Using an Antibiotic-Impregnated Cement Rod-Spacer in the Treatment of Infected Total Knee Arthroplasty

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Abstract

We present a new option for treatment of post–total knee arthroplasty periprosthetic infection associated with bone destruction and massive loss—use of an antibiotic-impregnated cement rod-spacer. This rod-spacer can be custom-made, at time of surgery, with Steinmann pins, intramedullary nails, Rush rods, Harrington spine rods, bone cement (polymethylmethacrylate), and antibiotics.

We used this technique in 9 cases of periprosthetic infection over a 6-year period. The rod-spacer provided stable fixation across the knee, local antibiotic delivery, maintenance of the joint space, and preservation of soft-tissue tension around the joint through enhanced stability and length maintenance.

Infection is one of the most disturbing and frightening complications of total knee arthroplasty (TKA) and one of the most feared complications in orthopedic surgery.

Post-TKA treatment of periprosthetic infection (PPI) associated with bone destruction and massive loss, severe instability, and recurrent infection usually includes removal of all prosthetic components, débridement of the joint, and insertion of an antibiotic-impregnated cement spacer. This spacer does not provide adequate mechanical support.

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In this article, we present an alternative for filling the joint space and linked bones with a stable, antibiotic-impregnated cement rod-spacer to improve mechanical stability. This rod-spacer can be custom-made, at time of surgery, with Steinmann pins, intramedullary nails, Rush rods, Harrington spine rods, bone cement (polymethylmethacrylate), and antibiotics. The technique, its advantages, and the results of clinical use over a 6-year period are described.

Surgical Technique

After all prosthetic components are removed, all infected and nonviable tissues are meticulously débrided (Figure 1). An antibiotic solution is used for extensive pulse lavage irrigation. The femoral and tibial intramedullary canals are reamed with flexible reamers. Then the canals are subjected to pulse lavage irrigation. We usually use three to six 40-g packs of bone cement (Palacos; Heraeus Kulzer, Wehrheim, Germany) with 2 g of vancomycin and 2.4 g of tobramycin per pack. Steinmann pins, intramedullary nails, Rush rods, or Harrington spine rods are selected according to anatomy encountered. A cylinder of antibiotic-impregnated cement is placed over the selected rod, and the rod is coated completely with cement (Figure 2). With the femoral and tibial intramedullary canals exposed, the cement-coated rod is placed into the canals to ensure that there will be no difficulties inserting the rod. While the cement is in the final stage of curing, the antibiotic-impregnated cement rod is placed within the intramedullary canals (Figure 3). Most often, this is done by inserting the rod retrograde up in the femur with the knee in flexion, extending the knee, and inserting the rod antegrade down within the tibia. With traction maintained across the knee, extra antibiotic-impregnated cement is used to fill the space between the tibia and femur to form an antibiotic-impregnated cement rod-spacer that will preserve length and improve stability (Figure 4). Adequate molding of the antibiotic-impregnated cement rod-spacer allows good soft-tissue closure. A knee immobilizer is used for additional protection. After surgery, patients are immediately allowed toe-touch weight-bearing and ambulating with crutches or a walker. They are advanced to partial weight-bearing with support over the ensuing 6 weeks. Based on their culture reports, they also undergo appropriate intravenous antibiotic therapy for 6 to 8 weeks or longer.

After infections were eradicated (confirmed with at least triple cultures), patients underwent second-stage TKA reim-

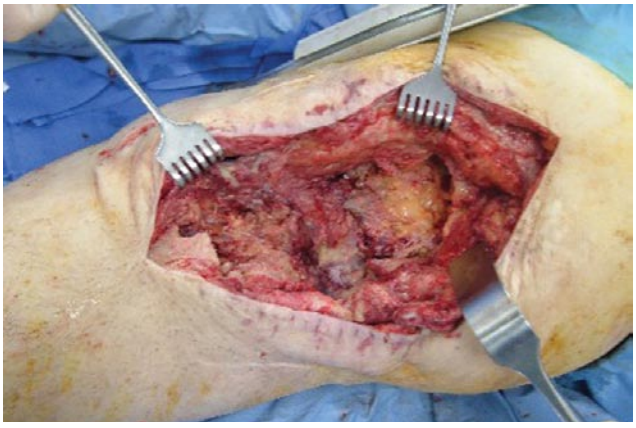

Figure 1. Wound view after removal of all prosthetic components, meticulous débridement of all infected and nonviable tissues, and extensive pulse lavage irrigation with antibiotic solution.

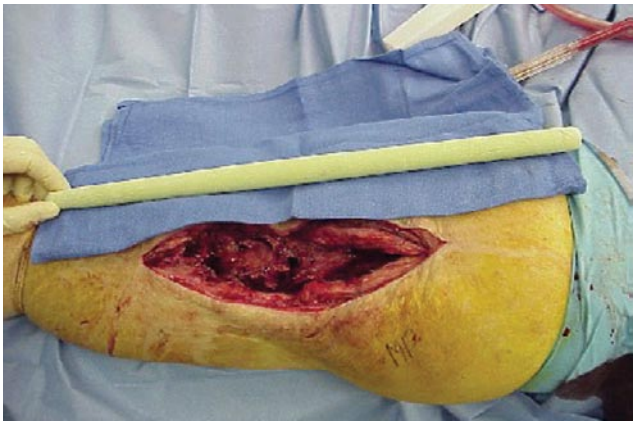

Figure 2. Cylinder of antibiotic-impregnated cement is placed over selected rod, and rod is coated completely with cement.

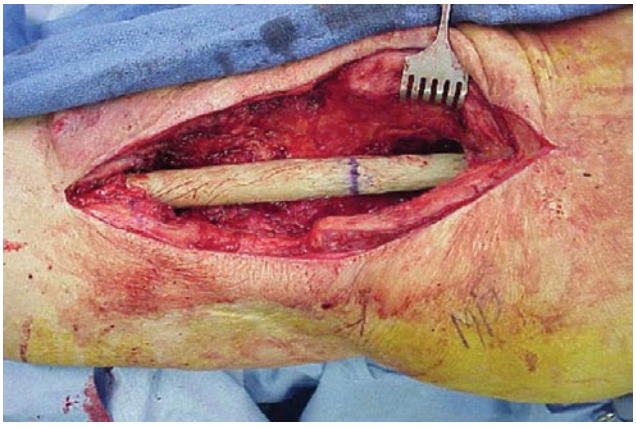

Figure 3. Antibiotic-impregnated cement rod is placed within femoral and tibial intramedullary canals.

Figure 4. With traction maintained across knee, extra antibiotic-impregnated cement is used to fill space between tibia and femur to form antibiotic-impregnated cement rod-spacer.

plantation or knee fusion. The antibiotic-impregnated cement rod-spacer was removed. The technique used to remove the antibiotic-impregnated cement rod-spacer was a reverse technique of implantation. The antibiotic-impregnated cement used to fill the space between the tibia and femur was removed all the way around the rod. Then the cement that was around the rod ends in the intramedullary canals was carefully loosened with an osteotome and partially removed. The rod was then inserted retrograde up in the femur or antegrade down within the tibia—whichever way was easiest—and removed. When there were difficulties moving the nail up into the femur or down into the tibia, we used a saw to cut the nail in half before removing it. For nail cutting, we took precautions and used good soft-tissue protection with copious irrigation to prevent tissues from overheating. All cement was meticulously removed. In all cases, the antibiotic-impregnated cement rod-spacer was removed without complications.

Clinical Series

Over a 6-year period, this technique was used in 9 cases, all of which were followed clinically. There were 7 chronic PPI cases and 2 acute PPI cases. Eight patients had multiple surgeries (mean, 7; range, 3-16) with recurrent infection, bone destruction and loss, severe instability, or deformity. Medical history was aggravated by morbid obesity (4 cases), diabetes mellitus (2), chronic lymphoma (1), vascular injury with insufficiency (1), and hypothyroidism (1). All patients presented with pain, swelling, elevated erythrocyte sedimentation rate, and elevated C-reactive protein. Four patients underwent second-stage TKA reimplantation with long-stem femoral and tibial components (Figures 5–8) and without bone graft at approximately 3 months (3 patients) or 20 months (1 patient). Patients were able to ambulate with crutches or a walker and became household or community ambulators in the time between the first and second stages. They received 6 to 8 weeks of intravenous antibiotics after antibiotic-impregnated cement rod-spacer implantation.

All 4 patients were doing well at a mean follow-up of 3.5 years (range, 1-6 years). Four patients ended up with a knee arthrodesis using long intramedullary nails; 3 of these patients had radiologically confirmed fusion and were doing well at their follow-ups (1, 2, 3 years), and the fourth patient was in fusion treatment. An 85-year-old patient selected the antibiotic-impregnated cement rod-spacer as a definitive treatment option.

Figure 5. Anteroposterior radiograph (patient A) after insertion of antibiotic-impregnated cement rod-spacer.

Figure 6. Lateral radiograph (patient A) after insertion of antibiotic-impregnated cement rod-spacer.

Figure 7. Anteroposterior radiograph (patient A) 2 years after reimplantation.

Figure 8. Lateral radiograph (patient A) 2 years after reimplantation.

Discussion

For staged management of infected TKA, antibiotic-laden polymethylmethacrylate spacers have been recommended. Antibiotic-impregnated cement spacers target medication delivery, achieving high local levels while limiting the potential for host toxicity associated with parenteral antimicrobial therapy.[1,2]

However, most proposed antibiotic-impregnated cement spacers do not provide adequate mechanical support. Antibiotic cement nails are used to treat infected tibial fractures,[3] septic tibial nonunions,[4] and intramedullary infections.[5] We have extended the concept of antibiotic cement nails and developed an alternative for filling the collapsible joint space and linked intramedullary noncollapsible dead space with a stable antibiotic-impregnated cement rod-spacer. Penner and colleagues[6] measured the cement release of vancomycin and tobramycin alone and in combination and found that the combination led to the largest release of both antibiotics when cement-antibiotic mixtures were prepared manually. Vacuum mixing reduces porosity and diffusion surface. Palacos bone cement has better elution characteristics than the other types of cement do, and a higher concentration of the antibiotic is achieved in the application site for a longer period.[1,2] Antibiotic elution is related to surface area, antibiotic amount, and cement porosity. The antibiotic-impregnated cement rod-spacer has the advantages of large surface area, high antibiotic concentration, and adequate cement porosity maximizing antibiotic elution. Selecting the endoskeleton for the rod-spacer makes this a versatile technique applicable to the wide range of anatomy types.

In cases of infected knee arthroplasty with bone destruction, severe instability, or deformity, resection arthroplasty with insertion of an antibiotic-impregnated cement rod-spacer for fixation and stabilization could be effective. The technique is easy. Cement can be loaded with antibiotics according to culture results and sensitivity. This rod-spacer not only provides stable fixation across the knee and local antibiotic delivery but has a beneficial role in maintaining the joint space and preserving soft-tissue tension around the joint through enhanced stability and length maintenance. The antibiotic-impregnated cement rod-spacer maintains limb length and knee joint space and thereby makes subsequent reimplantation technically easier. It also provides immediate stability and thereby makes patient rehabilitation and management much more comfortable. The rod-spacer maintains a stable joint gap between both bone segments and improves the quality of life of patients during treatment. It allows rapid mobilization, higher functional level, and less pain than does use of a simple antibiotic-impregnated cement spacer.

Given our experience, we believe that the antibiotic-impregnated cement rod-spacer is a valuable technique in treating difficult cases of PPI after TKA. As our experience was with a small group of patients, controlled prospective trials or multicenter studies for determining the validity of this antibiotic cement rod-spacer are needed.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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