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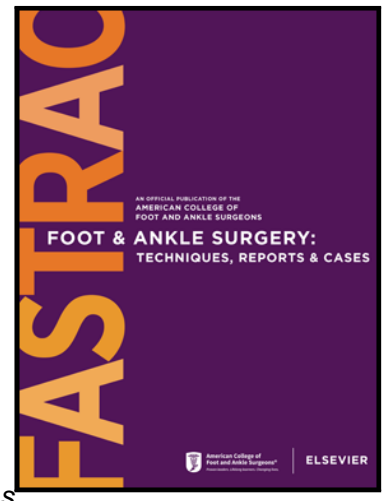

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Revision Total Talus Replacement with Constrained Implant

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Level of Clinical Evidence
4

Key words
Total talus replacement, constrained, revision
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Abstract
Avascular necrosis of the talus can oftentimes result in severe painful deformity due to the eventual collapse of the body. This condition historically has had limited options for joint sparing procedures. Total talus replacements are a relatively new implant type with limited data available in the literature concerning the most recent, third generation model. The non-constrained version of these implants contains the largest breadth of published literature and have performed well in mid-term length studies. This current case report presents a revision total talus replacement with a constrained implant. The patient of interest initially developed talus AVN four years after talus open reduction internal fixation resulting from a bicycle versus motor vehicle accident. Throughout the patient's course and numerous surgeries, progressive cavovarus deformity was a common theme that may have originated from the one week delay between the date of injury to the index procedure. Eventually the decision was made to prevent any further progression of this deformity through a constrained total talus replacement with fixation into the subtalar and talonavicular joints. This procedure occurred 3 years after the initial total talus replacement and was only performed after all conservative cares had been entirely exhausted. The surgical course of this case is followed in detail and describes a successful revision total talus replacement with a constrained implant. It is the authors' conclusion that this option is appropriate to preserve ankle range of motion and delay tibiotalocalcaneal fusion.

Keywords

Revision, total talus replacement, avascular necrosis

Introduction

Avascular necrosis (AVN) of the talus can result in loss or collapse of the articular surface and has limited treatment options (1,2). The talus is covered by about 60% articular cartilage, which limits the periosteal blood supply and contributes to a higher incidence of osteonecrosis. The most common etiology is post-traumatic arthritis, but may also be a result of failed-re-implantation, pigmented villonodular synovitis, osteosarcoma, alcoholism, prolonged steroid use, use of vasopressors, and systemic lupus erythematosus (3,4,5). Talar collapse has also been described following total ankle arthroplasty (TAA). Current treatment options have been tibiocalcaneal arthrodesis, pantalar arthrodesis, modified Blair tibiotalar arthrodesis, total ankle replacement or below knee amputation (6). These procedures require an extensive postoperative rehabilitation and are at an increased risk for infection and nonunion that may result in low success rates and comorbidities. Additionally, these procedures afford decreased shock absorption, potential limb shortening, and decreased propulsion in gait. Total talus replacement (TTR) was thus implemented as an alternative in order to maintain limb length, reduce pain, and regain function without sacrificing biomechanical stability.

Talar implants were first reported as a salvage procedure for talar AVN in 1997 (7). These stainless-steel implants included a peg that was inserted into the native talar neck. In this study, of 33 talar body prostheses there were 5 early failures within the first 4 years, and one at 13 years. Additionally, Taniguchii et al reported 22 first and second generation talar prostheses, and at one year post- operatively all the patients had signs of radiographic loosening and necrosis of the talar head (8).

Third generation implants can be categorized as constrained or unconstrained. The constrained implants provide fixation into the calcaneus, navicular, or concomitant ligamentous reconstruction. The unconstrained implants are press fit into the mortise without any additional restraints (eg. Lateral ankle ligament reconstruction). To date, unconstrained versions of the implant have a greater breadth of published literature and have performed well radiographically, functionally, and with patient satisfaction scores (8-15). The goal of this

current case presentation is to present a successful revision total talus replacement with a constrained implant type.

Case Report

A 54-year-old male was originally seen in the emergency department following a bicycle versus motorized vehicle accident. He was evaluated in the local emergency department and sent home in a short leg splint. Patient was seen about one week after the initial accident and continued to have pain and inability to weight bear on the left lower extremity. Radiographs revealed a talar neck fracture with severe dislocation of the talonavicular, subtalar and tibiotalar joints. The patient was educated on surgical treatment options and understood that given the fracture type, dislocation and injury delay there was an increased probability of long-term soft tissue deformity and talus osteonecrosis.

Surgical Technique

Stage I ORIF Talus

Patient conveyed understanding of the risks and complications and underwent open reduction internal fixation (ORIF) of the talus and lateral ankle reconstruction. To fully reduce and fixate the fracture a medial malleolus osteotomy was performed to gain access and reduction(Figure 1). Patient performed well in the postoperative setting and progressed without incident in the short term. Patient was followed on a yearly basis and started to complain of pain about two years after the index procedure. Upon physical examination, a global cavus deformity had presented and progressed. This was most likely secondary to soft tissue damage that was experienced in the initial week from injury to surgical intervention. Advanced imaging showed a slowly healing talus fracture, non-healing lateral ankle ligament complex, and complex peroneal tendon tears. The patient was counseled on reconstructive procedures and the complexity of the case which while qualify him for a fusion or arthroplasty.

Stage II Cavus Reconstruction

After exhausting conservative care, a decision to pursue surgical correction through a Dwyer calcaneal osteotomy and a first metatarsal dorsiflexory wedge osteotomy was performed (Figure 2). Again, patient performed well in the postoperative setting initially and progressed without incident. He was seen again on a yearly basis and continued to do well until 2 years

after cavus reconstruction. Four years after the initial ORIF the patient started to complain of significant ankle pain. An updated set of radiographs and computed tomography (CT) scans were obtained to fully assess the hindfoot and ankle joints as well as a magnetic resonance image to assess viability of the talus. Advanced imaging revealed severe osteoarthritis of the tibiotalar joint with joint space loss, subchondral sclerosis and cyst like changes. A discussion was then had regarding salvage options and preparing for the next stage. The patient was not ready for a fusion or arthroplasty at this time.

Stage III Arthroscopy with extensive debridement

After exhausting conservative care options, a decision was again made to pursue surgical arthroscopy with extensive debridement of scar tissue and possible OCD repair. This also allowed the operative team to get appropriate medical documentation of cartilage defects and arthritis changes. Arthroscopic findings revealed extensive delamination of the talar dome cartilage and cystic changes to the subchondral bone. Upon debridement it was revealed that there were large areas of osteonecrosis of the talar body (Figure 3). The patient was then made nonweightbearing in a fracture boot and prepared for the definitive procedure.

Stage IV Total Ankle Total Talus Replacement

These findings were discussed with the patient and family post operatively to address the significant talar collapse. Salvage procedures were discussed including talectomy with tibiotalocalcaneal fusion with the use of femoral head allograft versus Total Ankle Total Talus Replacement. The patient ultimately elected to undergo a Total Ankle Total Talus replacement with a mobile bearing ankle arthroplasty. A decision was made to utilize an unconstrained talus replacement given the supple range of motion of the talonavicular and subtalar joint and to leave an option for later fusion. A contralateral ankle CT was ordered to obtain the three-dimensional (3D) anatomic replica for the operative side, and the implant talar dome was made to custom match the polyethylene surface of the total ankle implant. A standard anterior ankle approach was utilized and the necrosed talus was meticulously excised in full with a meniscotome and osteotome. The distal tibia was prepared, and the tibial prosthesis was inserted (DJO Global, Vista, CA). A total talus trial was inserted and appropriately sized before the final custom total talus and polyethylene were implanted (Figure 4). At 2 weeks he was

allowed to weightbear as tolerated in a walking boot. Within the 6 month follow up appointment he was able to return to full weight bearing without any restrictions ini a supportive high-top ankle boot. Radiographs demonstrated a stable implant with maintained deformity correction. Patient was able to perform all activities with minimal pain or limitations during this timeframe. Patient was seen at a yearly basis, and the only clinical drawback he was experiencing was a painful first metatarsophalangeal joint with increased activity at the two year post-operative visit. This was fully resolved with custom orthotics. At year three however patient again complained of debilitating pain to the left ankle joint that had severely limited his activities.

On physical examination, it was noted that the patient had re-developed global varus deformity with a noticeable decrease in subtalar and ankle range of motion. Salvage procedures were again discussed with the patient including removal of the total talar implant, femoral allograft and tibiotalocalcaneal fusion versus revision of the total talus with a constrained total talus implant.

Stage V Revision Total Talus with Constrained Implant

The revision constrained total talus replacement was chosen, and the patient understood that there would be additional procedures performed based on intraoperative findings. The first procedure performed during this case was hardware removal of the posterior calcaneal screws previously utilized for the dwyer osteotomy. Afterward the previous anterior incision was again utilized for exposure. The adhered capsule was largely debrided and excised to reveal the Total ankle Total Talus replacement construct (Figure 5). The polyethylene spacer was removed, and it was noted that the tibial component was free of defects. The total talus implant was next to be excised, which required a difficult separation from adhesions along the medial, lateral and posterior joint. A Cobb elevator and large osteotome were utilized to pry the talar component from along the talar implant neck to free adhesions along the inferior aspect at the calcaneal interface. Once the talar implant was removed, an extensive portion of the posterior capsule was excised and debrided to improve ankle range of motion. The remaining articular cartilage along the posterior facet of the calcaneus and navicular were denuded of cartilage and prepared in standard fashion down to bleeding bone. A total talus trial was inserted and

appropriately sized before the final custom constrained total talus was implanted (Figure 6). Right before final implantation two suture anchors were placed into the distal anterior fibula to recreate the anterior-talofibular ligament (ATFL). The sutures were passed along the lateral neck of the talar implant (Figure 7). The total talus was implanted and two 7.0 mm partially threaded screws were used to fixate the calcaneus and two 4.5 mm partially threaded screws were used to fixate the navicular (Figure 8). The ankle was taken through range of motion and noted that there was still limited dorsiflexion with the knee flexed and extended. A percutaneous tendoachilles lengthening was performed which greatly increased the available dorsiflexion of the ankle. Simulated weight bearing intraoperative fluoroscopic images revealed that the forefoot was in varus deformity with the center of rotational angulation at the level of the tarsal bones. A decision was made to perform a derotational osteotomy through the level of the medial cuneiform, intermediate cuneiform lateral cuneiform and cuboid to achieve a rectus foot. This was fixated with Steinmann pins. This time simulated weight bearing intraoperative fluoroscopic images revealed a rectus foot and ankle (Figure 9). The patient healed through the post-operative course relatively uneventfully to date. The patient was made non-weightbearing for 8 weeks and then allowed to start physical therapy and restore function. He is currently able to ride a bike, walk on a treadmill and enjoys hiking. He states that he would do these surgical procedures again.

Discussion

The multiple staged surgical approach described here allowed for a viable salvage procedure following talar body necrosis and progressing deformity following an initial severe bicycle accident. The patient in this current case study continued to develop progressive cavovarus deformity secondary to the initial soft tissue damage. The evertors were more critically injured and thus could not act as an effective counter-force to the invertors. Patient understood early on in his care that the talus had a very low likelihood of surviving more than 5 years given the comminuted fracture pattern and dislocations of the tibiotalar, talocalcaneal and talonavicular joints. Utilization of the constrained total talus implant in theory locks the subtalar and talonavicular joint in order to prevent further inversion of the foot and ankle.

The results from this case series are consistent with and add to the current literature on total talar replacement. Short to medium term results show positive functional outcomes and minimal early complications. To the authors' knowledge, this case is the first mention in the literature of a revision total talus replacement. Due to the limited current available data it is difficult to form conclusive guidelines for TTR patient selection and even less so for revision surgeries. Most current models, and therefore the most published model, are unconstrained which are designed to recreate the anatomic design of the native talus and rely on the anatomic constraint of the ankle mortise and surrounding soft tissue. It has been reported in total knee arthroplasties that articulation of metal on native cartilage results in progressive degradation of the cartilage (19). Taniguchi in 2015 found in 55 unconstrained, isolated total talus patients that sclerosis was demonstrated in the distal tibia (44%), calcaneus (35%) and navicular (9%) just under the 5 year follow up mark (8). With these preliminary data in mind, the constrained version of total talar implants theoretically serve as a viable option for TTR failure in the setting of progressive deformity, and degenerative changes to the tibial plafond, navicular or calcaneal articulating surfaces. Currently the rate of creeping substitution through the porous segments of the TTR at these articulations is unknown, and so it is unknown how much reliance is placed solely on the calcaneal or navicular screws.

In conclusion, total talar implants are a viable alternative to fusion or amputation in cases of severe talar body osteonecrosis. The understanding of the third-generation TTR outcomes is still in the early stages and mostly focused on the unconstrained models. Few published results exists regarding the constrained version. Certainly, larger case studies with long term follow up are required to fully evaluate the survivability of the TTR.

Author Contributions

- Keegan Duelfer: 7301 E 2nd Street Suite 206, Scottsdale, AZ 85251. Duelfer1@gmail.com
- Literature Review, data extraction, case review and derived conclusions
- Jeffrey McAlister: 7301 E 2nd Street Suite 206, Scottsdale, AZ 85251. Jeff.mcalister@phoenixfai.com
- Surgical intervention, case review and derived conclusions

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Declaration of Patient Consent

Patient consented to involvement in study with the understanding that no identifying patient information is included.

Informed Patient Consent

Complete informed consent was obtained from the patient for the publication of this study and accompanying images.

Conflict of Interest

None to Disclose

Acknowledgements

none

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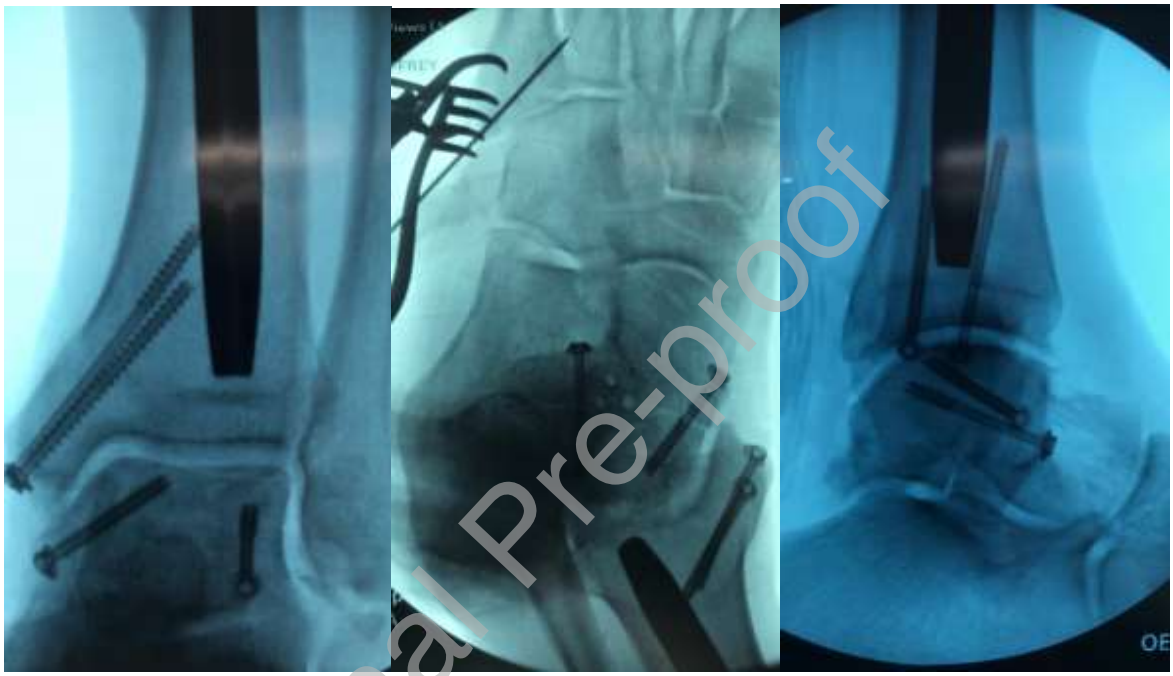

Figure 1. Initial ORIF of talus fracture with medial malleolus takedown for access.

Figure 2. Second surgical intervention to correct global cavus deformity with dwyer type osteotomy and dorsiflexory wedge osteotomy.

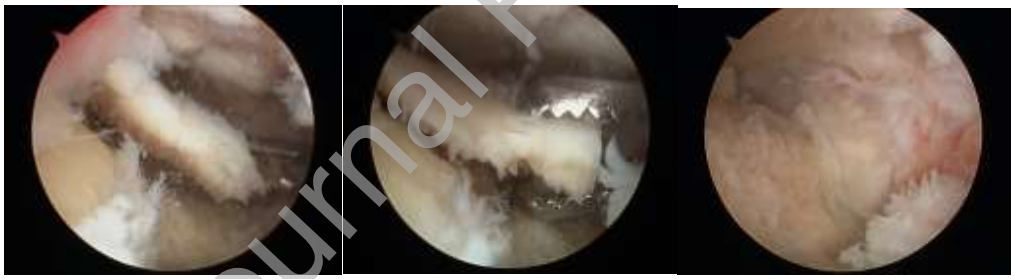

Figure 3. Arthroscopy images of the full delamination of the talar dome cartilage, which initiated discussions regarding total talus replacement.

Figure 4. Postoperative radiographs following Total Ankle Total Talus replacement with a mobile bearing component. The tibial component was chosen to be as low profile as possible given the presence of previously placed tibial nail.

Figure 5. Anterior incision with visualization of tibial component and total talus implant. In order to achieve this visualization extensive debridement of the thickened anterior capsule.

Figure 6. After trial implant sizing the appropriate talar implant was selected. The talo-navicular articulating surface is easily visualized here with its porosity to allow for creeping substitution. This porous surface can also be appreciated along the posterior facet. The navicular can be seen along the dorsal lipping of the implant and the larger holes just posterior and residing in the talar neck.

Figure 7. Recreation of the lateral collateral ligaments can also be performed with a total talus replacement. The suture anchors are placed in the standard location of the fibula. The sutures are then placed through the designated holes on the lateral process as depicted. This is easier to perform before placing the talus implant in its final location.

Figure 8. Final placement of the fixated talus into the navicular and calcaneus with a new polyethylene spacer placed. The tibial component was inspected and deemed to be in good condition.

Figure 9. Final intraoperative lateral radiograph of the constrained total talus implant and de-rotational tarsal osteotomy .

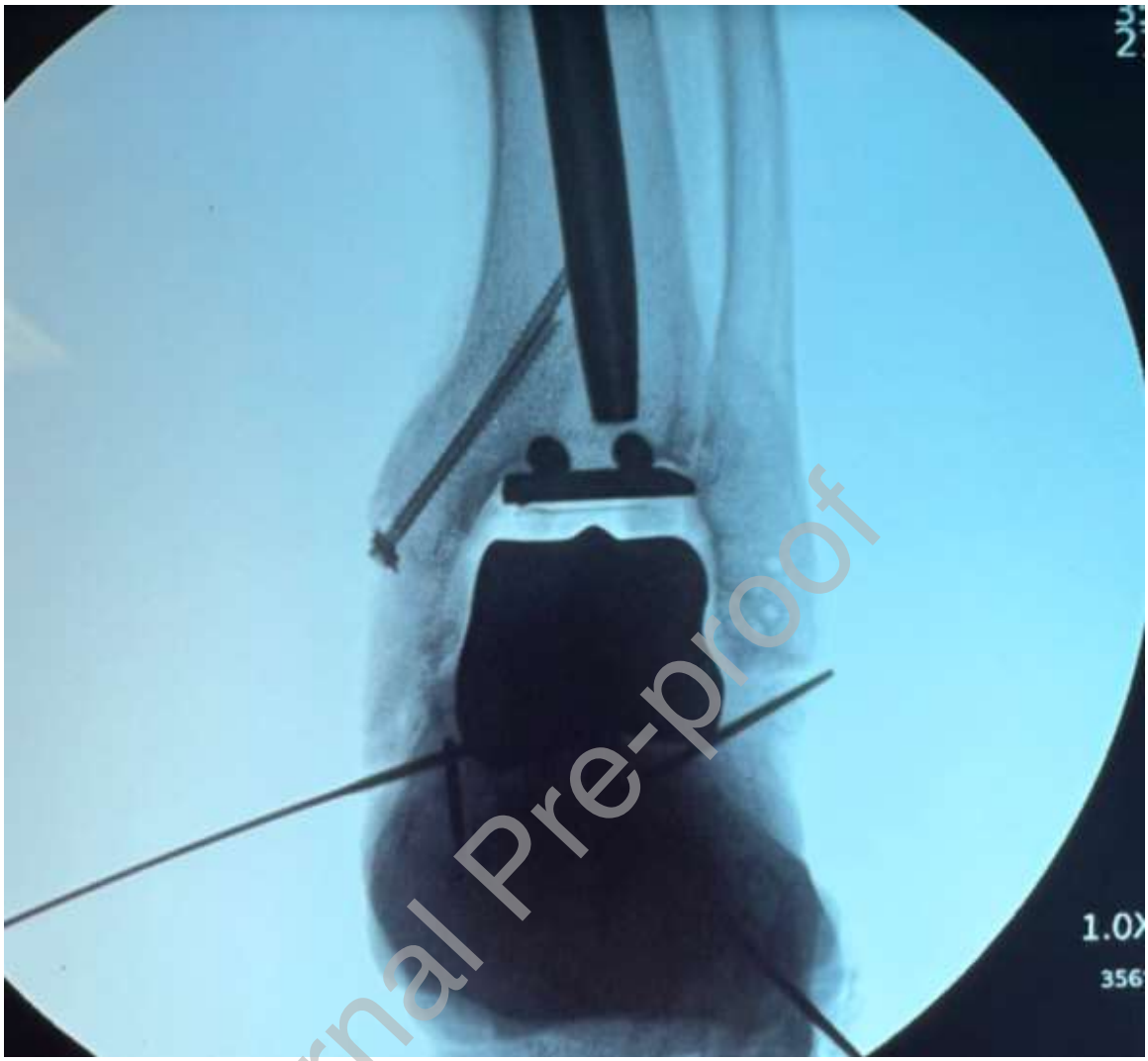

Figure 10. Final intraoperative AP radiograph of the constrained total talus implant and de-rotational tarsal osteotomy.