DOI: https://doi.org/10.30795/jfootankle.2025.v19.1846

Case Report

Total ankle replacement with antibiotic-impregnated cement: a case report on the infected ankle management

Reyanne N. Strong[1], Abigail E. Smith[1], Nathaniel T. Koutlas[1], James O. Sanders[1], Trapper Lalli[1]

1. University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA.

Abstract

Ankle fracture infection is a devastating complication that can lead to chronic pain, limited motion, post-infectious end-stage ankle arthritis, osteomyelitis, and amputation. Treatment historically involves aggressive debridement, hardware removal, and long-term antibiotic therapy. We describe a case of post-infectious end-stage ankle arthritis treated with a custom, fixed-bearing, 3D printed total ankle replacement with antibiotic-impregnated cement. The provided treatment allows continued elution of high-dose local antibiotics while preserving the ankle range of motion and allowing immediate weight bearing postoperatively.

Level of evidence V; Therapeutic studies; Expert opinion.

Keywords: Arthroplasty, replacement, ankle; Arthritis, reactive; Antibiotic prophylaxis; Bone cements.

Introduction

Infection following an ankle fracture is a dreaded complication that can lead to post-infectious arthritis, pain, limited range of motion, and even amputation. Treatment goal is the eradication of the underlying infection while preserving ankle function. Traditional treatment strategies after infection have involved aggressive surgical debridement, implant removal, and prolonged antibiotic therapy[1]. In the setting of end-stage ankle arthritis with underlying osteomyelitis, standard treatment is a two-stage procedure with implant removal, debridement, and placement of a temporary static cement spacer prior to definitive management. More recently, there has been a trend towards using static antibiotic cement spacers as definitive treatment[2]. Articulating antibiotic spacers for treating ankle infections has also been recently described in the literature with improved outcomes and possibility for use as a definitive treatment[3].

Over the past decade, there has been an increased use of 3D printing to create custom lower extremity implants, particularly in the setting of severe bone loss. As total ankle replacement (TAR) continues to increase in popularity for the treatment of end-stage ankle arthritis, there has also been an increase in patient-specific instrumentation for TAR procedures[4,5]. Novel techniques using 3D printing to design custom talar articulating cement spacers have been described, with promising short-term outcomes[6]. Currently, however, there are no prefabricated TAR spacers on the market. We present a case of post-infectious ankle arthritis in a 14-year-old patient treated with a custom 3D printed component for TAR with antibiotic-impregnated cement (TAR-AIC). Our technique allowed for immediate weight bearing and preserved range of motion, providing continued elution of antibiotics. To our knowledge, this technique has not been previously described in the literature.

Case description

The patient and his family provided consent for the reporting of this case. Patient was a 13-year-old male with no medical history who sustained a type III, open, right bimalleolar ankle fracture after an all-terrain vehicle accident. He was initially treated at an outside hospital with irrigation and debridement and closed reduction. Three doses of intravenous antibiotics were administered during initial hospitalization; however, timing of antibiotics administration is not documented

Study performed at the University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA.

Correspondence: Abigail E. Smith. 130 Mason Farm Road, CB# 7055, UNC School of Medicine, Chapel Hill, NC 27599-7055, USA. **Email:** Abigail.smith2@unchealth.unc.edu. **Conflicts of interest:** None. **Source of funding:** None. **Date received:** October 21, 2024. **Date accepted:** January 21, 2025.

How to cite this article: Strong R, Smith A, Koutlas N, Sanders J, Lalli T. Total ankle replacement with antibiotic-impregnated cement: a case report on the infected ankle management. J Foot Ankle. 2025;19(1):e1846.

in external records nor was tetanus administered. Patient underwent operative fixation nine days after initial injury. His postoperative course was complicated by superficial wound infection. At 25 days postoperatively, patient underwent irrigation and debridement and removal of medial hardware, with intraoperative culture growing *Klebsiella oxytoca*, *Raoultella ornithinolytica*, and *Pseudomonas aeruginosa*. Five weeks after initial injury, patient presented to our medical center with fever, nausea, and vomiting. He had elevated inflammatory markers, purulent drainage from his medial ankle incision, and an MRI concerning for osteomyelitis at that time (Figures 1 and 2). At our institution, patient initially underwent irrigation and debridement of his medial ankle wound. The lateral wound was overall healing well, with superficial wound dehiscence without deep tracking or purulence. Given the acuity of injury and well-appearing lateral incision, it was decided to leave the fibular plate in place with plans for later removal after the fibular fracture bony union. Intraoperative cultures grew *Pseudomonas aeruginosa*. Patient was treated with four weeks of intravenous antibiotics before switching to oral antibiotics in the setting of a developing leukopenia. He then underwent a planned repeat debridement and removal of his fibular plate one month after initial debridement.

In the year following his injury, patient had post-infectious end-stage arthritis, continued ankle pain, and limited mobility, requiring the use of a cane (Figure 3). Inflammatory blood markers had normalized. An MRI and a tagged white blood cell scan were obtained to evaluate a possible residual osteomyelitis and were reassuring. At this point, patient was 14-years-old and his physes were closed on radiographs, with CT imaging demonstrating a remodeling of the fibula and partial union of the medial malleolus. Patient and his family declined to have ankle fusion or amputation after discussion, requesting another discussion on a joint sparing procedure. After extensive conversation with patient and family, decision was made to proceed with a custom TAR-AIC. Patient and family understood that the TAR-AIC surgery results would be unpredictable, but they wished to avoid an ankle fusion and chose to proceed.

A CT scan was performed in accordance with computer-aided design (CAD) parameters. Bilateral lower extremities were scanned to allow the unaffected side to be mirrored and serve as the basis for implant design. Slice spacing was less than 1.25 mm, with a pixel size of 0.5 mm. Analyses were

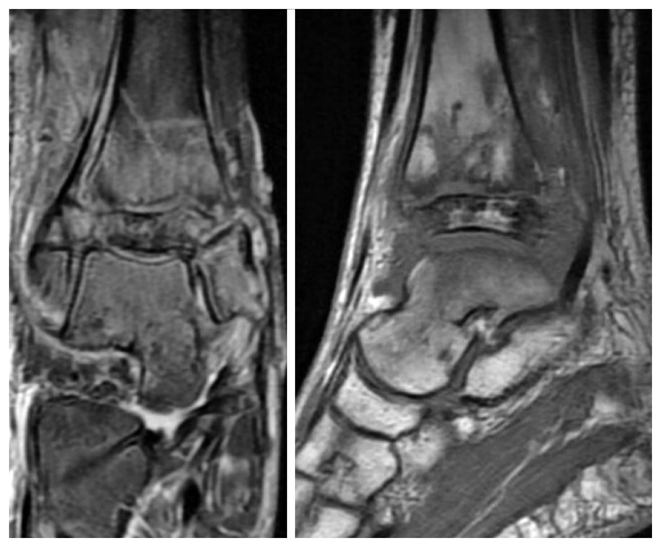

Figure 2. Right ankle MRI concerning for osteomyelitis upon initial presentation to our medical center.

Figure 1. Clinical photography of patient's right ankle upon initial presentation to our medical center, with purulent drainage from the medial ankle incision and superficial lateral incision dehiscence.

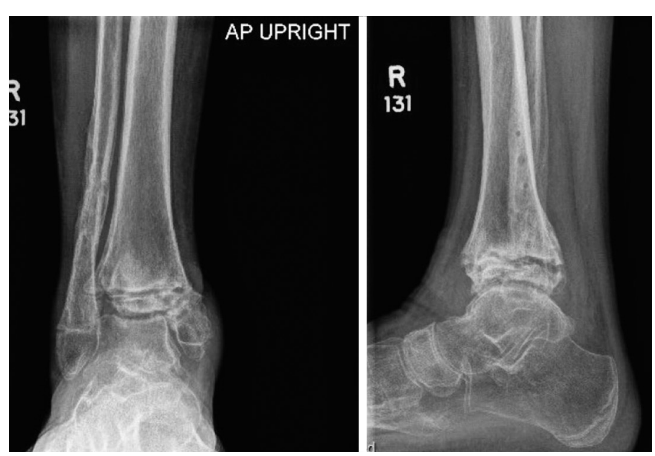

Figure 3. Preoperative anteroposterior and lateral right ankle radiographs demonstrating severe end-stage post-infectious arthritis.

performed in digital imaging and communications in medicine (DICOM) files within a timeframe where no significant change in patient anatomy had occurred. Implants were fabricated by Restor3d Inc. (Durham, NC) by selective laser melting (SLM) of cobalt chrome alloy (CoCrMo). Our design incorporated a stacked gyroid component to facilitate antibiotic cement impregnation. In terms of surgical technique, the custom TAR-AIC followed an approach similar to a patient-specific TAR procedure. We utilized an anterior approach to the ankle. We prepared the antibiotic cement by mixing 2 g of tobramycin with Simplex bone cement (Stryker, Limerick, Ireland) until it reached the appropriate consistency. Prior to implantation, the gyroid infill of the tibial and talar components were packed with the antibiotic-impregnated bone cement (Figure 4). An appropriately sized standard polyethene component was placed, and the ankle was found to be stable. The final implant fluoroscopic imaging can be viewed in Figure 5. A multilayer closure with monofilament suture was done. A negative pressure wound vac was applied. A compression wrap was applied as previously described by Schipper et al.[7] Postoperatively, weight bearing was immediately allowed as tolerated in a controlled ankle movement (CAM) boot. Patient underwent no further surgical procedures to date.

At six months postoperatively, patient reported no limitation in activities, being able to ambulate without an assistive device and engage in running activities. Patient's

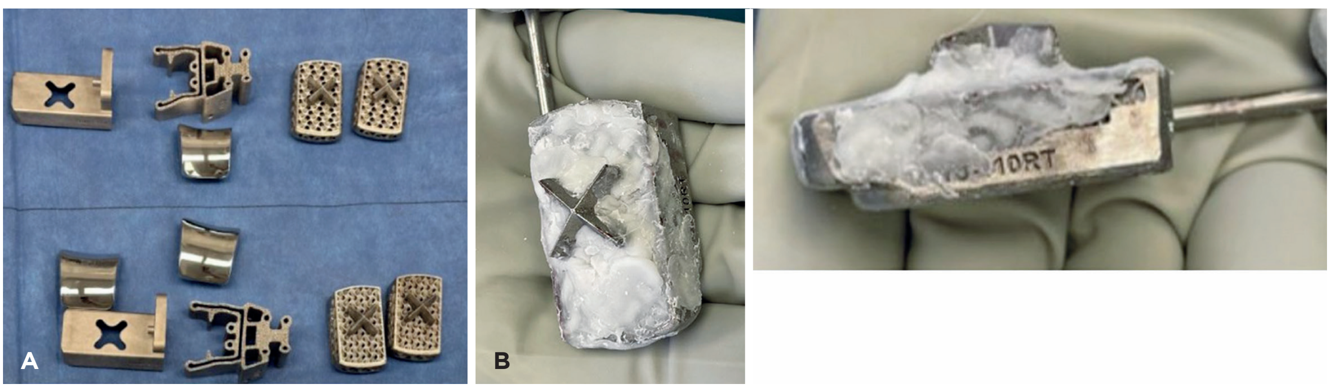

Figure 4. Total ankle arthroplasty components with gyroid tibial and talar components before (A) and after (B) impregnation with bone cement.

Figure 5. Intraoperative fluoroscopic radiographs of right total ankle replacement with antibiotic-impregnated cement (TAR-AIC).

American Orthopaedic Foot & Ankle Society (AOFAS) scores had improved from 46/100 preoperatively to 83/100 at six months, and his ankle dorsiflexion range of motion was 15 degrees, while plantarflexion range of motion was 30 degrees. Radiographic parameters showed no signs of implant failure, loosening, or change in alignment (Figure 6). The radiolucency visualized around the tibial component represent the cement mantle and remained stable compared to intraoperative fluoroscopy. Intraoperative cultures remained negative. At 17 months postoperatively, which was the last follow-up to date, patient continued to do well clinically, with no signs of infection recurrence. Radiographs at that time demonstrated minor tibial component subsidence and stable cement mantle at the perimeter of the tibial component. There was a stable, anatomic alignment of his custom total ankle (Figure 7).

Figure 6. Postoperative anteroposterior and lateral radiographs at six months, with stable positioning of implants, stable alignment, and stable cement mantle.

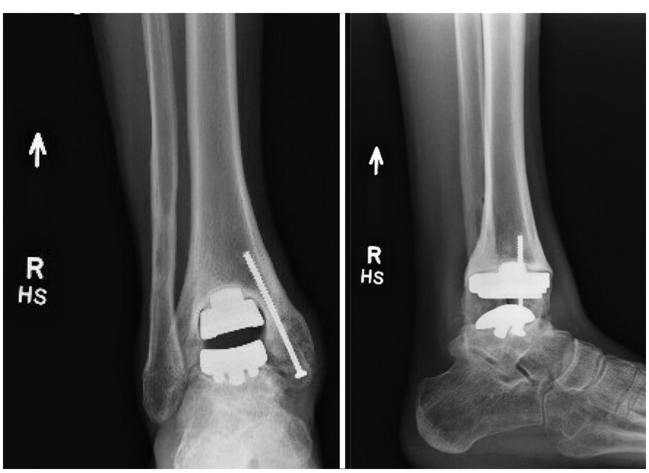

Figure 7. Postoperative anteroposterior and lateral radiographs at 17 months, with stable total ankle component alignment and minor tibial component subsidence.

Discussion

We present a case demonstrating the utilization of 3D generated prostheses for treatment of post-infection ankle arthritis. The TAR-AIC represents a potentially substantial advancement in the management of ankle infections.

With total ankle arthroplasty on the rise in the treatment of end-stage ankle arthritis, periprosthetic infections of TAR are also increasing, with infection rates cited at 2.4%–3.2%[8]. Infected TAR is a devastating complication, with current standard treatment for chronic infection being a two-stage revision with explantation of hardware, debridement, and placement of an antibiotic spacer followed by six to eight weeks of IV antibiotics prior to reimplantation of total arthroplasty components versus ankle or tibiotalocalcaneal fusion[9,10]. A single-stage procedure avoids a prolonged non-weight bearing status, additional procedures, and associated risks and expenses, potentially improving the quality of life. Tibiotalocalcaneal fusion with antibiotic-coated nails has been described as a single-stage procedure for infected ankle fractures and infected TAR with good functional outcomes[10]. However, with further research and continued technological advancements, TAR-AIC has the potential to become the gold standard for the treatment of infected TAR. This innovative approach combines the benefits of joint replacement and continued antibiotic elution. Our technique may allow for a single-stage procedure with local antibiotic delivery, early mobilization, and preserved ankle range of motion. Despite the promising results, challenges remain in the implementation of TAR-AIC. The cost of custom implants should be considered. Furthermore, long-term follow-up studies are needed to evaluate the durability and longevity of the implant.

Authors' contributions: Each author contributed individually and significantly to the development of this article: AES *(https://orcid.org/0009-0009-2186-4338) Participated in the writing and review process, bibliographic review, approved the final version; RNS *(https://orcid.org/0009-0008-9705-2881) Wrote final version, participated in review process, formatting of article; NTK *(https://orcid.org/0009-0007-3736-6021) Performed the surgeries, interpreted the results of the study interpreted the results of the study, participated in the review process and approved the final version; JOS *(https://orcid.org/0000-0001-7897-4161) Conceived and planned the activities that led to the study, conceived and planned the activities that led to the study, approved the final version; TL *(https://orcid.org/0000-0001-8357-0428) Conceived and planned the activities that led to the study, conceived and planned the activities that led to the study, performed the surgeries, approved the final version. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID) iD.

References

1. Zalavras CG, Christensen T, Rigopoulos N, Holtom P, Patzakis MJ. Infection following operative treatment of ankle fractures. Clin Orthop Relat Res. 2009;467(7):1715-20.
2. Elmarsafi T, Oliver NG, Steinberg JS, Evans KK, Attinger CE, Kim PJ. Long-Term Outcomes of Permanent Cement Spacers in the Infected Foot. J Foot Ankle Surg. 2017;56(2):287-90.
3. Short A, Penrose C, Adams S. A Novel Technique for Creating an Articulating Cement Spacer for Ankle Prosthetic Joint Infections. J Foot Ankle Surg. 2020;59(1):216-9.
4. Mazzotti A, Arceri A, Zielli S, Bonelli S, Viglione V, Cesare Faldini. Patient-specific instrumentation in total ankle arthroplasty. World J Orthop. 2022;13(3):230-7.
5. Faldini C, Mazzotti A, Langone L, Arceri A, Bonelli S, Zielli SO, et al. Custom-made total ankle arthroplasty with patient-specific instrumentation for severe bone loss conditions: a case series. Eur J Orthop Surg Traumatol. 2023;34(1):379-87.
6. Broughton KK, Chien B, Stenquist D, Williams C, Miller CP, Kwon JY. 3-D generated anatomic custom talar cement spacers: case reports, technical tips and literature review. 3D Print Med. 2021;7(1):30.
7. Schipper ON, Hsu AR, Haddad SL. Reduction in Wound Complications After Total Ankle Arthroplasty Using a Compression Wrap Protocol. Foot Ankle Int. 2015;36(12): 1448-54.
8. Patton D, Kiewiet N, Brage M. Infected Total Ankle Arthroplasty. Foot Ankle Int. 2015;36(6):626-34.
9. Atesok K, Scott DJ, Hurwitz S, Gross CE. Diagnosis and Management of Periprosthetic Joint Infections After Total Ankle Arthroplasty. J Am Acad Orthop Surg. 2024;32(16):728-37.
10. Miller J, Hoang V, Yoon RS, Liporace FA. Staged Treatment of Infected Tibiotalar Fusion Using a Combination Antibiotic Spacer and Antibiotic-Coated Intramedullary Nail. J Foot Ankle Surg. 2017;56(5):1099-103.