

# The Use of a 3D Custom Implant For Treatment of Avascular Necrosis of the Navicular

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## Statement of Purpose

The purpose of this case study is to describe a case of avascular necrosis of the navicular with subsequent arthritis of the talonavicular joint treated with a 3D custom implant along with a talonavicular arthrodesis

## Introduction and Literature Review

Avascular necrosis in the foot is a severely debilitating pathology that can lead to progressive deformities in the foot and ankle causing an overall decrease in quality of life. Pathology of the navicular can arise from etiologies such as trauma, infection or rare neoplasm amongst others. (1) In cases such as trauma, there is not a current standardization of care to protect the navicular from developing avascular necrosis, despite the well-studied and documented limited blood supply of the Navicular that can be disrupted after a trauma. (2) Current methods include non-weight bearing with cast immobilization, serial radiographs, orthotics or ORIF to prevent osteoarthritis from developing. This treatment options rely on the early detection of acute pathologies to assist in the prevention of future arthritis or avascular necrosis. (3) Given the principal problem, whether the acute fracture, infection or neoplasm tends to drive decision-making, the treatment of Avascular necrosis of the Navicular is not well-represented in modern research. Through a comprehensive literature review, similar case representations have been only shown twice in recent years. Perler and Constantino had the first known case study incorporating a 3D implanted for Avascular Necrosis of the cuboid and navicular, potentially paving the way for modern treatment options and new avenues of research to study to the long-term sequela of these pathologies. This case study described a patient would suffer cuboid and navicular fractures that was acutely treated with closed reduction and pinning that went on to develop osteonecrosis. Resection of the necrotic bones was performed followed by replacement with patient specific implants with full healing. (4) Custom 3D implanted navicular for navicular osteonecrosis was also shown from Adams et al, whose surgical procedure involved resurfacing of the navicular articular surface which spared the talonavicular joint. (5) However, after a traumatic event, patients are at increased risk of developing osteoarthritis in addition to osteonecrosis. The purpose of this case study is to describe a case of avascular necrosis of the navicular with subsequent arthritis of the talonavicular joint treated with a 3D custom implant along with a talonavicular arthrodesis

## Case Study

A 62 y.o. female with a past medical history of asthma, hypertension, T2DM, hypothyroidism, insomnia and lower back pain presented to the Podiatry clinic with complaint of right foot pain. The patient suffered an inversion type injury to the right ankle and was seen by sports medicine two years prior, where they were attempting to treat her with conservative therapy. She was unable to relate a specific inciting event of the original injury. At this initial encounter, she relates her pain is aching and throbbing and notes that it bothers her all the time. It does interrupt her daily activities. She has had previous treatment with bracing, immobilization, NSAIDs without good relief, as she continues to have pain every day. She does relate a history of type 2 diabetes mellitus however it is well-controlled. She denies a history of neuropathy. She does currently smoke. As a review of the timeline the patient had previously been seen for, previous imaging of a right ankle XR revealed a questionable fracture of the navicular. With a questionable fracture found on X-Ray, an MRI of the right foot was ordered after the initial injury two years ago and found to have severe talonavicular degenerative changes with fragmentation and collapse of the medial aspect of the navicular, moderate naviculocuneiform, mild calcaneocuboid and mild tarsometatarsal degenerative changes, mild subtalar degenerative changes and mild peroneal tenosynovitis. At this time, she was placed in a CAM boot with repeat ankle X-Rays to follow in two weeks. Two weeks later, the patient obtained repeat right ankle X-Rays, showing stable degenerative changes to the talonavicular joint and navicular deformity. At this time the patient was encouraged to weight-bear as tolerated in CAM boot and return to clinic in 2-3 weeks. Conservative treatment was then encouraged until she presented to the Podiatry clinic for continued pain to the right foot, two years after the original injury. On physical exam, the patient was found to have 5/5 muscle strength for all groups of the foot and ankle bilaterally: dorsiflexion, inversion, eversion and plantarflexion. Ankle joint, subtalar joint, midtarsal joint, and metatarsophalangeal joint ROM are full and pain free bilaterally with the exception of right midfoot particularly about the talonavicular joint. For a vascular exam, patient was found to have 2/4 pulses bilaterally for the dorsalis pedis and posterior tibial arteries

## Case Study Continued

Dermatologically, No abrasions, lacerations, or ecchymosis noted. No open lesions. Web spaces are dry, clean and intact without maceration were noted. Neurologically, Protective sensation is normal when tested with 5.07 Semmes Weinstein monofilament bilaterally with Epicritic sensation intact. Repeat right foot X-Rays were obtained in clinic showing similar destruction of the talus with essentially unchanged pseudoarticulation and possible slight increased sclerosis at the right navicular. Two weeks later, a right foot MRI was obtained, showing fragmentation of the navicular with severe degenerative changes of the Talonavicular joint with associated marrow edema and subcortical cystic change. After these findings, it was recommended that the patient obtained a CT scan of her right foot. After obtaining the CT scan, it was confirmed that there was severe degenerative changes of the Talonavicular joint with loss of volume to the Navicular, likely due to prior trauma. At this time, it was discussed with the patient that she likely had Avascular Necrosis of the right navicular. Conservative and surgical intervention was discussed with the patient, and a decision to move forward with a custom implant was made. Of note, when discussing nitinol and properties of the implant, the patient did not have any allergies to any potential implanted material. Given the patient's history of Diabetes and smoking history, a Nicotine panel and Ankle Brachial Index was ordered to assess nicotine levels and perfusion to the right lower extremity. At a follow-up visit with normal Ankle Brachial Index and nicotine panel results, the patient was consented and signed up for elective surgery for a custom navicular implant with talonavicular fusion and calcaneal bone graft harvest. 4 months after presenting in the Podiatry clinic, the patient underwent surgical intervention for a custom 3D Navicular implant with a talonavicular arthrodesis.



## Discussion

Avascular Necrosis in the foot is a challenging pathology, with no current standardization of care. These pathologies typically develop from a traumatic event, infection or neoplasm, with the focus of the original pathology to heal the fracture, suppress the infection or prevent the spread of a neoplasm. As a sequela of these pathologies, avascular necrosis can develop, which poises the question of how to manage and recommend treatment options for a patient. As the world of implants continues to develop and evolve in foot and ankle surgery, the case study builds off previous, although limited, research as an alternative treatment guide. Given severe flattening, impacted volume and bone loss, modern technology serves as a guide for potential patients. The implant used in this case study offered many advantageous properties. First, by having CT scans sent to the device company, true amount of bone loss and osteonecrosis can be visualized allowing for custom planning of the surgery. This allowed for improving planning and lead to a potential decrease in tourniquet and operative time, thus preventing potential complications for the patient. Additionally, the porous edges of the graft allowed for application of bone graft which may assist in fusion, integration and prevent against future degeneration. This porous structure also allowed for ease of the beam placement that was used in the talonavicular fusion, increasing fusion, integration and prevention of future degeneration as previously listed. Finally, the modern approach of using a custom implant allowed for complete removal of the navicular, decreasing the opportunity of further osteonecrosis of the bone. This study has its limitations, as it was one singular patient, who had no known allergies to nitinol. The small sample size does not allow for a standardization of care for all who develop osteonecrosis. However, this study achieved its purpose in demonstrating that 3D custom implants with associated talonavicular fusion is a viable treatment option for patients with avascular necrosis of the navicular.

## References

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