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CASE REPORT

The First Stage of Knee Revision Arthroplasty in Periprosthetic Infection with Replacement of a Large Defect Double Cementing Method: A Case Report

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Aim: Large bone defects in patients with chronic deep periprosthetic knee infection is a major problem. It is widely accepted that bone defects filling with polymethylmethacrylate (PMMA) cement could be used only in selected cases of small bone defects (up to 5 mm) and less than 50% of articular surface due to multiple reasons: risk of thermal bone damage, inadequate cement pressurization and bone cement shrinkage, etc. Staged cementing for preventing bone heating and over negative effects of cementing on a thick layer of bone cement has limited support in the literature.

Case Presentation: We present the case of 4.5 years follow up after temporary-permanent spacer implantation in a 63-year-old male with chronic deep knee PJI and tibial AORI type 3 bone defect reconstructed via double cementing method.

Results: Method of double (staged) cementing used for reconstruction of epiphyseal tibial bone defect in a patient with fistula form of knee PJI shows excellent clinical results at 4.5 years follow up.

Keywords: bone cement, knee joint, periprosthetic joint infection, tibial defect

Introduction

Metaepiphyseal bone defects are serious challenges in revision total knee arthroplasty (RTKA). Several methods have been proposed for bone defect management in RTKA, including cementation, metal augmentation, bone grafting, metaphyseal fixation using sleeves and cones, megaprosthesis and custom-made implants.[1] However, the clinical results of revision surgeries are far from optimal, especially in cases of major bone defects in patients with PJI.[2] Bone defect filling with polymethylmethacrylate (PMMA) bone cement loaded with antibiotic (ALBC) or/and other antibacterial agents is an unexpansive and safe method,[3] but usually limited to bone defects <5 mm of depth.[1,4] Some authors do not recommend to use bone cement for Anderson Orthopaedic Research Institute (AORI) type 2 and 3 bone defects (AORI, 1997) due to the risk of thermal bone trauma with subsequent implant loosening.[5–8] The release of heat to 100°C provoking thermal lesion of bone.[9–11] Polymerization of PMMA bone cement in a thick layer negatively influence cement pressurization and can lead to its shrinkage and lamination of cement[12] and potentially increase risk of components malalignment.

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To avoid negative effects of thermal bone exposure and diminish the influence of PMMA shrinkage on the quality of components fixation and alignment, we applied staged cementing that we called "double cementing" technique.

This work has been reported in line with the CARE criteria.[13]

Clinical Case

Informed consent was obtained from the patient for inclusion in this case report.

A 63-year-old man was admitted to our clinic with fistula connected to the joint medially and below the patella. Primary cemented total knee arthroplasty (TKA) with a posterior-stabilized knee was performed for rheumatoid arthritis at an external hospital 9 years previously. One year after the primary TKA fistula opened and functioned for 8 years (Figure 1). In preoperative punctate *Staphylococcus aureus* was identified (10^6).

Knee radiography demonstrated massive bone lesion under the tibial component (Figure 2).

The American Knee Society Score (KSS) and Oxford Knee Score (OKS) were obtained upon admission to our clinic and at 48 months.

On admission, the KSS Clinical score was 55 points, KSS Functional score was 60 points, and OKS was 30 points.

Under general anesthesia, we explanted the prosthesis and after radical debridement and jet-lavage with 10 liters of antiseptic solution we evaluated size and shape of bone defects, range of motion, joint stability and patella tracking using revision knee trials. After we accomplished tibial component of a "spacer" out of polyethylene liner fixed on antibiotic loaded bone cement (ALBC) dowel armed by 6 mm threaded stainless-steel rod and femoral armed dowel (Figure 3). As soon as tibial component and femoral dowel cement polymerized and cooled to the room temperature, femoral dowel was introduced into femoral canal (Figure 4).

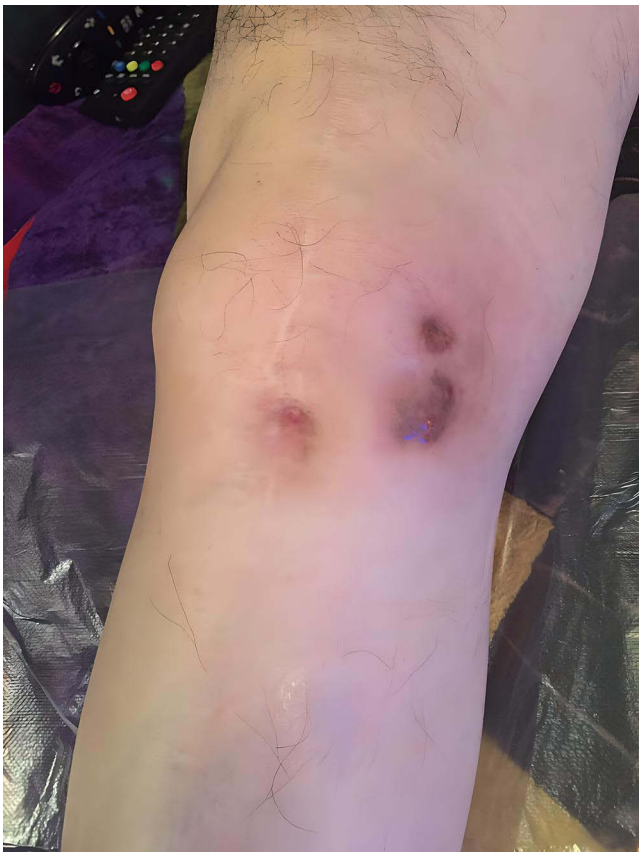

Figure 1 Picture of a knee before spacer implantation. Fistula could be visible on the medial side of the knee.

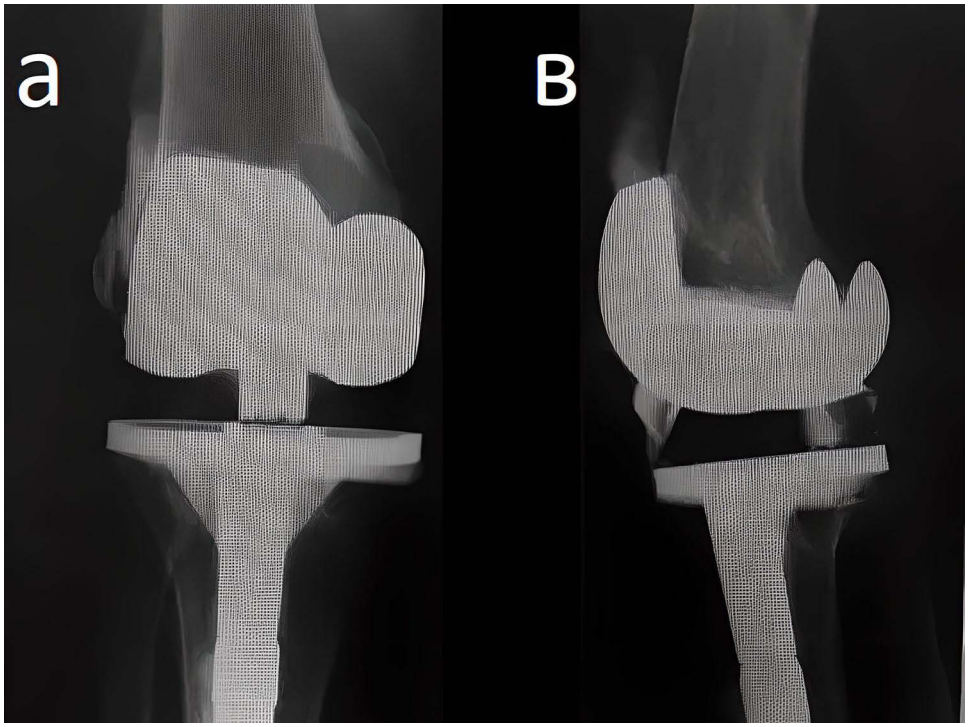

Figure 2 Radiography of the right knee joint before spacer implantation. Severe bone loss could be visible under tibial component. (**a**) in the frontal plane; (**b**) in the sagittal plane.

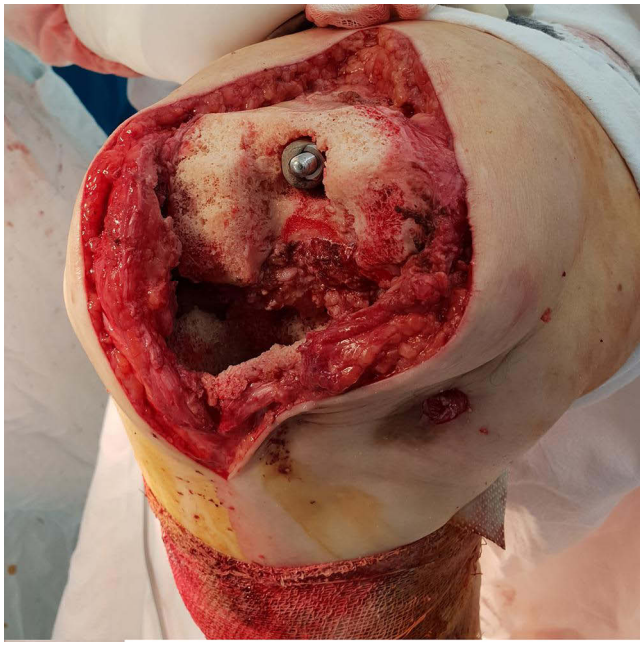

Figure 3 Intraoperative image after removal of the endoprosthesis components. An extensive T3 tibial defect by AORI and an F1 femoral defect by AORI are defined.

Figure 4 Tibial component of a spacer with metaphyseal "sleeve" for bone defect reconstruction.

Tibial and femoral components of the spacer were implanted on ALBC separately (DePuy® SmartSet GMV Endurance + 2 g of Vancomycin and 1 g. of microsilver (BioGate Germany provided by Prof. R. Schnettler, Germany) per 40 g pack of cement).

Stem of a tibial component was implanted press-fit and metaphyseal part-cemented. We did not perform augmentation on the femoral side due to the minor femoral bone defects (AORI type F1) and optimal patellar tracking was achieved. Three cultures were obtained intraoperatively, and methicillin-sensitive *S. aureus* (MSSA) was identified in all of them. The joint was drained for 24 h postoperatively.

After spacer implantation for 2 weeks, the patient received two antibiotics intravenously: cefazolin 1 g three times a day and amikacin 500 mg twice a day, and later for 3 weeks, peroral Amoxicillin + clavulanic acid 1000 mg twice a day.

At 3 months after the spacer implantation patient rejected proposed knee reimplantation.

At the last follow-up (at 52 months) knee radiography revealed the proper components and limb alignment.

At the last follow-up the patient had no clinical or laboratory signs of PJI (no pain or laboratory signs of infection), full range of motion 0°/0°/125° (Figure 5). The KSS showed improvements in clinical scores of up to 90 points and functional scores of up to 85 points and up to 18 points in the OKS. After 52 months (Figure 6), radiography showed no change at the cement/bone interface, no plastic deformation of the bone cement. Patient was employed and physically active.

Discussion

AORI type T3 bone defects could be a challenge for a surgeon.[6] It is known that metaphyseal fixation is the key for long lasting RTKA function.[14] Currently, to fill such defects porous metaphyseal sleeves and cones are most often recommended.[1] But it is unclear if these constructs could be successfully used during one-stage revisions or as

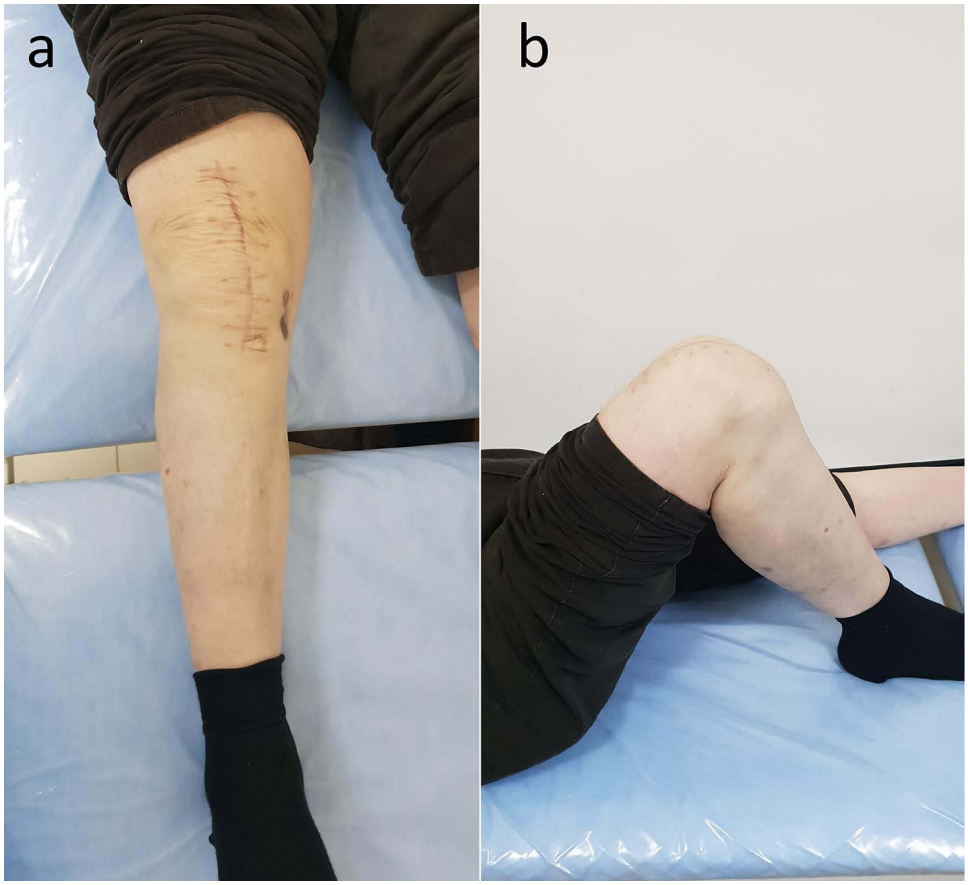

Figure 5 Photograph of the knee joint 48 months after spacer implantation knee joint is determined. (**a**) in the frontal plane; (**b**) in the sagittal plane.

components of long-lasting spacer in PJI patients.[15–17] It was shown that infection is the key reason for knee re-revisions,[18] so antibacterial protection of revision constructs is logic. High risk of infection treatment failure[19] and subsequent need for knee revision or spacer exchange emphasize the need for "easy to extract" constructs that is not the case with metaphyseal metal constructs.[20] Moreover, metaphyseal cones significantly increase chances for component malalignment.[21] In general, surgeons prefer to limit amount of hardware being implanted in PJI patients.[3] Several authors claim that bone cement should not be used if bone defect exceeds 5 mm due to its physical properties.[9,22] It was published that bone cement augmentation should be limited to defects of less than 5 mm due to the risk of thermal damage of the bone and subsequent components loosening and knee failure.[9]

We did not find supporting literature for using massive constructs of PMMA in cases of metaphyseal bone loss in patients with PJI.

Presented case report describes the application of knee spacer implantation according to the idea of a temporary-permanent spacer proposed by Rimashevskiy et al[23] and a 1.5 stage revision applied by Siddiqi et al[24] with additional use of our double cemented method in a patient with type T3 bone defect of the tibia.

We did not observe recurrence of the periprosthetic infection in this case. When this method of plastic deformation of the bone cement was used, bone destruction at the cement/bone interface was not observed.

In the presented case follow-up period is quite short (48 months), but we have a series of such cases and plan to continue monitoring them and publish results in a future.

The proposed method could be an alternative to metal augments, sleeves and cones in cases of one stage knee revision knee in patients with PJI. It saves all benefits of PMMA spaces meanwhile potentially prevents bone from excessive temperature exposure, improved quality of cementing.

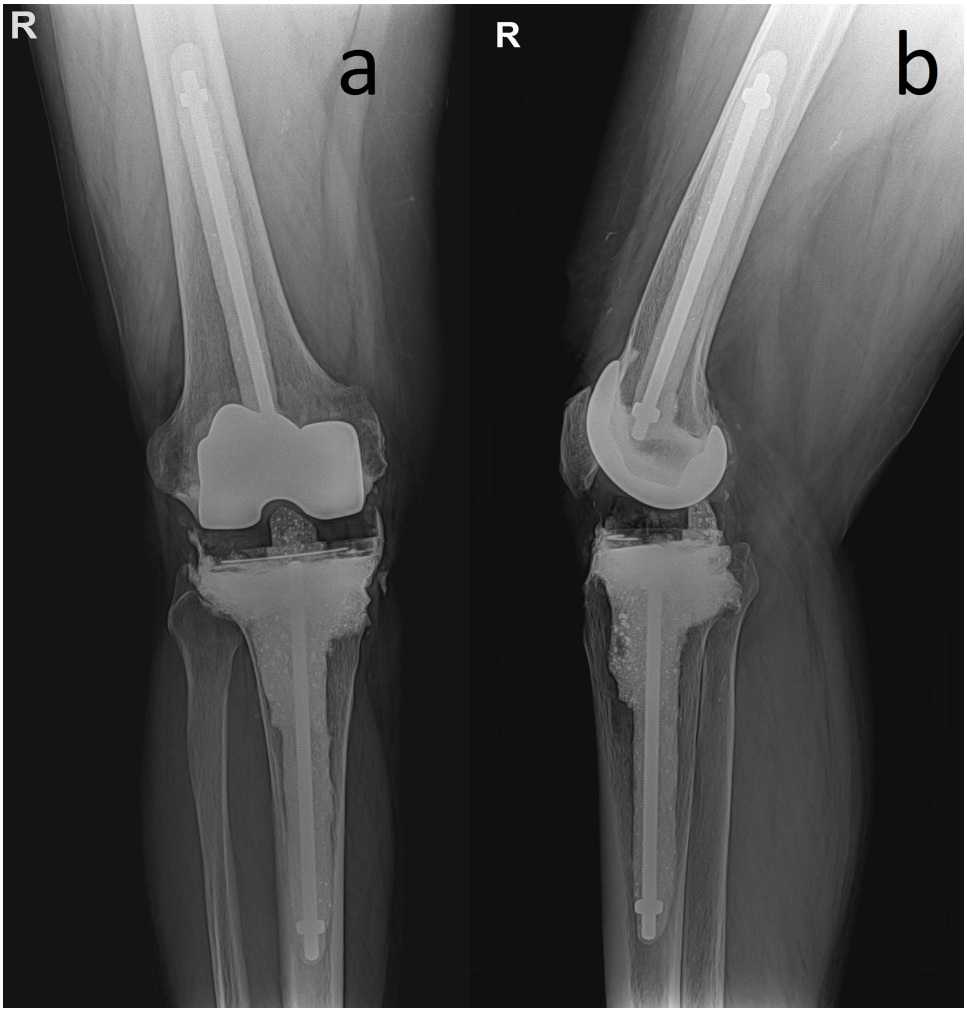

Figure 6 Radiography of the knee joint 48 months after surgery. (**a**) in the frontal plane; (**b**) in the sagittal plane.

Conclusion

In this case we presented a 63-year-old male with periprosthetic knee PJI and tibial AORI type T3. Implantation of a massive PMMA spacer in tibia did no lead to plastic deformation of bone cement or any other negative consequences. Proposed method could be applied in cases of long-lasting spacer implantation or for one stage revision in patients with knee PJI. The obtained results make a fundament for the new study of the double cementing method in patients with knee bone defects.

Data Sharing Statement

All data generated or analyzed during this study are included in this published article.

Ethics Approval and Consent to Participate

Written informed consent was obtained from this patient. The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the National Scientific Center of Traumatology and Orthopedics Named after Academician N.D. Batpenov (protocol code #4 and date of approval October 19, 2021).

Consent for Publication

Written informed consent has been obtained from the patient to publish this paper and all of accompanying images.

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Disclosure

The authors declare that they have no conflicts of interest.

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