

Ankle Joint Distraction Arthrodesis with Titanium Truss: A Case Report

Timothy P. McConn, DPM¹; Elizabeth P. Parry, DPM¹; Alan R. Catanzariti, DPM, FACFAS¹

¹The Foot & Ankle Institute, West Penn Hospital, Allegheny Health Network, Pittsburgh, PA



Literature Review

Revisional tibiototalcalcaneal arthrodesis procedures with large bony defects at the level of the ankle joint can pose a challenge to successful reconstruction (1). These defects can result from failed total ankle arthroplasty, non-union, avascular necrosis of the talus, traumatic injuries such as pilon and talus fractures, osteomyelitis, and Charcot neuroarthropathy (2). Excessive shortening can result, with reported average limb length discrepancies ranging from 1.5 cm to 3.5 cm, which can cause gait abnormalities with subsequent stresses placed on proximal joints such as the hip, knee, etc (2). Various interpositional allograft and autograft bone block techniques have been used to prevent shortening and increase skin tension. However, fusion rates vary between 58-93%, and have the potential for late collapse of the structural graft, slow revascularization, and poor host incorporation (3). In a study by Clifford et. al, 32 patients underwent a tibiototalcalcaneal arthrodesis with bulk femoral head allograft with 16/32 (50%) with complete consolidation at the fusion site, and an average height loss of 3.6 mm over the average 41 month follow-up period. 19% went on to require a below-knee amputation (2). Titanium inter-body spinal trusses packed with bone graft are considered to be the gold standard in the spinal orthopedic community for surgical treatment of severe degenerative disc disease, restoring alignment and disc height (4). In recent foot and ankle literature, there have been few documented cases reports of custom titanium trusses used for interpositional revision ankle fusions (5).

Purpose

The presented case studies demonstrate a novel reconstructive approach for revisional ankle arthrodesis with resultant large bony defects using custom interpositional titanium trusses, allowing for near anatomic alignment with maintenance of limb length. CT scans were utilized post-operatively to assess the degree of bone consolidation, and confirm union.

Case Report #1

A 46 year-old male employed as a heavy diesel mechanic with a positive smoking history presented with a chief complaint of left foot and ankle pain. On physical examination, a fixed hindfoot valgus was noted, with tenderness along the both the posterior tibial tendon and sinus tarsi. MRI demonstrated severe degenerative arthritis of the ankle joint along with moderate arthritis of the subtalar joint. A stage IV flatfoot reconstruction with a tibiototalcalcaneal arthrodesis using an anterior plate with screw fixation was performed in December 2016. At 3.5 months post-operatively, a CT scan showed lack of consolidation consistent with non-union and screw fixation failure at both the subtalar and ankle joints. The patient returned to the operating room 3.5 months after the initial index procedure for bone biopsies of the tibia and talus, which were both negative for osteomyelitis. In April 2017, a hardware removal was performed with repair of non-union, and insertion of an antibiotic spacer. Patient returned to the operating room in May 2017, for a definitive tibiototalcalcaneal arthrodesis using a custom titanium truss and an intra-medullary nail. Post-operatively, the patient remained non-weight bearing in a short-leg cast for 16 weeks, and was transitioned partial-weight-bearing in a CAM boot at that time. A CT scan was performed 3.5 months post-operatively, which showed near complete fusion of the truss and the bone graft at the ankle joint.



Figure 1: Case Report #1; CT scan at 3.5 months status post TTC fusion.

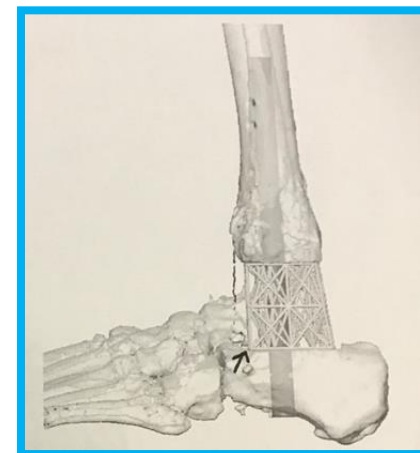


Figure 2: Case Report #1; CT generated and computer aided 3D model of proposed custom titanium truss



Figure 3: Case Report #1; Intra-operative titanium truss with packed bone graft



Figure 4: Case Report #1; CT scan at 3.5 months status post revision TTC arthrodesis with custom titanium truss and IM nail.

Case Report #2

A 44 year-old female employed as an insurance human resources employee presented status post total ankle arthroplasty 3-4 years prior with stiffness and limited motion of the left ankle. Prior to the total ankle replacement, patient had undergone multiple surgical procedures including a lateral ankle stabilization and an OATS procedure. Since the total ankle replacement, the patient experienced little symptom relief. On physical examination, her ankle was noted to be in a fixed plantarflexed position, causing her to walk on her toes. Loss of motion and pain at the subtalar joint secondary to the fixed plantarflexed position of the ankle was also noted. A CT scan demonstrated the ankle prosthesis in approximately 10° of fixed plantarflexion. In February 2017, she underwent removal of the ankle prosthesis with insertion of an antibiotic spacer. In a subsequent procedure, a tibiototalcalcaneal arthrodesis with a custom titanium truss and an intra-medullary nail was performed. Post-operatively, the patient remained non-weight bearing in a short-leg cast for 8 weeks, and then transitioned to partial weight-bearing in a CAM boot at that time. At 13 weeks post-operatively, a CT scan was performed which showed approximately 75% fusion of the truss and bone graft at the ankle joint. Since the surgery, patient returned to work with no difficulties, and is able to conduct all activities of daily living, with noted improvement in overall function.

Procedure

Custom titanium trusses were manufactured from pre-operative CT scans prior to surgery. Intra-operatively, an incision was made laterally overlying the central aspect of the fibula. A fibular takedown was performed to be utilized as autograft. Using the lateral incision, the antibiotic spacer and ankle prosthesis were removed respectively. All interposed fibrotic or non-viable soft tissue or bone were removed and flat top cuts of the tibia and talus performed. Under image intensification, the custom template was then trialed to ensure adequate anatomic alignment and height restoration. The custom titanium trusses were then packed with autograft, bone marrow aspirate, cancellous bone chips, platelet-derived growth factor product, and demineralized bone matrix product. All arthrodesis surfaces were prepped in standard fashion followed by insertion of the custom truss with temporary fixation. Intra-medullary nails were used for definitive fixation, and threaded through the titanium truss. This feature was incorporated into the custom design construct by the manufacturing company. Prior to placement, the foot was translated posteriorly, and positioned at 90° from the level of the tibia.



Figure 5: Case Report #2; CT scan with failed ankle prosthesis prior to revision

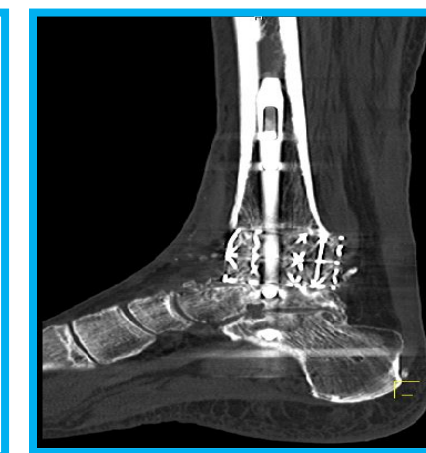


Figure 6: Case Report #2; CT scan 13 weeks status post revision TTC arthrodesis with custom titanium truss and IM nail.

Discussion

Custom titanium trusses provide a new, reliable approach for revisional tibiototalcalcaneal arthrodesis procedures and limb salvage. The use of a custom titanium interpositional truss maintains limb length and allows for healing across large bone defects. Furthermore, the customized designs from pre-operative CT scans allows for intimate contact between all osseous surfaces. In theory, this maximizes osseous consolidation, by promoting cellular infiltration.⁵ These case reports demonstrated excellent results with both patients progressing to union. Although limited to a small series, these initial results suggest that custom titanium trusses may be a viable option for revisional tibiototalcalcaneal arthrodesis procedures with resultant large bony deficits.

References

1. Thevendran J, Wang C, Murray JP, et al. Nonunion Risk Assessment in Foot and Ankle Surgery: Proposing a Predictive Risk Assessment Model. *Foot and Ankle International*. 36 (B): 901-907, 2015.
2. Jeng CL, Campbell JT, Tang EY et al. Tibiototalcalcaneal Arthrodesis with Bulk Femoral Head Allograft for Salvage of Large Defects in the Ankle. *Foot and Ankle International*. 34 (9): 1256-1266, 2013.
3. Delloye C, deNayer P, Allington N, et al. Massive bone allografts in large, skeletal defects after tumor surgery: a clinical and microradiographic evaluation. *Arch Orthop Trauma Surg*. 107 (1): 31-41, 1988
4. Serra T, Capelli C, et al. Design and Fabrication of 3D Printed Anatomically Shaped Lumbar Cage for Intervertebral Disc (IVD) Degeneration Treatment. *Biofabrication*. 8: 035001, 2016.
5. Mulhern JL, Protzman NM, White AM, Brigid SA, Salvage of Failed Total Ankle Replacement Using a Custom Titanium Truss. *The Journal of Foot and Ankle Surgery*. 55: 868-873, 2016.