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Surgical Technique

Acetabular Screws With Cement Augment for Tibial Plateau Defects in Dynamic Spacer Implantation: A Case of Recalcitrant Native Knee Septic Arthritis

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ABSTRACT

Treating tibial bone defects in the setting of recalcitrant native knee arthritis presents a challenging biomechanical problem for orthopaedic surgeons. A dynamic antibiotic spacer offers an effective solution to preserve patient function and manage infection. However, severe bone loss may compromise the fixation of the dynamic spacer. We describe the application of acetabular screws as rebar in a case of an Anderson Orthopaedic Research Institute type 3 defect of the medial tibial plateau. Additionally, we outline a facile method for fabricating the tibial stem component to ensure optimal fit within the intramedullary canal. Short-term follow-up (8 months) indicates successful fixation of the tibial component, absence of knee pain, and a knee range of motion up to 100 degrees.

Introduction

Treating severe tibial plateau defects in recalcitrant native knee septic arthritis or revision total knee arthroplasty (TKA) is a challenging biomechanical problem. Current surgical solutions are guided by the Anderson Orthopaedic Research Institute (AORI) classification for bone defects in TKA. [1] Since then, modifications to the AORI classification have been proposed to account for uncontained and contained tibial plateau defects. [2] Surgical management options include bone restoration using impaction bone grafting and allografts or replacement using techniques such as cement augmentation with or without screws, metal augments, and porous tantalum sleeves, among others. [3–7] These methods vary in advantages and disadvantages, with choices influenced by defect type, cost, and surgeon experience.

Less literature exists on managing bone defects with dynamic spacers compared to static spacers, which are traditionally employed to ensure stability in cases of significant defects. However, the evidence does not favor static over dynamic spacers regarding efficacy. Moreover, dynamic spacers may be preferable based on patient-specific factors. The recommended treatment for type 3 AORI tibial plateau defects in revision TKA involves a large structural allograft or a custom tibial spacer accompanied by a canal-filling stem for rotational stability.

In this case, we adopted an integrated approach, using an antibiotic-cemented dynamic spacer to manage the infection and maintain stability. We detail the creation of a custom tibial spacer using cement augmentation and acetabular screws as rebar. Additionally, we present a facile technique for fabricating the keel of the tibial stem, which offers cost-efficiency and surgical simplicity while ensuring adequate dynamic spacer fixation in an AORI type 3 tibial defect.

Surgical technique

Patient background

Our patient, a 41-year-old immunocompromised male, had a history of recalcitrant septic arthritis in his right knee. His medical history included hepatitis B virus, cirrhosis, and active lymphoma

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with brain metastasis. Currently undergoing chemotherapy, he had previously experienced a liver transplant complicated by right tibia avascular necrosis. Initial radiographs at our institution revealed right tibial cement augmentation (Fig. 1). Aspiration yielded synovial fluid cultures positive for Aspergillus fumigatus, treated with irrigation, debridement, and targeted intravenous antibiotic therapy, which failed to resolve the septic knee arthritis. Consequently, we opted for definitive treatment with a dynamic spacer and cement augmentation following the debridement of necrotic tissue.

Approach

A parapatellar approach was employed, dissecting down through the anterior knee region to expose the knee capsule. A standard medial parapatellar arthrotomy and a significant medial release were performed, including the proximal tibial medial soft tissues, the deep medial collateral ligament, and the semimembranosus bursa. Purulent fluid was released under pressure, extensive synovitis was debrided for culture, and a complete synovectomy was carried out. The femoral canal was reamed, irrigated, and suctioned. A 5-degree valgus and 10 mm resection of the distal femur were completed.

Attention then shifted to the proximal tibia, where extensive cement was discovered encasing the medial proximal tibial plateau and metaphysis. Care was taken to remove the cement and preserve the native tibia, and multiple cultures and pathologic specimens were collected. Following cement removal, a deficiency in the medial tibial plateau metaphysis was evident (Fig. 2, AORI type 3 defect). An extramedullary tibial guide was positioned and pinned, and a 10 mm resection was planned from the lateral side. The tibial resection was verified with a varus/valgus drop rod for appropriate coronal and sagittal alignment.

Femoral resections proceeded using a 4-in-1 sizing guide that was pinned at 0 degrees of external rotation, according to the tensioning device. All femoral resections were completed, osteophytes were removed from the posterior aspect of the femur, and the medial meniscus was removed.

Trial components were then placed. The posterior stabilizing box was cut, and the knee was tested for stability with varus and valgus stress in full extension, mid-flexion, and 90 degrees of flexion without tibial tray liftoff. Patellar resection was performed, removing only the layer of cartilage for debridement without cutting a substantial portion of the bone. The patella was not resurfaced. Femoral lug holes were drilled, all trial components were removed, and attention was turned to the tibia, where the tibial baseplate was pinned with appropriate external rotation at approximately the junction of the medial and middle thirds of the tibial tubercle. The knee was thoroughly irrigated, and all surfaces were dried. Despite the large medial tibial defect, the medial collateral ligament remained intact. The knee was irrigated with 3L of normal saline through the tibia, femur, and surrounding soft tissue, followed by Bactisure (Zimmer Biomet, Warsaw, IN) and then dilute betadine. Finally, the knee joint was irrigated with Irrisept (Irrimax Corporation, Lawrenceville, GA), followed by normal saline.

Dynamic antibiotic spacer fabrication and implantation

The stem was fabricated with a 4.8 mm threaded Steinmann pin (Zimmer Biomet) molded in a 40Fr chest tube, combined with one bag of Palacos R&G cement (Heraeus Medical Inc.) premixed with 0.6 g Gentamycin, 1 g vancomycin, 1 g meropenem, and 300 mg voriconazole. The tibial stem was drilled into the keel of the All-Polyethylene PS Tibia (Size 4, 14 mm, Zimmer Biomet NexGen). Four 6.5 mm acetabular screws (Zimmer Biomet Inc. G7) were drilled into the medial aspect of the tibial component as rebar for reconstructing the medial tibia (50 mm × 4, 30 mm drill bit). Once the cement hardened, the chest tube was removed (Fig. 3).

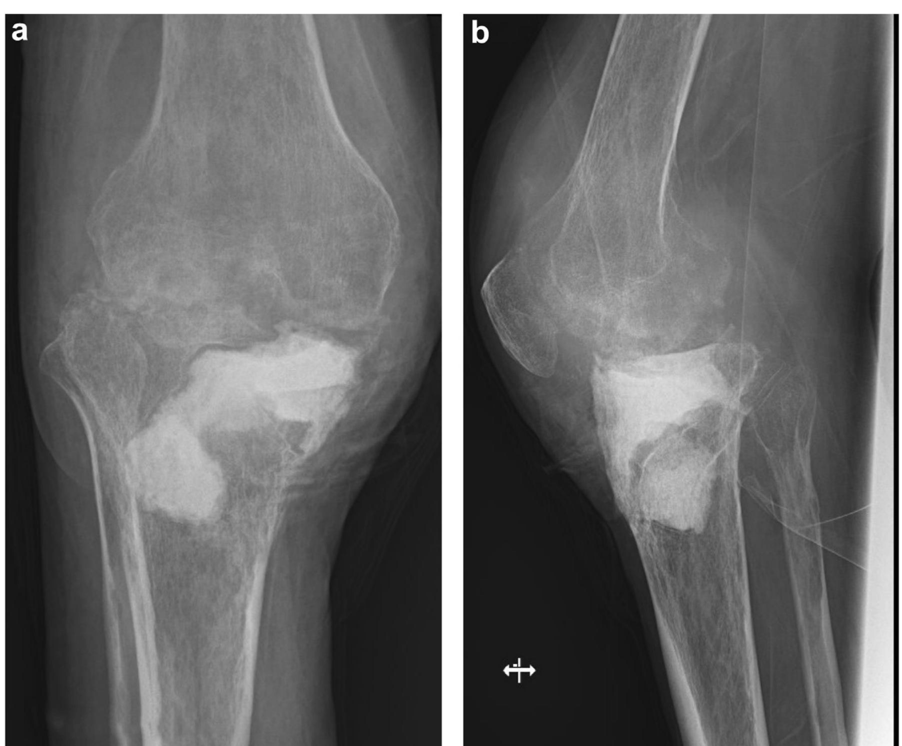

Figure 1. Preoperative (a) anterior-posterior and (b) lateral view radiographs demonstrate radiolucency of cement augment.

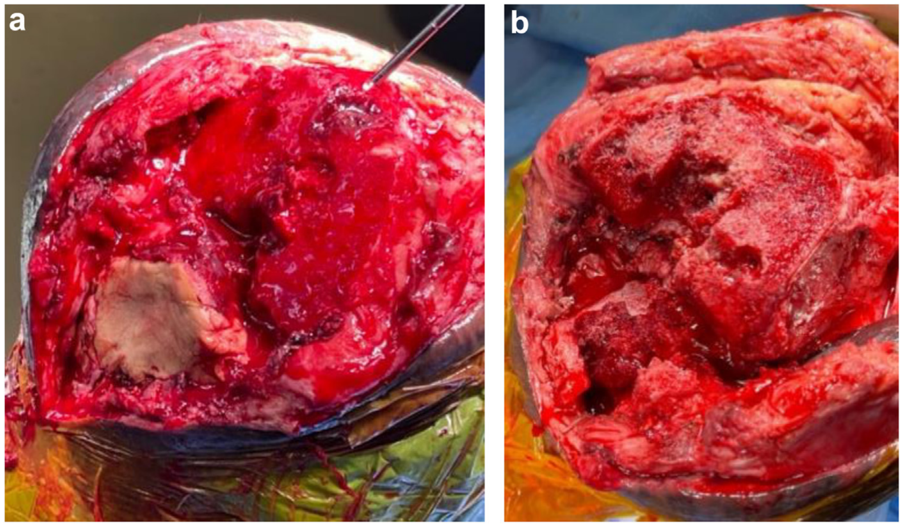

Figure 2. Gross view of the tibial defect after cement augment removal. (a) Prior to the removal of cement. (b) After the removal of the tibial cement.

The femoral stem (Zimmer Biomet, Persona Right PS femur, size 7 standard) was then inserted. The femoral and tibial components were cemented with 3 bags of Palacos R&G plain cement mixed with 3 g vancomycin, 3 g meropenem, and 900 mg voriconazole (Fig. 4). The tibial defect was then packed with cement. The knee was then held in full extension. Once all the cement hardened, the knee was again taken through range of motion. The construct's PS insert was balanced with excellent patellar tracking and good stability. The knee was then irrigated with 1 liter of normal saline using a pulse lavage.

Due to the complex nature of the wound, the plastic surgery team performed a rotational gastrocnemius medial slip rotational flap to provide soft tissue coverage over the implant. A skin graft was also applied for closure. A vacuum dressing was placed over the entire incision and skin graft, with 2 drains in the deep space of the gastrocnemius donor site.

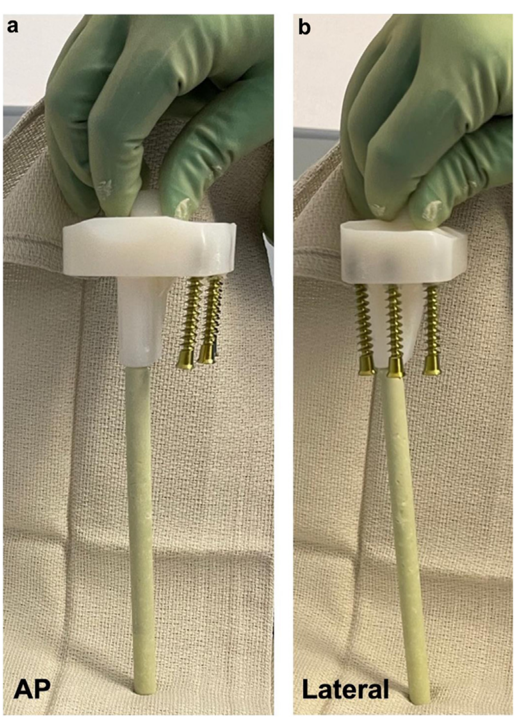

Figure 3. Gross view of the tibial component after fabrication. (a) Anterior-posterior view and (b) lateral view.

Postoperative management

Initial care. The patient was fitted with a knee immobilizer and advised to bear weight as tolerated using bilateral upper extremity supports. No knee range of motion was allowed for the first 6 weeks postsurgery.

Progressive mobility. After the initial 6-week period, the knee immobilizer was removed, and the patient was permitted a limited range of motion from 0 to 30 degrees. Postoperative radiographs taken 54 days after surgery confirmed the proper placement of the femoral and tibial components. Subsequent radiographs, as recently as 8 months postoperatively (Fig. 5), have shown no interval displacement.

Antibiotic regimen. The patient was prescribed voriconazole indefinitely to manage infection risks, with a potential discontinuation considered at the 1-year mark based on the patient's condition and the infectious disease team's assessment.

Functional status and follow-up. At subsequent follow-ups, the patient demonstrated satisfactory mobility, using a cane or walker, with no reported concerns about his knee. Most recent 8-month follow-up checks showed a range of motion from 10 to 100 degrees and the ability to walk 1-5 city blocks. Knee aspirations showed no active infection, indicating effective infection management.

Ongoing care and monitoring. The treatment plan includes regular monitoring and continued physical therapy to maximize functional recovery. While there is no immediate plan for additional surgery, regular follow-ups are scheduled to monitor the implant's status and assess any potential need for future interventions.

Discussion

Treating joint infections with antibiotic spacers in the setting of large bone defects is a complex problem for orthopaedic surgeons.

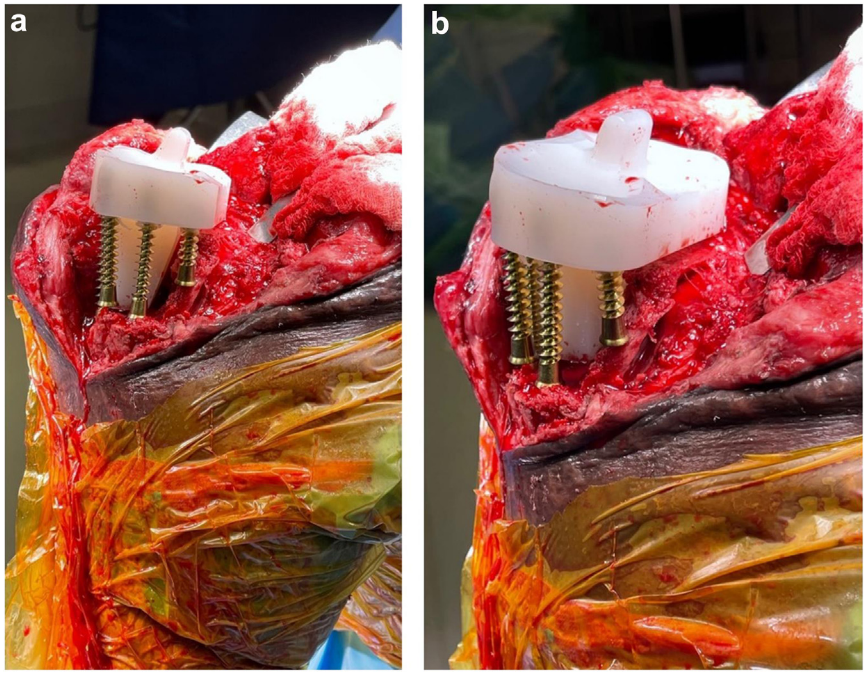

Figure 4. Gross view of the implanted tibial component. (a) Provides a lateral view, and (b) provides an oblique perspective.

The goal is to eradicate infection and construct integrity while providing the patient with good short-term function. Therefore, a recent push has been to utilize dynamic spacers over static spacers. Our technique reflects these considerations, addressing an uncontained tibial plateau defect with a dynamic articulating spacer to treat recalcitrant septic knee arthritis.

Recently, the literature has shown that dynamic spacers perform similarly to static spacers, with the added benefit of increasing patient function. Tao et al. performed a meta-analysis comparing dynamic and static spacer outcomes for treating infections following TKA. [8] They found that dynamic spacers had significantly improved Knee Society Scores and functional scores compared to static spacers. Furthermore, no difference in the rate of infection control was found. A recent cohort found no difference in infection eradication, mechanical outcomes, or reoperation rates. [9] These studies further support the use of dynamic spacers. In contrast, static spacers are now utilized for cases of ligamentous instability, insufficient extensor mechanism, massive bone loss, or a compromised overlying soft tissue envelope. [10]

Although our patient had a tibial plateau AORI type 3 defect, we decided to proceed with a dynamic spacer to increase short-term patient function and comfort in the setting of their active lymphoma with metastasis to the brain. Given the patient's bone defect, careful consideration of the reconstruction technique was taken to ensure adequate spacer support was provided. Furthermore, the loss of compressive modulus of the polymethyl

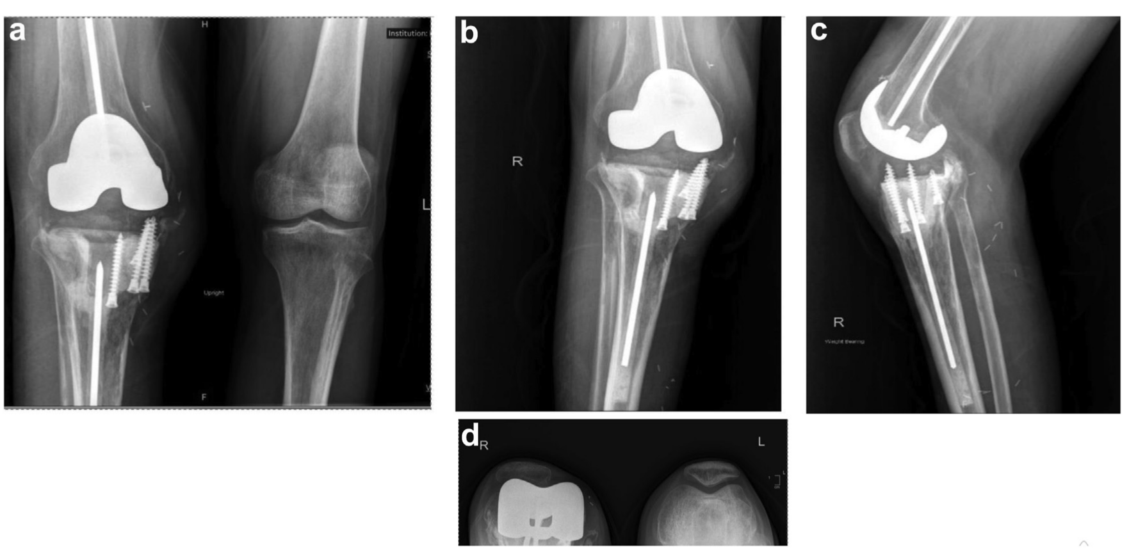

Figure 5. Eight-month postoperative radiographs. (a) Bilateral weight bearing Anteroposterior; (b) Anteroposterior; (c) Lateral; (d) Sunrise view demonstrating well-aligned components in a good position—no lucencies, fractures, or dislocations.

methacrylate (PMMA) due to antibiotic loading was considered. [11] Therefore, we decided to utilize cement augmentation of the defect with acetabular screws to enhance the integrity of the dynamic spacer repair.

Acetabular screws were utilized to reinforce the tibial tray, cement, and bone, enhancing the construct's durability and biomechanical stability. Given the patient's significant comorbidities and the extensive bone defect, acetabular screws were preferred over less expensive options such as 3.5 mm small fragment screws due to their superior mechanical properties and structural integrity.

The unique thread design of acetabular screws increased the surface area, improving the adhesion between the cement and the tibial tray-screw construct. Their larger diameter and specialized design provided better grip and optimized load distribution on the compromised tibial plateau, essential for maintaining the structural integrity and longevity of the dynamic spacer in this complex clinical setting. Another advantage of rebar is that it increases the tensile strength of the PMMA cement, which has a weaker tensile strength than its compressive strength. [12] A study by Randall et al. examined the durability of PMMA augment for an uncontained tibial defect with or without threaded Steinmann pins (rebar). [13] Their study found that PMMA with rebar had improved bonding with the native bone, increased strength (force to failure), and increased durability (cycles to failure). [13] Several other studies have found similar results, [14–16] supporting our use of rebar for AORI type 3 tibial defects in joint reconstruction.

There is no consensus on how to treat uncontained tibial plateau defects in joint reconstruction. Various methods have been described, ranging from cement augmentation with or without screws, bone grafting, modular rectangular metal augments, acetabular wedge augments, or custom-designed components. [2,6,17,18] A recent retrospective study by Johnson et al. reviewed patients who underwent 2-stage revision TKA for deep periprosthetic infections, including 4 cases of type 3 tibial bone loss treated with a dynamic spacer without implant failures. [19] Lastly, the authors acknowledge that while the current construct's PS insert was balanced and deemed appropriate, a constrained condylar knee-style polyethylene insert could have been appropriate to offer additional support in this case of extensive bone loss and instability. Although our patient's follow-up period is limited, their postoperative progress has been satisfactory, with stable implant positioning for nearly 1 year.

Summary

This paper presents a technique for addressing type 3 tibial bone loss during the implantation of a dynamic spacer. By drilling acetabular screws into the tibial tray component for rebar during cement augmentation, we propose a straightforward method to enhance the mechanical integrity of the construct. This approach is not only cost-effective but also simplifies the surgical process.

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.2024.101437.

CRediT authorship contribution statement

Paulos Y. Mengsteab: Writing – review & editing, Writing – original draft. **John J. Corvi:** Writing – review & editing, Writing – original draft, Conceptualization. **Auston R. Locke:** Writing – review & editing, Writing – original draft. **Hannah S. Rhee:** Writing – review & editing, Writing – original draft, Project administration, Formal analysis, Conceptualization. **Brett L. Hayden:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Conceptualization.

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