Case Studies in the Management of Chronic Prosthetic Joint Infection of the Knee Utilizing a Two-Staged Exchange and Pre-Fabricated Articulating Cement Spacers

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Summary of Cases Presented

	CASE 1	CASE 2	CASE 3
Patient Characteristics	**58 yoM, BMI 38**	**58 yoM, BMI 44**	**61 yoF, BMI 58**
Symptoms	Ongoing Effusion	Pain with ambulation, swelling, and erythema	Active drainage from three sinuses on the anterior knee, significant erythema of the knee and lower leg
Implant In Situ on Presentation	Primary Femoral & Tibial Component	Primary Femoral & Tibial Component	Revision Femoral and Tibial Components with Stems and Porous Metaphyseal Cones and Varus/Valgus Constrained Articulation
ESR	57	44	77
CRP	3.0	2.8	8.9
Cell Count/ Differential	13,936 WBCs/cmm, 98%	22,350 WBCs/cmm, 95%	12,260 WBCs/cmm, 86%
Femoral Bone	Type 2B Defect	Type 2B Defect	Type 3 Defect
Tibial Bone	Type 2B Defect	Type 2B Defect	Type 3 Defect
Ligaments	Intact, Stable	Intact, Stable	Inadequate

Case 1

58-year-old male presents for second opinion regarding ongoing effusion following right total knee arthroplasty 9 months earlier (Figure 1a). His past medical history is notable for rheumatoid arthritis treated with methotrexate and etanercept and an uncomplicated left total knee arthroplasty. He reports being treated for cellulitis and prepatellar bursitis 4 weeks after his index procedure with 10 days of oral cephalexin. His swelling and erythema returned 2 months later, and he underwent irrigation and debridement with modular polyethylene exchange. Intraoperative cultures from this procedure were positive for Staphylococcus epidermidis. He was then treated with IV Ceftriaxone and daptomycin for 6 weeks followed by three months of oral doxycycline. On presentation he has been off of antibiotics for 4 weeks.

Physical exam finds a well-healed anterior midline incision. He has a large effusion with range of motion from 1-110 degrees. Ligamentous exam is stable and there is no erythema or drainage present. Laboratory findings included an ESR of 57 mm/hr and a CRP of 3.0 mg/dL. Synovial fluid aspirate grew S. epidermidis and Viridans group Streptococcus species.

A lengthy conversation was had with the patient discussing the risks and benefits of a single stage revision versus and two-staged exchange. With a polymicrobial infection and immunosuppressive medications he was indicated for a two-staged procedure. Intraoperative findings included well fixed implants. Following careful removal of the implants, an aggressive debridement was performed, including the femoral and tibial canals. Care was taken to remove all interdigitated cement and the resurfaced patellar implant. Cement dowels were created using a single batch of PMMA mixed with 3 grams of vancomycin and 2.4 grams of tobramycin. Doughy cement was applied to a large, threaded Steinmann pin. Cement dowels aid the delivery of surgeon directed antibiotics to the femoral and tibial canals. Trials were utilized to determine appropriate sizes for the femoral and tibial spacers and the need for a tibial wedge to optimize soft tissue tension. The large femoral spacer and large tibial spacer with large wedge were cemented with 2 batches of doughy PMMA mixed with 6 grams of vancomycin and 4.8 grams of tobramycin (Figure 1b). The cement is dyed with 2 mL of methylene blue to aid in removal at the second stage.

Following the spacer placement, the knee was immobilized for 3 weeks. The patient completed a 6-week course of daptomycin followed by a 6-week antibiotic free holiday. His CRP was 0.4 and his knee ROM was 0-110 degrees. At the second stage, the femoral and tibial spacers were easily removed, and all fibrous tissue was debrided and sent for culture. The knee was reconstructed utilizing a hybrid technique of press-fit stems and metaphyseal cement pre-mixed with gentamicin (Figure 1c). A porous cone was used in the tibial metaphysis.

Postoperatively, the patient was allowed to weight bear as tolerated and began physical therapy for strength and range of motion. He completed 8 weeks of oral doxycycline and resumed methotrexate and etanercept 8 weeks after reimplantation.

Take home points:

- Aggressively debride all retained cement during first stage
- Minimize bone loss by using doughy cement to fix spacers
- Dye cement to aid removal during second stage
- Use dowels to deliver surgeon directed antibiotics to the femoral and tibial canals, fixation of stems is rarely indicated

Figure 1a: Preoperative X-rays

Figure 1b: Prefabricated articulating spacer with dowels

Figure 1c: Postoperative X-rays

Case 2

50-year-old male presents for follow-up one year after right total knee arthroplasty. His post-operative course was complicated by a patella fracture at 4 months following a ground level fall directly onto the anterior knee. The knee was erythematous at that time and an aspiration was negative. He has had several bouts of cellulitis managed by his primary care physician with oral antibiotics and a recent positive blood culture. On presentation the patient reports pain with ambulation, swelling, and erythema. Past medical history is significant for well-controlled type 2 diabetes.

Physical exam finds a morbidly obese male with a BMI of 44 and an antalgic gait. He has a well-healed midline incision with a warm effusion and erythema. The knee is tender to palpation globally. Range of motion is 0-120 degrees with a stable ligamentous exam. Radiographs demonstrate concerning radiolucencies. ESR was elevated to 44 mm/hr and the CRP was elevated to 2.8 mg/dL. A synovial fluid aspiration was performed yielding 22,350 WBCs/cmm with a neutrophil differential of 95%. Cultures grew two different strains of Staphylococcus epidermidis. Following a long discussion regarding management options focusing on comorbidities of morbid obesity and diabetes, it was determined that he was a candidate for a two-staged exchange.

Intraoperatively he was found to have a grossly purulent effusion and well-fixed, cemented implants (Figure 2a). A quadriceps snip was utilized for exposure. Following careful removal of the implants, an aggressive debridement was performed, including the femoral and tibial canals. Two batches of PMMA were mixed with 6 grams of vancomycin and 4.8 grams of tobramycin. Roughly 25% of the powdered mixture was placed into a second bowl and mixed with monomer until doughy. It was applied to a large Steinmann pin to create a dowel. Once the cement was polymerized the dowel was sectioned. The REMEDY® knee spacer trials were utilized to determine appropriate spacer sizes and the need for a tibial wedge. The large femoral trial was too small in the sagittal plane. An XL femoral spacer was opened and utilized as a trial to determine the need for a tibial wedge. Because the XL spacer sat more proximal on the femur the large tibial spacer and wedge provided excellent soft-tissue tension. The cement dowels were placed in the canals to aid antibiotic delivery. The remaining cement mixture was mixed with 2 mL of methylene blue until doughy and used to fix the spacers (Figure 2b).

Postoperatively, the knee was immobilized for 3 weeks. At the 3-week visit he was allowed range of motion from 0-90 degrees and gentle weight bearing with assistive devices. The patient was treated with 6 weeks of IV vancomycin followed by a 6-week antibiotic free holiday. Inflammatory markers normalized (CRP 0.8 mg/dL) and he was indicated for reimplantation. At the second stage, a quadriceps snip was again required for exposure. The femoral and tibial spacers were easily removed, and all fibrous tissue was debrided and sent for culture. The knee was reconstructed utilizing a hybrid technique of press-fit stems and metaphyseal cement pre-mixed with gentamicin (Figure 2c). A porous cone was used in the tibial metaphysis. The patient was allowed to weight bear as tolerated and began immediate physical therapy.

Take home points:

- Aggressively debride all retained cement during first stage
- Minimize bone loss by using doughy cement to fix spacers
- Dye cement to aid removal during second stage
- Use dowels to deliver surgeon directed antibiotic to the femoral and tibial canals

Figure 2a: Preoperative X-Rays

Figure 2b: Prefabricated articulating spacer with dowels

Figure 2c: Postoperative X-rays

Case 3

61-year-old female presents for recommendations regarding left knee chronic prosthetic joint infection. Her history finds that she had bilateral total knees in 2004. She did reasonably well for 10 years but required revision of the left knee in 2014 for aseptic loosening. The tibial component was revised again in 2015 for aseptic loosening and the patient reports significant wound drainage following this procedure. She was diagnosed with an MSSA infection and treated with irrigation and debridement and placement of absorbable antibiotic beads. She has been treated intermittently since that time with IV and oral antibiotics. She is currently seeing an infectious disease doctor who placed her on oral cephalexin prior to referral. Her past medical history is significant for stage III chronic kidney disease and she is a current cigarette smoker.

Physical exam is significant for morbid obesity with a BMI of 56. She has an antalgic gait. The left knee has a well-healed anterior incisional scar. There is no significant effusion, erythema, or warmth. She has full active range of motion. Her ESR and CRP are currently normal. The recommendation was for continued oral suppression of a presumed chronic PJI.

The patient returned 10 months later with elevated inflammatory markers (ESR 77mm/hr, CRP 8.9 mg/dL) and active drainage from three sinuses on the anterior knee (Figure 3a). She had been converted to IV antibiotic therapy by her infectious disease specialist and now has a BMI of 58. She was able to successfully stop smoking one month earlier. She has significant erythema of the left knee and lower leg. Multiple options were discussed with the patient regarding treatment options for her PJI including transfemoral amputation. We ultimately decided to proceed with semi-urgent explant and placement of an antibiotic loaded cement spacer.

Intraoperatively, the sinus tracts were excised. The femoral component was well-fixed, but easily removed with minimal additional bone loss. The tibial components were loose and easily removed. There was extensive proximal tibial bone loss. The severity of proximal tibial bone loss prohibited the use of articulating spacers. Following an extensile debridement, a single batch of PMMA was mixed with 3 grams of vancomycin and 2.4 grams of tobramycin. Two cement dowels were created using large, threaded Steinmann pins. The dowels were placed in the femoral and tibial canals, meeting in the articular space. Three additional batches of PMMA were mixed with 9 grams of vancomycin and 7.2 grams of tobramycin. Methylene blue was added to dye the cement. The articular cavity was filled with doughy cement while keeping gentle traction on the lower limb and slight flexion in the knee (Figure 3b). Intraoperative cultures were negative x5. The patient was treated with 6 weeks of IV cefazolin for presumed MSSA PJI.

Following a 4-month antibiotic free holiday, the inflammatory markers had normalized (CRP 0.6 mg/dL). The patient is quite disabled and strongly desired reimplantation. Follow-up radiographs demonstrate a large displaced lateral condyle periprosthetic fracture extending into the posterior femoral diaphysis. Following a lengthy discussion regarding the risks of reimplantation, including potential for limb loss, the patient elected to proceed with reimplantation.

The degree of femoral bone loss necessitated a distal femoral replacement (Figure 3c). Tissue cultures from reimplantation remained negative. The patient was able to bear weight immediately following surgery.

Figure 3a: Preoperative X-Rays

Figure 3b: Hand-made Static Spacer with dowels

Figure 3c: Postoperative X-Rays