entire trabecular bone, making it challenging to heal[11,12]. Thus, calcaneal osteomyelitis in adults refractory to conservative treatment should be treated surgically as soon as possible to preserve function. In these cases, in addition to antibiotic therapy, surgical debridement of the avascularly necrotic bone and sequestrum is necessary[9,13]. The surgical treatment of calcaneal osteomyelitis can be divided into calcanectomy and calcaneal preservation[10]. Calcaneal resection includes total or subtotal calcanectomy and amputation proximal to the calcaneus[10,14-16]. Total and subtotal calcaneal arthroplasties have low rates of infection[10]. However, they require special shoes or orthotics for ambulation due to foot deformity and limited range of motion[10]. Calcaneal bone sparing is based on a free or local musculocutaneous flap or an antibiotic-containing artificial bone filling in the dead space created by debridement of the infected lesion[12,17-25]. Calcaneal-sparing surgery is an excellent method for preserving function but is inferior to calcaneal amputation in infection control[10]. Local muscle flaps and fasciocutaneous flaps are easy to use and can cover the defect with vascularized tissue; however, they are challenging to use when the bone defect is significant[19,26]. Free musculocutaneous flaps and antibiotic-loaded calcium sulfate can be used to treat extensive bone defects[12,16-21,27]. Suppose debridement leaves the cortical shell and removes the marrow cavity, including osteomyelitis, followed by a free flap or antibiotic-loaded calcium sulfate filling, in this case, it can maintain morphology and function[18]. However, these methods have been used in cases where

Figure 4. (A) Appearance 2 years after the operation. (Left) Medial lower leg. (Center) Posterior lower leg. (Right) Lateral lower leg. (B) Postoperative radiographic findings. (Left) Lower leg. (Right) Calcaneal bone.

most of the calcaneal cortex was preserved and are not indicated for calcaneal osteomyelitis with pseudarthrosis, in which the calcaneal shell has already been destroyed.

In this case, long-term conservative treatment by the previous orthopedic surgeon was ineffective, and two debridements by our orthopedic surgeon were inadequate and did not result in healing. Our patient presented with chronic osteomyelitis of the calcaneus refractory to conservative treatment, skin defects on the heel and lateral aspects of the foot, and pseudarthrosis at the calcaneal fracture site. As a manual laborer, surgical treatment with preservation of foot function was necessary. However, extensive calcaneal bone loss and calcaneal instability resulted from the debridement. Therefore, we selected a vascularized fibular bone graft with a skin flap for reconstruction, which can supply vascularized tissue and achieve bone stabilization for the defect. There are four reports of a free fibular osteocutaneous flap for chronic calcaneal osteomyelitis, as far as we could find in literature[11,28-30]. All four cases had chronic osteomyelitis with skin defects and were refractory to conservative and multiple surgical treatments. There were two cases after internal fixation of calcaneal fractures and two cases after open fracture surgery. One case had pseudarthrosis, as in the present case. In all cases, the infection subsided, bone was stabilized, and normal gait was achieved[11,28-30]. Based on these references, we can summarize the advantages of a free fibular osteocutaneous flap for calcaneal osteomyelitis: infection resistance and early bone healing due to vascularized tissue, load-bearing and stable bone fixation due to high bone density of the grafted bone, and availability of healthy tissue reconstruction for skin and soft tissue defects[11,28-30]. However, a dead space between the calcaneus and grafted bone is likely to develop because it is unlikely that the shape of the calcaneal bone defect after surgical debridement will match the morphology of the grafted fibula. Lykoudis et al. and Mata-Ribeiro et al. reported that the use of a flexor hallucis longus muscle flap combined with a free fibular osteocutaneous flap for chronic calcaneal osteomyelitis reduced the dead

space that developed between bones and improved wound vascularity and resistance to bacterial infection[29,30]. This method is considered an excellent treatment; however, there are concerns about the sacrifice of the flexor hallucis longus muscle and the possibility of necrosis due to compression of the muscle tissue between the bones. In our method, an iliac autograft was placed in the dead space between the bones instead of the muscle, resulting in early bone formation and infection control. Since we believe that a free fibular osteocutaneous flap alone is sufficient for infection control, the combination of auto-cancellous bone grafting, which requires less donor sacrifice, fills the dead space between the calcaneus and grafted bone, and is expected to provide bone stability and early bone formation, is considered a practical option. The other most promising candidate for this case would be an osteocutaneous SCIP flap[31]. This method is excellent because it is less invasive and allows for the elevation of thin skin and a vascularized bone graft[31]. It is considered less invasive compared to our method because it does not require additional autogenous bone harvesting. The high cortical density of the fibula enables the reconstructed calcaneus to withstand weight-bearing pressure while standing or walking[29]. In this case, we used a fibula, not an ilium, because the time between injury and reconstruction is quite long and rehabilitation of the lower extremity and weight-bearing should be performed as early as possible. In fact, in a case report using an osteocutaneous SCIP flap for calcaneal reconstruction, the postoperative time to full weight-bearing was 14 weeks[31], whereas in this case, it was 8 weeks.

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Author Contributions: Toru Miyanaga contributed in the core writing of the report and was the main operator. Takayoshi Kaneko and Mikio Yagishita collected the data. Miyuki Kishibe, Masanobu Yamashita, and Kenichi Shimada interpreted the data and reviewed the final draft.

Conflicts of Interest: There are no conflicts of interest.

Ethical Approval: This case report was conducted in compliance with the Declaration of Helsinki.

Consent to Participate: The patient provided written informed consent to participate in this study.

Consent for Publication: Written informed consent for the publication of images and information about the patient was obtained.

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