



Revision of Failed Total Ankle Replacement With a Custom 3-Dimensional Printed Talar Component With a Titanium Truss Cage: A Case Presentation

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ABSTRACT

An innovative technique is presented for salvage of a failed total ankle replacement resulting from talar subsidence with the use of a custom 3-dimensional printed articulating talar component with a titanium truss cage. This introduces a better alternative to an ankle arthrodesis with which ankle joint function and range of motion may be preserved.

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Total ankle replacements (TARs) have become more prevalent in the treatment of end-stage ankle arthritis as an alternative to ankle arthrodesis (1). Of the various complications associated with TARs, severe talar subsidence is very difficult to treat (2). The primary salvage procedure has been a tibiotalar calcaneal arthrodesis with bone grafting and intramedullary nail fixation (3).

The purpose of this case study is to present a new surgical technique for salvage of a failed TAR resulting from talar subsidence using a patient-specific custom 3-dimensional (3D) printed articulating talar component with a titanium truss cage. To the best of our knowledge, there are no other studies in the literature in which a similar type of implant has been used for the treatment of a failed TAR.

Case Report

A 54-year-old male with a history of an open reduction with internal fixation for a left ankle fracture secondary to trauma presented with severe posttraumatic arthritis of the ankle and subtalar joint (STJ). The patient underwent a primary TAR with the Wright Medical INBONE™ (Wright Medical Technology Inc., Arlington, TN) and STJ arthrodesis, rather than a tibiotalar calcaneal arthrodesis, to preserve motion of the ankle joint (4,5).

Approximately 4 years after the initial TAR, the patient started experiencing persistent ankle pain related to recurrent osteophyte

formation in the medial and lateral gutters of the ankle joint, and pain in the STJ related to hardware failure and nonunion (6). The patient then underwent a revisional STJ arthrodesis that necessitated replacement of the talar component for access.

Three years following the revisional surgery, the patient had a recurrence of severe ankle pain on weightbearing and range of motion (ROM). Radiographs and computed tomography (CT) scans demonstrated osteolysis and severe subsidence of the talar component (Fig. 1). Despite years of conservative treatment, the patient's pain interfered with his activities of daily living and he required another surgical procedure. Because of the patient's desire to preserve ankle joint function, he opted again to avoid an ankle arthrodesis, electing revisional TAR with the use of a custom talar component with titanium truss cage to salvage the ankle joint.

Surgical Technique

The procedure was performed with the patient in the supine position under general anesthesia and a thigh tourniquet. A linear longitudinal incision was made over the anterior ankle joint, lateral to the tibialis anterior tendon and medial to the extensor hallucis longus tendon. Dissection was continued to the ankle joint, all synovitis was debrided, and osteophytes were resected. The ankle joint was exposed, and the polyethylene insert, talar component, and STJ screw were removed. The remaining talus revealed hypertrophic bone formation and metallic corrosion (Fig. 2). Extensive bone debridement was performed of all nonviable bone and metal fragments down to healthy, bleeding cancellous bone. The talar dome was flattened to a smooth surface and the ankle gutters were resected. Next, inductive bone graft

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Fig. 1. Preoperative anteroposterior, mortise, and lateral ankle views showing talar subsidence.

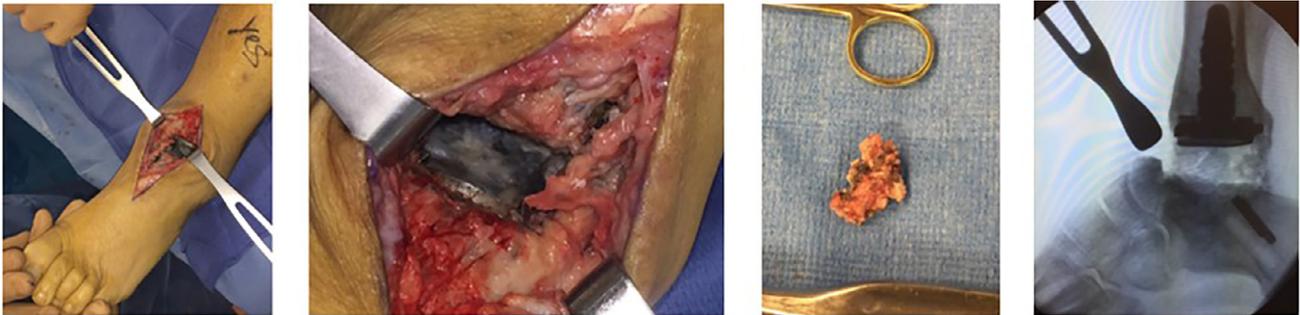


Fig. 2. Intraoperative imaging showing degree of talar collapse and extent of nonviable bone and metallic corrosion.

was injected into the screw removal site in the talus. The custom titanium truss cage with talar component (4WEB Medical, Frisco, TX) was then filled with a mixture of bone morphogenetic protein allograft, cortical cancellous bone chips, and autogenous bone marrow aspirate (Fig. 3). Next, the ankle joint was distracted and the talar component with the packed truss cage was placed within the ankle joint over the remaining talus. The talar component of the implant was placed with excellent positioning under the tibial component. A 6.5 x 80 mm cannulated screw (Vilex Inc., McMinnville, TN) was inserted through the talar component across the STJ and into the calcaneus for fixation of the talar truss. The polyethylene component was then inserted using standard technique. Layered closure was performed and the surgical site was dressed with dry sterile dressings, followed by a posterior splint to the lower extremity. Immediate postoperative radiographs

showed excellent alignment of the new talar component and positioning of the hardware (Fig. 4).

Postoperative Course and Outcome

Postoperatively, the patient was immobilized and non-weightbearing for 6 weeks before being transitioned to weightbearing as tolerated in a controlled ankle movement boot for 2 weeks. At 8 weeks postoperatively, the patient began full weightbearing in supportive shoes, and was found to have improved ankle joint ROM and absence of pain. Radiographs and CT scans performed at 48 weeks postoperatively revealed excellent alignment and placement of the implant with no subsidence or osteolysis and good bony ingrowth into the trabecular portion of the talar truss (Fig. 5). At 11 months postoperatively, patient has returned to full activity with no restrictions and remains pain free without the use of a brace.

Discussion

Talar subsidence is one of the most common complications associated with TARs; conventional treatment is an ankle arthrodesis (2,7). We pursued an alternative technique that allowed preservation of ankle joint ROM and function with the use of customized patient specific implant. A 3D printing technology combined with computer-aided design software and 3D CT reconstruction allows customization of patient-specific implant components (Fig. 6). Mulhern et al (8) used this

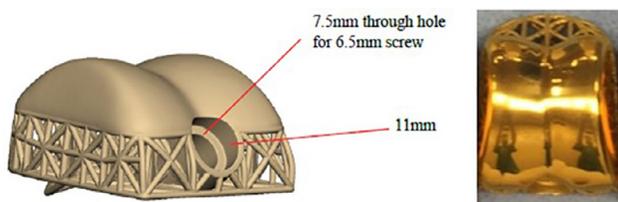


Fig. 3. Custom 3-dimensional printed talar component with titanium truss cage implant.

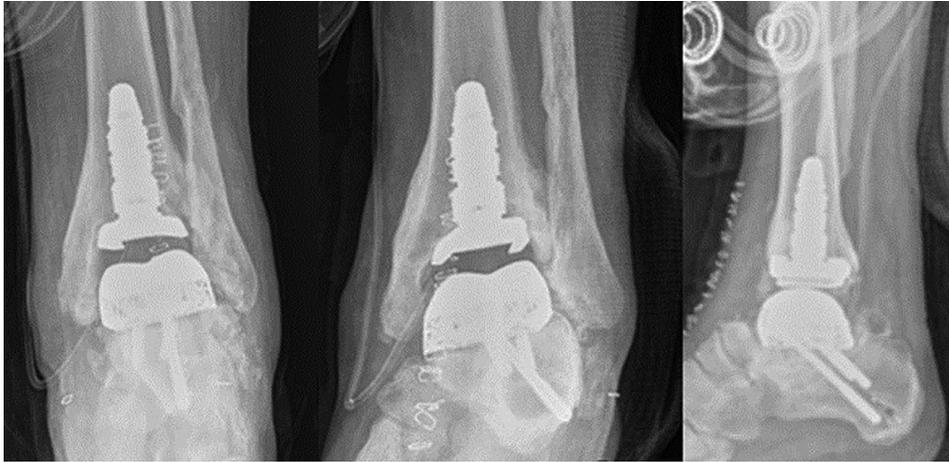


Fig. 4. Postoperative anteroposterior, mortise, and lateral ankle views.



Fig. 5. Scan 48 weeks postoperatively showing excellent alignment of the implant.

innovative technology to construct a custom titanium truss for salvage of a failed TAR by filling a bony void and converting to a tibiotalarcanal arthrodesis. Hsu et al (9) similarly used a patient-specific 3D printed titanium truss cage for a tibiotalarcanal arthrodesis for salvage of a distal tibia nonunion.

Using a custom titanium truss cage fabricated as 1 with a talar component makes revision surgery for a failed TAR a viable option. Using this type of implant accounts for extensive bone loss of the talar body, restoring the height of the talar component. This type of revision surgery also allows for preservation of ankle joint function and ROM. Another advantage is the open structure of the truss that allows placement of biologics and bone allograft, which encourage osteoblast migration and osseous consolidation (10).

Although no complications were encountered in this study, there are some potential problems that could arise. There are always risks, such as infection or hardware failure and loosening, associated with using implants. Disease transmission is another potential complication and may occur when using allografts. Also, if improper resection of the non-viable talar bone is performed, further osteolysis and subsidence may occur leading to additional complications.

In conclusion, our study had 2 primary limitations: sample size of 1 patient and a short follow-up period. Although our outcome showed favorable results, we realize more research is needed with a larger sample size and longer follow-up period to further assess this as a salvage procedure for TAR failure. This case study introduces a new surgical technique for revision of a failed TAR associated with severe talar subsidence for patients who wish to avoid ankle arthrodesis in hopes of salvaging the ankle and preserving its functional ROM.

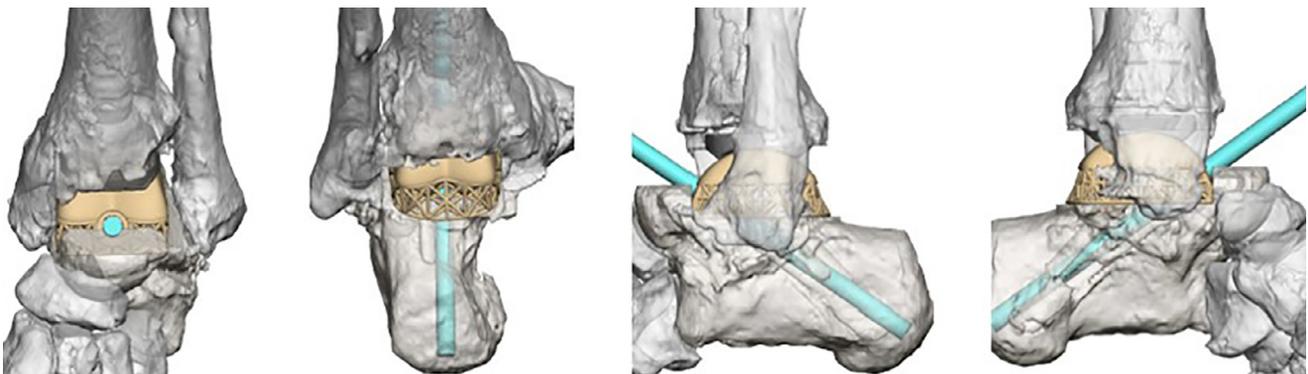


Fig. 6. Scan showing a 3-dimensional model of the patient's ankle with implant placement.

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