

3D Printed Cobalt Chromium Total Talus Prosthesis for Talar Avascular Necrosis, a 16 month Follow-Up

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Statement of Purpose

Talar avascular necrosis is a devastating disease. Avascular necrosis (AVN) has been defined as cellular death secondary to interrupted blood supply. The talus bone is covered by approximately 60% cartilage, which leaves little room for blood supply¹. Several etiologies of AVN have been described. Trauma accounts for 75% of AVN with the remaining 25% attributed to a plethora of conditions². Treatments for talar AVN can be grouped into four categories: non-surgical, surgical-joint sparing, surgical-joint salvage, and surgical-joint destructive. Treatment choice depends on the patient, disorder severity, cartilage condition, adjacent joints, and any pre-existing deformities. In contrast to joint destructive procedures, total talar prosthesis offers maintained joint motion and limb length. The purpose of this case report is to present our institution's experience with total talar prosthesis. We assessed AOFAS outcome scores, range of motion, and radiographic evidence of post-operative periarticular sclerosis, with greater than one year follow-up.

Literature Review

Total talar prosthesis is a relatively novel treatment modality for talar avascular necrosis. A literature review was performed encompassing the last 10 years. The majority of the literature is restricted to case series with small sample sizes and relatively short follow-up. Seven articles were identified and are outlined in Table 1. The procedure and implant material have evolved over time with alumina ceramic, stainless steel, and cobalt chrome all being used.

Table 1: Summary of Literature Review

Author	Journal, Year	Patients	Implant Used	Follow-Up	Outcome Measures
Tonogai et al.	Case Reports in Ortho, 2017	2	Alumina Ceramic Total	12 months	JSSF 22&29 -> 90&95/100
Ruatti et al.	JFAS, 2017	1	Cobalt Chromium Total	12 months	AOFAS 11 -> 77/100 SF-36 17 -> 82
Ando et al.	JFAS, 2016	1	Aluminum Ceramic Total	24 months	AOFAS 45 -> 90/100
Taniguchi et al.	JBJS, 2015	55 ankles 51 patients	Alumina Ceramic Total	52.8 months	JSSF 43.1 -> 89.4 AOS 6.1 -> 2.0
Harnroongroj and Harnroongroj	JBJS, 2014	33 (28)	Stainless steel Partial	120 - 432 months	AOFAS 74.3
Angthong	Ortho Reviews, 2014	1	Stainless steel Total	7.6 months	VAS-FA 6.0 -> 57.5 SF-36 19.3 -> 73.7
Taniguchi et al.	JBJS-British, 2012	22	Ceramic Partial	98 months	1 st gen AOFAS 46.6 -> 80.0 2 nd gen AOFAS 50.4 -> 81.1

Case Study

Patient is a 69 year old male who initially presented for ankle swelling following a motor vehicle accident. Radiographs revealed a comminuted non-displaced talus fracture that was treated conservatively with an extended period of non-weightbearing. He had progressively worsening ankle pain over the following two years. SPECT CT was performed which revealed increased uptake in the talus consistent with global talar AVN (Figure 1). Conservative and surgical options were discussed with the patient including continued conservative care versus surgical intervention. The patient declined joint destructive treatments such as tibiototalcalcaneal arthrodesis and elected for a total talus prosthesis.

Procedure

Prior to surgery, a custom made 3D printed, cobalt chromium talar prosthesis was constructed using the contralateral CT scan as a template (Figure 2). An anterior incisional approach was used through the interval of the tibialis anterior and extensor hallucis longus tendon. A reciprocating saw was used to excise the entire native talus. Talar trial components were inserted and the "true" sized implant was found to have adequate ankle range of motion without significant translational or axial instability. Following this, the talar prosthesis was implanted. At this point, a restriction in ankle dorsiflexion was noted and thus a gastrocnemius recession was performed with noted increase in dorsiflexion. The ankle and subtalar joints were noted to be in anatomic alignment and stable after the procedure. Intra-operative photographs are noted in Figures 3-6. The patients postoperative course was uncomplicated and he remained non-weightbearing for 2 weeks.

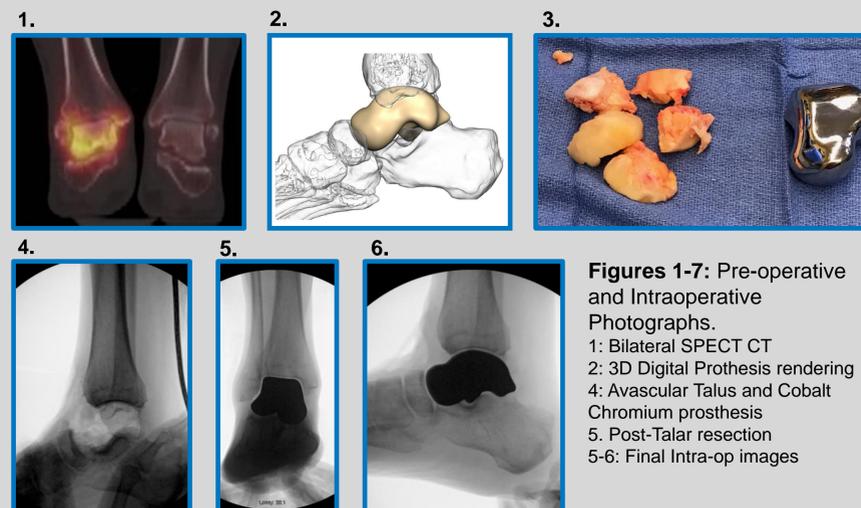


Figure 7: Preoperative to Postoperative Progression



Figure 8: Final POD #493 Radiographs



Results

Progressive images from pre-operative to final post-operative day (POD) follow-up is illustrated in Figure 7. At final follow-up of 16 months, the patient's AOFAS Ankle-Hindfoot score improved from 34 to 80. AOFAS Ankle-Hindfoot subscores of pain, function, and alignment along with ankle dorsiflexion plantar flexion were all increased at final follow up as noted in Table 2. Mild peri-articular sclerosis was noted to the distal tibia and calcaneus radiographically at final follow up as noted in Figure 8. The patient was highly satisfied with the outcome of the procedure. He was able to return to activities of daily living without complication.

Table 2. Preoperative and Postoperative Outcomes

	Pre-Operative	16 months Post-Operative
AOFAS Ankle-Hindfoot Score	34	75
-Pain	0	20
-Function	24	45
-Alignment	10	10
Ankle Dorsiflexion (Degrees)	8	12
Ankle Plantarflexion (Degrees)	20	40
Peri-Articular Sclerosis	Absent	Present

Analysis & Discussion

Previously, treatment options for talar AVN were limited. Major developments have been made with the advent of 3D printing. This allows for complete resection of the necrotic bone without relying on re-vascularization. In addition to this, a total talar prosthesis maintains joint function and limb length in contrast to previously described joint destructive procedures. The purpose of this case report is to evaluate our institution's experience with total talar prosthesis and examine the primary outcomes of AOFAS Ankle-Hindfoot score, range of motion, and radiographic evidence of post-operative periarticular sclerosis. Our short-term results are encouraging with increases in all outcome measures at 16 month follow up. Despite the evidence of periarticular sclerosis, the patient has no clinical complaints.

The current literature on total talar prosthesis is limited to small case studies with short follow-up. Previous studies by Ruatti and Harnroongroj^{4,7} evaluated post-operative AOFAS scores of total talar prosthesis which were found to be 77 and 76, respectively. This correlates well with our results of an AOFAS score of 75 at final follow-up. Taniguchi et al.¹ is the only study that evaluated peri-articular sclerosis. Out of the 55 patients, they found 44% incidence of distal tibial sclerosis and no sinking or osteolytic changes in adjacent bones. Peri-prosthetic sclerosis was noted in our patient at final follow-up. This sclerosis was not associated with complications or patient dissatisfaction. Further follow-up will be needed to evaluate its progression.

Talar avascular necrosis is a disease that causes significant morbidity and presents challenges for definitive surgical treatment. While the literature is limited and follow up is often short, this case study presents a successful surgical treatment option in total talar prosthesis with encouraging outcome results at sixteen months.

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Financial Disclosures

Jacob R. Hagenbucher – None
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