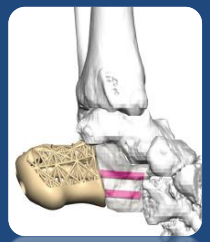

Radical Sub-total Calcanectomy for Osteomyelitis with Staged Custom Titanium Cage Implant: A Case Study

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Purpose:

The purpose of this case report was to provide a novel surgical approach as a limb salvage option for an ambulatory patient with calcaneal osteomyelitis (OM).

Limb salvage procedures following wide resection of the calcaneus are limited and infrequently described. Amputation is often indicated or an end result. Potential alternatives include pedicle bony allograft, autograft, or a custom implant. Overall, treatment options for extensive calcaneal OM are somewhat limited and many of these procedures are technically challenging. The primary end treatment goal is to eradicate the OM and provide the patient with a pain-free functional limb for ambulation.

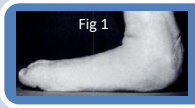


Fig 1


Fig 2

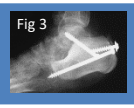


Fig 3

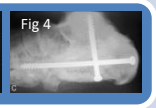


Fig 4

Literature Review:

Calcaneal OM in an ambulatory patient is surgically and functionally challenging to treat. Previous authors have described various treatment options. Smith, 1992 (Fig 1) treated patients with recurrent heel ulcerations with partial calcanectomy; 1/3 developed recurrent ulceration or went on to below-knee amputation (BKA). Baumhauer, 1998 discussed patients who underwent total calcanectomy after chronic calcaneal OM and the possible late stage complications, including subluxation or the risk for BKA (Fig 2). Muscolo, 2000 presented two cases and suggested that reconstruction with a total calcaneal allograft may be a durable reconstructive option, but may be prone to fracture or malalignment (Fig 3). Similarly, Ayerza, 2016 reports that massive structural allograft at 5 and 10 years was 83 % successful for calcaneal allograft, but also demonstrated highest complication rates including local recurrence, infection, fracture, and nonunion (Fig 4). These grafts are high risk, as Ottolenghi, 1953 observed partial resorption of the bone and trophic changes from denervation and resorption due to lack of blood supply.

More recently, Imanishi , 2015, reported using a solid 3D-printed calcaneal prosthesis after total calcanectomy as a viable alternative to amputation (Fig 5) . The patient was weightbearing at 5 months without pain. Dekker, 2018 described 15 patients with 3D-printed implant cages for other pedal issues that demonstrated successful outcomes as well (Fig 6 & 7). In this case, we took an approach utilizing the advances in technology to develop a custom titanium implant from CT imaging.

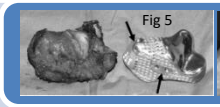


Fig 5

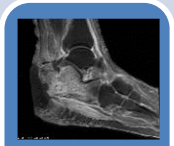

Fig 6


Fig 7

Case Report:

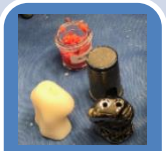
Following a spinal surgery, a 41 year old autistic male developed a chronic ulcer to his left heel, and subsequently calcaneal OM. Cultures were positive for Enterobacter and MRSA, which required multiple courses of intravenous and oral antibiotics. The wound eventually healed with local wound care and negative pressure vac therapy. Months later, the patient presented to the emergency room febrile with persistent left limb swelling and redness.

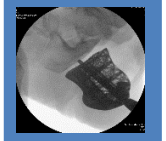
MRI demonstrated erosion of the posteromedial aspect of the left calcaneus involving 75% of the calcaneus, compatible with worsening OM. There was a pathologic fracture of the posterosuperior calcaneus due to the underlying OM and multiple abscesses in the soft tissues.



A staged surgical treatment approach was planned. The patient first underwent a radical sub-total calcanectomy, Achilles detachment, and insertion of a gentamycin/tobramycin antibiotic bone cement spacer. The resected portion measured 4.0 x 3.0 x 4.5 cm. Pathology reports confirmed active chronic OM.

Exactly seven months later, the patient returned to the operating room. A custom titanium implant cage was fabricated from CT imaging. The patient-specific implant included two screws for fixation to the remaining anterior calcaneal fragment, as well as portion to reattach the Achilles.





The patient received a nerve catheter block preoperatively, was placed in a prone position, and thigh tourniquet placed. Bone marrow aspirate (BMA) was harvested from the proximal lateral tibia. A standard Baumann gastrocnemius lengthening was performed. An 'S' shaped incision directed proximal medial to distal lateral was made over the insertion of the Achilles tendon and calcaneus. The antibiotic cement spacer was explanted. The posterior portion of the remaining calcaneus was then debrided to healthy bleeding bone and subchondral drilling was performed. On the back table, cryopreserved cancellous bone combined with demineralized cortical bone matrix was mixed with the BMA – this was then packed within the custom implant. The implant was anatomically placed and secured with two 5.0 mm partially-threaded cannulated screws. #2 FiberWire was passed through the Achilles tendon in a Kraków fashion and the tendon was then re-anchored into the posterior superior implant.

Results:

Postoperatively, the patient was non-weightbearing in a gravity plantarflexion splint. This was transitioned to a fiberglass cast at the first follow-up and he remained non-weightbearing for ten weeks total.

The clinical results for this patient has been promising. Follow-up plain films have demonstrated excellent implant alignment at six months. The patient demonstrates sufficient ankle motion and the Achilles tendon functions normally. He currently is working well with physical therapy and partial weightbearing in an Arizona brace for stability. Some plantar fat-pad atrophy has been observed, but remains a non-issue at this point.

Analysis and Discussion:

This case study demonstrates a successful alternative for surgical treatment of calcaneal OM. Advances in technology to allow custom titanium implants from CT imaging offers an innovative approach to limb salvage that could potentially be less morbid than an amputation in the right patient. Patient selection is critical. The patient's prior functional status, comorbidities, bone quality, vascular status, and soft tissue coverage should all be carefully considered in the preoperative phase. Other considerations include cost of implant, surgical competency, and patient's ability to be compliant. A limitation to this study is the length of follow-up. Additional studies with larger populations and long-term results are needed to further draw comparative conclusions to other surgical options in treating calcaneal OM.

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