

Hindfoot and Foot Arch Reconstruction by Atypical Subtalar Arthrodesis and Achilles Tendon Lengthening for a Severe Comminuted Calcaneal Fracture: A Case Report

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Introduction

Open calcaneus fractures are rare but severe injuries. High-energy trauma often causes significant soft tissue and bone damage, posing extraordinary challenges for treatment.³ The rates of complications associated with treatment are high, including malunion, nonunion, and fracture-related infections.⁵ These complications are associated with an amputation rate of the lower limb of 8%.² Even if amputation is avoided and treatment and complication management are successful, the patient's quality of life is compromised, similar to those suffering from bone infections in the long bones. Apart from compromised soft tissue, bone defects present the main obstacle to successful treatment. Anatomical bone reconstruction becomes difficult, if not impossible, in cases of severe compound fractures. Open fractures necessitate thorough surgical debridement to prevent infection, which may result in significant bone defects requiring bone reconstruction.^{3,4} Given the immense challenges of surgical treatment following high-energy injuries, where bone transplantation and extensive osteosynthesis offer limited promise, we present a case illustrating an atypical subtalar arthrodesis and hindfoot reconstruction in a patient with a Gustilo type IIIa^o comminuted calcaneus fracture.

Case History

A 38-year-old male patient suffered polytrauma in a motorcycle accident in May 2022, primarily affecting his extremities. He experienced a complex trauma involving the left lower extremity, including a IIIb^o distal fracture of the leg



Figure 1. Lateral radiograph of the left calcaneus after transfer to our hospital.

with subsequent avulsion of the anterior tibial artery, compartment syndrome, ipsilateral pilon, and severe foot trauma with a IIIa^o open calcaneal comminuted fracture (Sanders type IV) (Figure 1). At the initial hospital, negative-pressure wound therapy was administered for the IIIb^o

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Figure 2. Lateral radiograph of the left calcaneus (A) 6 weeks, (B) 3 months, (C) 6 months, (D) 9 months, and (E) 12 months after trauma.

distal lower leg fracture on the left, as well as the IIIa° open calcaneal comminuted fracture on the left. Subsequently, the patient was transferred to our hospital for further surgical treatment.

On admission, the negative-pressure wound therapy previously inserted was removed. This was followed by soft tissue debridement and debridement of the tibia and calcaneus. Because of necrosis of the bone fragments, excision of the ventral calcaneus was necessary. Granudacyn (Mölnlycke Health Care, Germany), a hypochlorous acid-containing irrigation solution for treatment of acute, chronic, and contaminated wounds, was used for irrigation. Furthermore, the initially subluxated talonavicular joint was transfixated with 2.0-mm K-wires, and an antibiotic-bead-pouch (40 g Palacos [Heraeus, Germany] + 2 g vancomycin + 2 g meropenem) was inserted in the left lower extremity and calcaneus area. The plantar calcaneus wound was temporarily closed using Epigard (Biovision Biomaterial, Germany), an artificial skin graft for temporary wound coverage.

Initially, an empirical intravenous antibiotic therapy with piperacillin/tazobactam was administered. After *Klebsiella pneumoniae* was detected in the blood culture and *Enterococcus* spp and *Stenotrophomonas maltophilia* were found in the intraoperative sonication, levofloxacin was added to the antibiotic regimen for an additional 6 weeks. During a follow-up surgery, the calcaneus was debrided again, the antibiotic beads were removed, and a new antibiotic bead pouch was inserted. In total, the antibiotic bead pouch was changed twice, and the secondary suture in the calcaneus area was performed after 2 weeks.

After an additional 4 weeks, which corresponds to a total of 9 months after the initial injury, the calcaneal comminuted fracture received its final treatment. The previously inserted antibiotic beads were removed, and another debridement of the calcaneus was performed. During the surgery, great care was taken to preserve the calcaneal tuberosity, promoting its union with the subtalar articular surface. However, because of existing Achilles tendon shortening, which hindered the dorsal tilting of the tuber calcaneus by approximately 60 degrees, a triple hemisection approach was required for percutaneous Achilles tendon lengthening. Following the debridement of the subtalar joint surface, cannulated screw osteosynthesis was carried out using 7.3-mm partially threaded screws (Figure 2). Meticulous care was taken to achieve normal valgus hind-foot alignment. Additionally, a K-wire was inserted to stabilize a lateral tuber calcanei fragment. Six Perossal pellets (Osartis, Muenster, Germany), a nanocrystalline *hydroxyapatite* and calcium sulfate-containing biodegradable composite bone substitute, which is suitable for delivering local antibiotics, was mixed with 0.1 mg vancomycin. This antibiotic-loaded bone substitute was then added to prevent infection as well as to improve bone healing at the subtalar fusion zone.

After a 3-month follow-up, the patient was able to bear weight up to 20 kg. Complete weight bearing was permitted 8 months after the final defect filling of the distal tibia, which was performed using the Masquelet technique.

At the 12-month mark following the initial trauma, the patient is able to engage in full weightbearing activities,



Figure 3. Clinical images 1 year after trauma from the (A) back, (B) medial, (C) lateral, and (D) front showing normal valgus positioning of the hindfoot (A) and a still existing foot arch despite atypical subtalar arthrodesis (panels B and D). The lower leg soft tissue defect associated with fracture-related infection of the tibia was reconstructed by latissimus dorsi muscle free flap transfer (panels B, C, and D).

including walking up to a distance of 7 km and cycling up to 20 km on a daily basis. During the clinical examination, the hindfoot exhibits a plantigrade position (Figure 3). The range of motion of the ankle joint was sufficient: extension/flexion 10-0-20 degrees. Radiographic imaging confirms that the implant is properly positioned, and there is evidence of subtalar consolidation, indicating successful healing (Figure 2).

Discussion

In a case of a polytrauma patient with severe injuries to the left lower leg and calcaneus, an atypical subtalar arthrodesis successfully achieved not only preserving the foot but also establishing a sustainable load-bearing condition reconstructing the hindfoot and foot arch. After resection of the necrotic bone fragments during surgical debridement, bone defect reconstruction was not deemed to be possible, and atypical subtalar arthrodesis of the tuber calcanei was performed after Achilles tendon lengthening. After the 12-month follow-up, the patient is able to walk several kilometers and is pain free.

To our knowledge, the reported technique was for the first time successfully applied in a patient with calcaneal bone defect after trauma. However, in surgical oncology, Kamal et al¹ presented a case of a patient with a giant cell tumor in the calcaneus that had infiltrated the adjacent tissue, including the Achilles tendon. Despite the intraoperative risks of amputation and tumor recurrence, extensive removal of the calcaneus and surrounding soft tissue was performed. To address the resulting defect, a femoral allograft was used to fill the void and secured to the talus using screws. Furthermore, the Achilles tendon was lengthened and anchored within the femoral allograft, and a sural flap was utilized to cover the soft tissue. In the one-year follow-up, the patient achieved a pain-free ability to bear

full weight, thanks to this intricate and tailored procedure.¹ Similar to our trauma patient, this oncology patient was able to restore the arch and achieve pain-free full weight-bearing despite significant loss of calcaneal material.

The significance of our findings may be limited by the analysis of a single case. Thus, generalizing of our results should be performed with caution.

In conclusion, the use of atypical subtalar arthrodesis in the management of severely comminuted calcaneus fracture can be a viable surgical approach that leads to favorable functional and aesthetic outcomes in otherwise desperate cases.

Ethical Approval

Ethical approval was not sought for the present study because this is a case report.

Declaration of Conflicting Interests


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