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Case report

Utilization of a Revision Acetabular Shell as a Tibial Cone in a Revision Total Knee Arthroplasty Setting

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ABSTRACT

One of the biggest challenges of a revision total knee arthroplasty is how to obtain adequate tibial metaphyseal fixation in the setting of significant bone loss. There are multiple implants, including stems, metaphyseal cones, and metaphyseal sleeves, that help provide increased fixation and stability. This report demonstrates a case in which a porous tantalum metal revision acetabular shell was used as a large tibial cone, as none of the above options were viable due to the size and position of the tibial defect.

Introduction

There are multiple challenges a surgeon faces when performing a revision of a total knee arthroplasty. One of the biggest potential difficulties of a revision total knee arthroplasty (rTKA) is providing adequate fixation in cases of significant metaphyseal bone loss [1]. To achieve optimal implant stability, fixation is desired in at least 2 of 3 defined zones. Zone 1 is the joint surface, zone 2 is the metaphysis, and zone 3 is the diaphysis [2]. Several different techniques have been described to achieve optimal fixation, including bone grafts, stemmed components, metal cemented or press-fit augments, metaphyseal sleeves, and porous cones [3].

The most commonly used classification of both femoral and tibial bone loss is the Anderson Orthopedic Research Institute classification, which classifies defects based on size and whether or not the defect is contained or uncontained [4]. This classification system is important because it helps guide treatment. However, it does not distinguish between contained and uncontained for type II and type III defects. It also does not include central cavitary lesions [1]. Stambough et al. propose a modification to the Anderson Orthopedic Research Institute classification which separates type II and type III defects into contained and uncontained categories and provides recommendations for surgical treatment of these defects [5]. For a large, contained defect, Stambough et al. recommend a long-stemmed implant with asymmetric or stacked cones vs a large sleeve [5].

This report describes an rTKA case in which the largest metaphyseal cone did not adequately fill a large, contained tibial defect, and (as an off-label use) a porous trabecular metal revision acetabular shell (Zimmer Trabecular Metal [Zimmer Biomet, Warsaw, IN]) acetabular component was used and successfully provided adequate tibial fixation.

Case history

A 54-year-old male with past medical history of class 2 severe obesity (body mass index 39), chewing tobacco use, and an allergy to penicillins initially presented in 2017 with a chief complaint of left knee pain. Written consent was obtained from the patient to report and publish this case report. Imaging demonstrated left knee medial compartment osteoarthritis, and he underwent a left medial unicompartmental knee arthroplasty (Zimmer-Biomet Oxford system [Warsaw, IN]). The patient tolerated this procedure well and was recovering without complications until 4 months postoperatively when he was diagnosed with an Methicillin-sensitive Staphylococcus Aureus prosthetic joint infection. The patient underwent a stage I explantation of the left unicompartmental knee arthroplasty with placement of an antibiotic-laden articulating

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cement spacer. At the 10-week follow-up visit, the left knee aspiration was negative, and a stage II revision left total knee arthroplasty (Zimmer Biomet Vanguard 360 [Zimmer Biomet, Warsaw, IN]) was performed. Multiple femoral augments were used, and a $31 \times 31 \times 25$-mm trabecular metal tibial cone was used to increase fixation in the setting of a small, contained metaphyseal defect. At his 1-year postoperative visit, the patient was doing well with no reported left knee pain and range of motion (ROM) from 0 to 125 degrees.

Approximately 20 months after the stage II rTKA, the patient presented to the emergency department with a painful and swollen left ankle. A left ankle aspirate grew Methicillin-sensitive Staphylococcus Aureus. In the previous 2 months, he had also been treated for left ankle cellulitis and a nonhealing ulcer on the left second toe. The septic left ankle was successfully treated with arthroscopic irrigation and debridement. The patient then presented 4 months after the ankle washout and debridement with a 2-day history of increasing left knee pain and swelling along with headaches, fevers, and chills. Aspiration of the left knee was performed, and 30 mL of brown, purulent fluid was obtained. Synovial fluid cultures grew beta-hemolytic streptococci. Given the acute onset of symptoms, his left knee periprosthetic joint infection was treated with a synovectomy, poly-exchange, and intravenous antibiotics. The left second toe infection had not resolved with antibiotic treatment, and the patient underwent a left second toe amputation for chronic osteomyelitis with podiatry during this same admission.

The patient continued to have mild to moderate pain in his left knee, which became acutely worse 6 weeks after the operation. Repeat aspiration demonstrated a nucleated cell count of 28,856 cells/μL. The decision was made to return to the operating room for a 2-stage revision arthroplasty. He underwent his stage I revision without complications and continued intravenous antibiotics. The revision construct included an antibiotic-laden cement rod that spanned both the femur and the tibia, as well as a static cement spacer block using 3 batches of high-viscosity bone cement with 3 g of vancomycin and 2 g of tobramycin per batch (Fig. 1).

At 3 months postoperatively, aspiration was negative for bacterial growth, and laboratory values had returned to normal. He was taken to the operating room for stage II revision knee arthroplasty. A medial parapatellar approach was used, and a synovectomy was performed. There was a large contained tibial defect noted after debridement. The available porous trabecular metal cones (Zimmer Persona [Zimmer Biomet, Warsaw, IN]) were unable to obtain circumferential purchase in the metaphyseal defect and provide adequate stability. In addition, the largest tibial tray in the revision knee system was not large enough to provide both adequate anterior-posterior (A-P) and medial-lateral (M-L) tibial coverage when trialed with standard, 3-mm, and 6-mm offset stems. The defect was measured to be 50 mm from A-P, 54 mm from M-L, and 25 mm from proximal-distal. This defect was greater in both A-P and M-L diameters than in the available metaphyseal cones and sleeves at our institution. To solve both these issues, we opted to use a 54 Trabecular Metal Revision Shell (Zimmer Biomet, Warsaw, IN). The defect was sequentially reamed from 49 mm, which was just smaller than the defect in the A-P dimension, up to 54 mm, which allowed for an adequate circumferential fit, and the implant was placed into the metaphyseal defect with adequate coverage. The trial construct was then assembled on the back table and placed next to the trabecular metal revision shell. A carbide-tipped burr was used to make a small hole at the measured site of stem placement. The shell was then placed into the metaphyseal defect, and the burr was then used to cut out the rest of the slot for the stem and keel in an appropriate position. The slot was cut slightly larger than the stem so the stem could be placed through the slot and into the tibial canal after the acetabular component was placed. This was done to allow for more uniform peripheral coverage of the tibial component around the entire tibial surface. After preparation of the tibia,

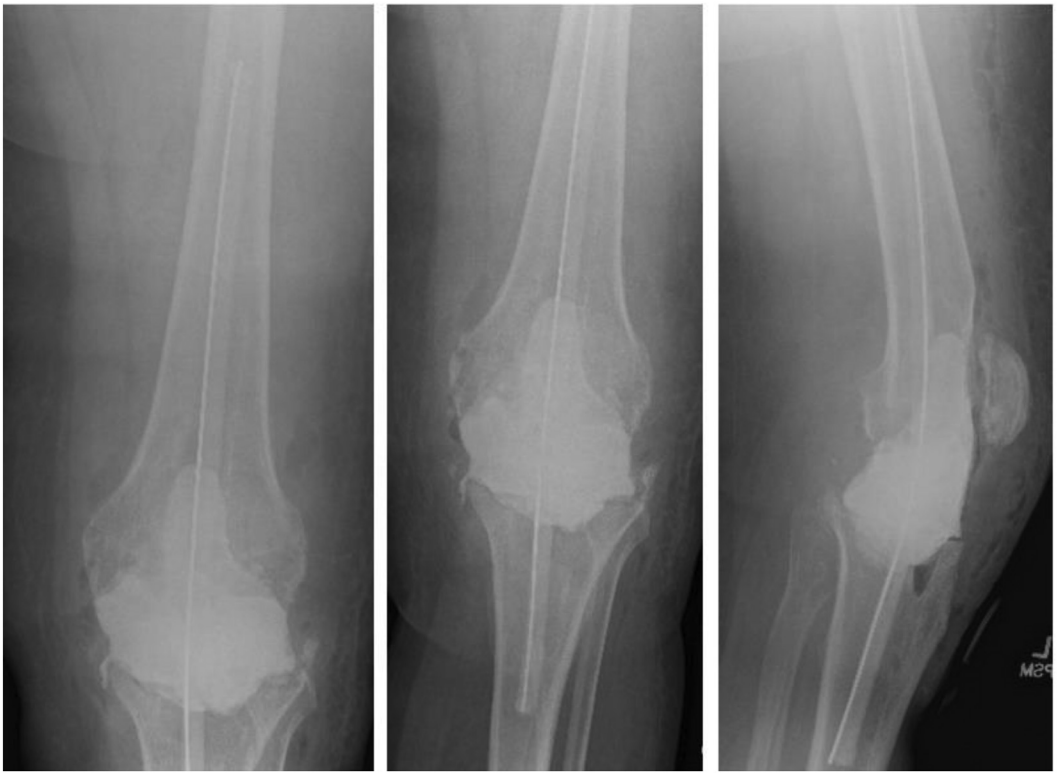

Figure 1. Anteroposterior (left, middle) and lateral (right) radiographs of the left knee with a static antibiotic-laden cement spacer.

the trial components for the femur and tibia were placed and demonstrated excellent collateral balance, and the patella tracked appropriately. The trial components were subsequently removed. Cement was then placed into the tibia, with the cement filling the tibial canal and then the entire revision acetabular component. The final tibial component with 5-mm augments and a size 16 × 135, 6-mm offset splined stem was then inserted (Fig. 2). Although it is not common to cement a splinted stem, it was the only stem available that could be used as an offset stem at our institution at that time. A size 10 condylar constrained poly insert was used. The final cemented construct allowed for fixation in zone 2 and zone 3. Intraoperative ROM was 0-130 degrees. The patient was made weight-bearing as tolerated postoperatively with no restrictions on ROM and worked with physical therapy on postoperative day #1. Intraoperative cultures were negative for bacterial growth. Tissue examination demonstrated dense fibrous tissue with dystrophic calcifications.

The patient was seen most recently at 16 months postoperatively with adequate stability and ROM of 5-110 degrees (Fig. 3). He reports mild pain in the left knee but is able to ambulate without difficulty.

Discussion

In this report, we present a case in which we had to employ unorthodox techniques using existing surgical implants to provide stability and fixation to a revision tibial construct with a metaphyseal defect that was too large for standard metaphyseal cones. With the number of primary total knee arthroplasties projected to grow 673% to 3.48 million procedures per year from 2005 to 2030 and total knee revisions expected to grow 601% between 2005 and 2030 [6], there are likely to be an increasing number of cases in which surgeons will need to use creative solutions for these operative challenges, especially in the setting of multiple revisions.

There were 2 challenges in this case that were both resolved by off-label utilization of the revision acetabular shell. The first challenge was that the size of the defect was greater than that of all available cones at our institution. The second challenge was that the tibial stem needed to be placed more anterior than any cone or sleeve would allow. Creating a new hole in the revision shell based on the position of the tibial canal allowed us to place the tibial component in a position optimal to achieve adequate A-P and M-L tibial coverage.

There are other case reports and case series that demonstrate novel techniques for providing adequate fixation. There are multiple case reports and case series that describe a stacked cone technique, in which multiple metaphyseal cones are stacked for increased fixation in the setting of a severe metaphyseal defect. This is a useful technique when the largest metaphyseal cones are only able to achieve fixation below the joint line, and increased length of the construct is needed [7,8,9]. Another case series by Stambough et al. demonstrated the use of acetabular wedge augments in the setting of a unicondylar uncontained metaphyseal defect [5]. These augments offer more load-bearing capacity by maximizing surface contact area due to the hemispherical design and can also be directly affixed to bone via either screws or cement.

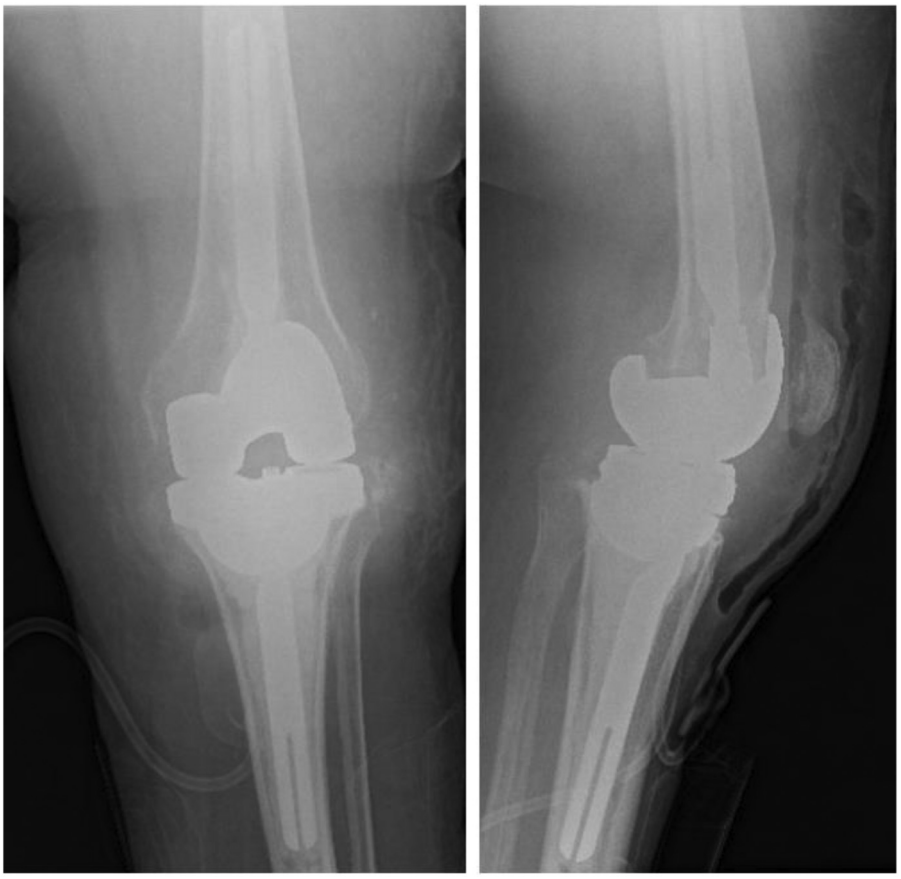

Figure 2. Anteroposterior (left) and lateral (right) radiographs of the patient's left knee postoperatively. The tibial construct includes a size-54 trabecular metal revision acetabular shell, 5-mm augments, and a tibial base plate.

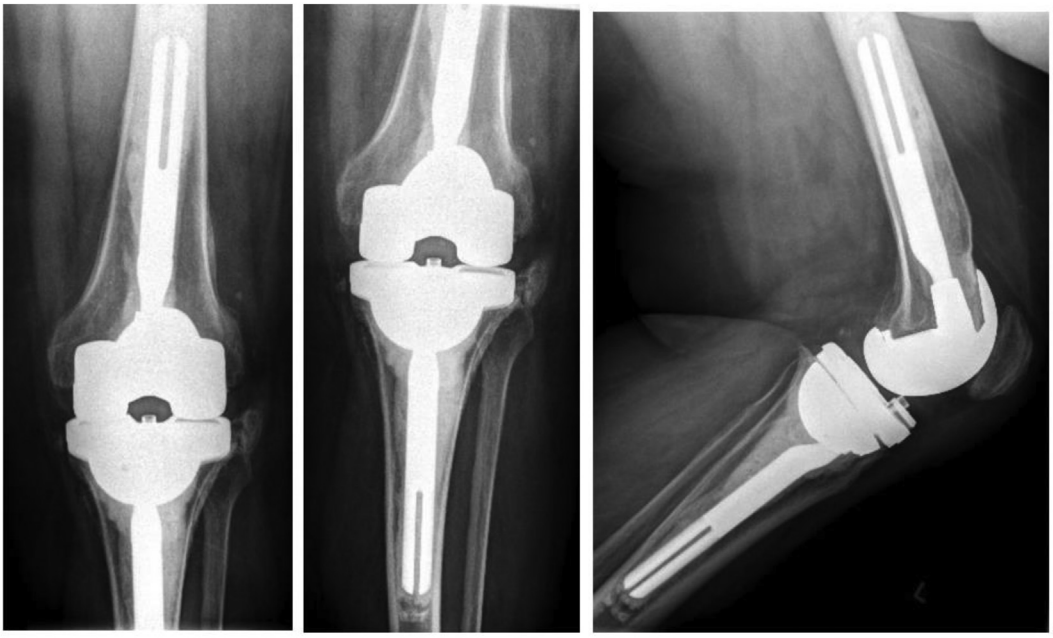

Figure 3. Anteroposterior (left, middle) and lateral (right) radiographs of the patient's left knee at 16 months postoperatively.

Another technique for filling a large tibial defect is the use of a structural allograft. Most commonly, a femoral head or upper tibial segment allograft is used. These can be used in large contained or uncontained defects [10], with some stating that they should be used when the defect involves >50% of either tibial plateau [11]. Multiple studies have demonstrated successful use of femoral head structural allografts [11–13], with a higher complication and failure rate in studies using bulk allografts [14–16]. The difference between the 2 is likely how these grafts fail—the smaller femoral head allografts tend to fail secondary to allograft resorption, resulting in component loosening, while the bulk allografts are used in larger defects and tend to fail secondary to infection or nonunion [17].

In cases of severe proximal tibial bone loss, a proximal tibia megaprosthesis can be used to replace the entire proximal tibia. While this may allow for immediate mechanical stability, the failure rate is significant [17]. Kostuj et al. performed a retrospective review of patients who had undergone proximal tibial replacement for both oncologic and nononcologic indications [18]. The infection rate for patients in the nononcologic group was found to be higher than that in the oncologic group (29.5% vs 9.1%, respectively, [18]). However, there were no significant differences in the Western Ontario and McMaster Universities Osteoarthritis Index score. Another case series by Fram et al. demonstrated 6 patients who successfully underwent proximal tibial replacement for rTKA, demonstrating the utility of this technique [19].

Conclusions

This case demonstrates that the use of a porous trabecular metal revision acetabular shell can be an additional tool in providing adequate fixation to tibial constructs in the setting of a large contained defect. While this procedure was only performed on 1 patient, we believe that it is an adequate technique that deserves further usage and exploration.

Conflicts of interest

The authors declare there are no conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2022.101095.

Informed patient consent

The author(s) confirm that written informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

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