Original Article

Cement Pedestal Spacer Technique for Infected Two-stage Revision Knee Arthroplasty: Description and Comparison of Complications

Abstract

Background: Infection following total knee arthroplasty (TKA) is a significant complication, with an incidence of up to 2% in primary TKA and 4%–8% in revision cases. Two-stage revision is the gold standard treatment for long-lasting infections of TKA. The purpose of this study was to describe the cement pedestal spacer technique used in infected two-stage revision knee arthroplasty and compare complications against conventional fixed and mobile cement spacers. **Patients and Methods:** A retrospective review was conducted in all cases who underwent two-stage TKA revision for infection between 2009 and 2015. These cases were separated into groups depending on the cement spacer utilized (fixed, mobile nonpedestal, and mobile spacers with cement pedestal). The cement pedestal technique involves press fitting a cement cylinder into the femur before definitive spacer insertion. **Results:** Forty four patients underwent two-stage revision TKA. Fewest complications were observed in the pedestal group, with no spacers having subluxed/tilted. The longest followup was also observed in the pedestal group (mean 52.5 months). Mobile spacers with no cement pedestal displayed the highest reinfection rate (16.7%) and the greatest number of cases with complications (malalignment, subluxation, tilting, and spacer fracture). All patients in the pedestal group were ambulatory after the first-stage revision. **Conclusions:** The cement pedestal technique minimizes complications by optimizing component positioning and balancing. It also safely extends the indication for an articulated spacer into a set of cases with more extensive bone loss and allows for extended monitoring of inflammatory markers.

Keywords: *Cement pedestal technique, Cement spacer, two-stage revision knee arthroplasty*

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Introduction

Infection following total knee arthroplasty (TKA) is one of the most significant complications faced by both patient and surgeon alike, with an incidence of up to 2% in primary TKA and 4%–8% in revision cases.[1] This is despite the use of prophylactic antibiotics. Controversy also exists regarding the length of time for observation between first- and second-stage procedures and the management in complex presentations including re-revisions and patients with skin changes and chronic sinuses.

Two-stage revision, first advocated by Insall *et al*.,[2] is the gold standard treatment for long-lasting infections of TKA, allowing time to monitor wounds and inflammatory markers while administering systemic antibiotics for several weeks. The technique of placing an antibiotic-impregnated cement block after debridement and removal of the infected prostheses was first described by Cohen *et al*.[3]

Articulating spacers are now popular due to their advantage of preserving a range of motion and maintaining muscle strength. However, these can have a high incidence of complications, including fractures, dislocations, and malalignment.[4,5] Such articulating spacers must be balanced in a way similar to ordinary TKAs, but this can be difficult to achieve due to loss of bone stock and ligament laxity. A modified surgical technique, therefore, seems necessary not only to improve such balancing during first-stage revision but also to provide time to monitor higher risk patients for longer periods while maintaining their range of motion and mobility.

The purpose of this study, therefore, was to describe the cement pedestal spacer technique used in infected two-stage

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revision knee arthroplasty and compare complications against conventional fixed and mobile cement spacers.

Patients and Methods

A retrospective review was conducted in all cases in our institution who underwent two-stage TKA revision for infection between 2009 and 2015. These cases were then separated into three groups depending on the cement spacer utilized. These were (1) fixed spacers, (2) mobile nonpedestal spacers, or (3) mobile spacers with cement pedestal. The cement pedestal technique (3) is described in detail below.

A comparison was then made between the groups based on the incidence of complications encountered including gap size, malalignment (defined as more than ten degrees of varus/valgus angulation), tilting, subluxation, and spacer fracture. The interval between the first and second stages was also determined, as well as those patients undergoing repeat first stages. Ambulatory status after first-stage revision surgery was also obtained.

Fixed, nonmobile cement spacers were inserted after debridement and removal of both infected components to occupy the remaining knee joint cavity, with extension into both femoral and tibial canals. Two 40 g bags of Palacos R® (Heraeus Medical, Wehrheim, Germany) cement including 2 g gentamicin were used.

Mobile spacers without cement pedestal were inserted utilizing premolded Spacer-K (Tecres®, Verona, Italy) which is a temporary implantable device indicated to replace a joint prosthesis removed as a result of a septic process, being cemented in. Two 40 g bags of Palacos R® cement including 2 g gentamicin were used.

Cement pedestal technique

The cement pedestal technique is used to optimize exposure, stability, and component positioning. The technique also allows the surgeon to balance the joint precisely while also maintaining bone length and soft-tissue tensions and preserving bone stock.

After removal of both infected knee components followed by irrigation and debridement of the femoral and tibial canals, the technique is carried out using Spacer-K and two 40 g bags of Palacos R® cement which include 2 g gentamicin. The first mix of cement can be split into three phases: early, middle, and late. In the early phase, the tibial component of the cement spacer is cemented orthogonally at the height of the proximal fibula, and the remaining cement is then molded into a large cylinder [Figure 1].

During the middle phase, the cylinder of cement which is still just malleable is loosely press fitted into the shaft of the femur, leaving it proud for several centimeters [Figure 2]. The aim is to leave smooth conical shapes in the diaphyseal parts of both the tibia and femur which will be relatively easy to remove at the second stage of the revision.

In the late phase, when the cement is set, serial cuts to the cement protruding from the femur are made facilitating positioning of the femoral component of the spacer into a semi-stable situation. Care is taken to support the spacer posteriorly to avoid breakage of the flanges during testing. Adjustments to length, anteroposterior position, and rotation (keeping anatomical reference points visible) can be made at this juncture to optimize alignment, ligament tensions, and therefore, stability [Figure 3].

The second cement mix is used to fix the femoral component of the spacer in place [Figure 4]. Cement is carefully used to build up any commonly occurring deficiencies, the epicondylar ridges as well as buttressing the posterior flanges of the femoral component, which are prone to subsequent breakage.

In this way, therefore, during the second mix, important final adjustments can be made which include fine tuning of alignment and the flexion gap. Stability in extension, which is crucial for successful mobilization, is then assessed. Some flexion laxity seems acceptable at this stage to increase range of motion.

Plain radiographs of the mobile spacer *in situ* having utilized the cement pedestal technique are shown in Figures 5 and 6.

Results

Forty four patients underwent two-stage revision TKA between 2009 and 2015. The results are summarized in Table 1.

Fewest complications were observed in the cement pedestal group, with no spacers having subluxed or tilted in this group. The longest followup was also observed in the pedestal group. Mobile spacers with no cement pedestal displayed a higher incidence of malalignment, subluxation, tilting, and spacer fracture. This is in addition to having the

Figure 1: Cement pedestal formation

highest reinfection rate and the greatest number of cases with complications.

Ambulatory status after first-stage revision was also obtained across the three groups. These are summarized in Table 2.

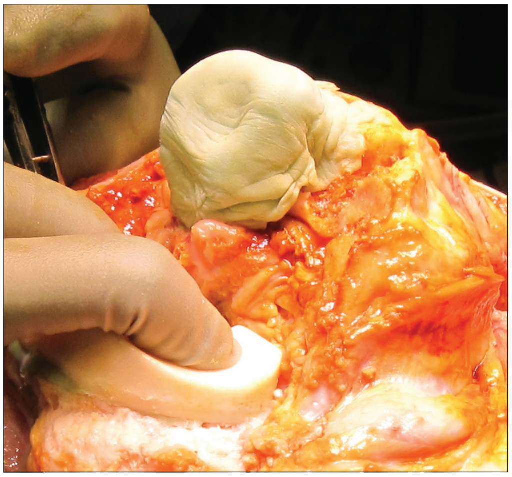

Figure 2: Cement pedestal insertion into the femur

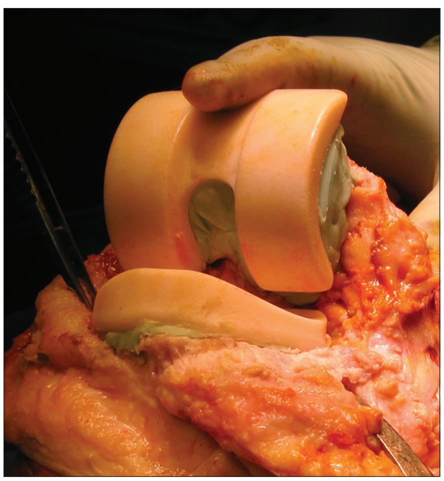

Figure 4: The femoral component is cemented into place while the epicondylar ridges are built up and the posterior flanges of the femoral component are buttressed

Discussion

This study was conducted to assess the complications encountered using the cement pedestal spacer technique in infected two-stage revision knee arthroplasty compared to conventional fixed and mobile cement spacers. We have

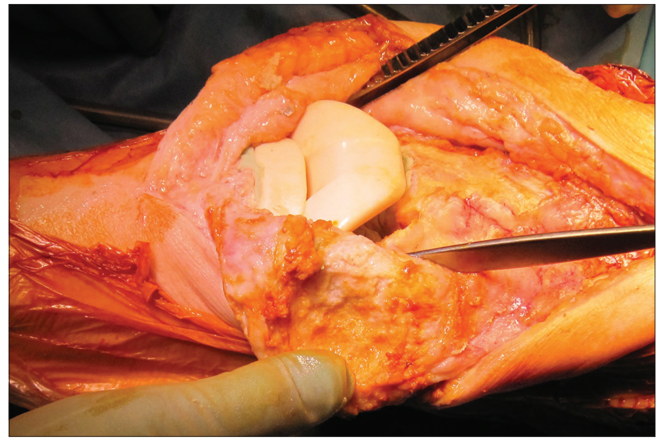

Figure 3: Adjustments to length, anteroposterior position, and rotation can be made late in the first cement mix

Figure 5: Anteroposterior plain radiograph of a mobile cement spacer *in situ* having used the cement pedestal technique

Table 1: Complications seen across the three groups

	Fixed spacer (*n*=17)	Mobile spacer nonpedestal (*n*=13)	Mobile spacer with pedestal (*n*=14)
Male:female	11:6	6:7	6:8
Mean age (years)	81.3	69.1	73.4
Mean followup (months)	46.0	32.9	52.5
Mean gap size (mm)	58 (40-95)	44 (20-65)	49 (35-70)
Malalignment (>10° varus/valgus)	3	6	2
Subluxation (>5 mm)	1	4	0
Tilting (loss of spacer fixation)	3	5	0
Fracture of spacer	1	2	0
Mean interval first to second stage revision (days)	275	291	233
Repeat first stage	2	2	1
Reinfection rate (%)	5.9	16.7	7.7
Total cases with complications (%)	6 (35)	10 (77)	2 (14)

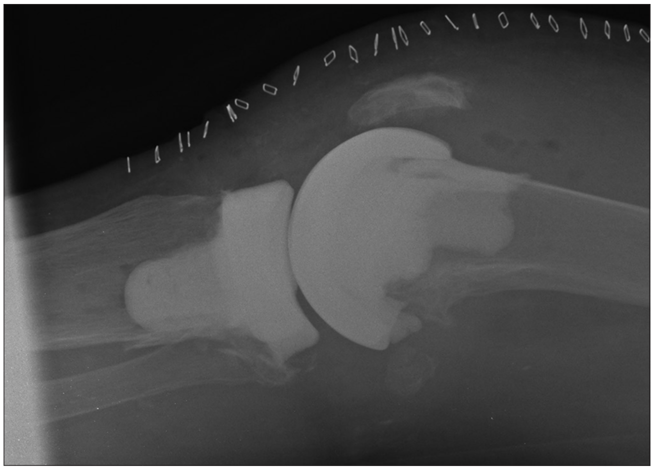

Figure 6: Lateral plain radiograph of a mobile cement spacer *in situ* having used the cement pedestal technique

Table 2: Ambulatory status across the three groups after first-stage revision

	Fixed spacer (*n*=17)	Mobile spacer nonpedestal (*n*=13)	Mobile spacer with pedestal (*n*=14)
Number of patients ambulatory	15	11	14

found that the cement pedestal group was associated with far fewer complications compared with that of the fixed and mobile spacer nonpedestal groups, by optimizing component positioning and balancing. All patients in the cement pedestal group were ambulatory after first-stage revision surgery, supporting the fact that range of motion can be preserved while utilizing the cement spacer technique.

Management of an infected TKA remains one of the major challenges faced by a knee surgeon. Several options, including single-stage revision and chronic antibiotic suppression, exist to manage this particular severe clinical problem. However, two-stage revision is still considered to be the best way forward to monitor for recurrent infection and reduce the need for rerevision of fully cemented components while preserving knee function.[2] The results of our series not only confirm this but also seem to safely extend the indication for an articulated spacer into a set of cases with more extensive bone loss which previously would have required a fixed spacer, as evidenced by the increased gap sizes in the first stage of revision observed in the cement pedestal group.

To only use a fixed spacer is still somewhat controversial, but some surgeons believe that the stabilized and nonmobile nature of the spacer provides a better environment for the eradication of infection.[6] The main disadvantage of fixed spacers is, however, joint stiffness and poor range of motion after the second stage of the revision. Instability and wound healing problems have also been associated with fixed spacers although to a lesser extent compared to mobile spacers. In addition, some authors state that static spacers may not restore the normal anatomic joint contours, particularly in heavier patients, thus leading to significant bone loss associated with a higher risk of spacer displacement.[7]

Static spacers do, however, seem to have a role in patients with severe ligamentous instability, highly compromised extensor mechanisms, and massive bone loss after the infected prosthesis has been removed. They may also have a role to play when inadequate soft-tissue cover necessitates plastic surgical intervention.[8] Johnson *et al*.[9] discovered comparable reinfection rates among 115 total knee arthroplasties (34 articulating spacers and 81 static spacers). Six patients in the dynamic spacer cohort (17%) and 14 patients in the static spacer cohort (17%) became reinfected and underwent further debridement. Four complications were found in the dynamic spacer group (2 fractures, 1 subluxation, and 1 dislocation). However, the authors state these could all be explained by surgical technical errors or patient weight-bearing compliance.

As opposed to static spacers, some authors believe that articulating mobile spacers provide satisfactory infection control while also improving function and range of motion.[10,11] This motion can maintain adequate length and preserve the extensor mechanism while preventing scar tissue formation around the knee joint, which contributes to quadricep shortening, capsular thickening, and contracture. Such motion seems to explain easier reimplantation noted during revision surgery following the use of such a technique.[12]

Van Thiel *et al*.[5] reviewed 60 patients with infected TKA using a cement-on-cement articulating antibiotic spacer fashioned intraoperatively from prefabricated silicone molds. After mean followup of 35 months, reinfection rate was 12% (7 patients). Mean duration between first- and second-stage revision surgeries was 75 days (30–326 days).

No cement spacer fractures or subluxation/dislocations were observed in the 14 patients undergoing articulating spacer insertion using the cement pedestal technique in the present study.

Several spacer-related problems have also been reported by Struelens *et al*.[4] during a retrospective analysis of 154 patients who underwent a two-stage revision procedure for an infected TKA using an articulating cement spacer. The main finding of this study was the large incidence (57%) of spacer-specific problems – spacer tilting and mediolateral translation. These were found to be the most frequent problems (24% and 21% of the cases, respectively). In 3% of cases, the spacer had dislocated; in 5%, the spacer had fractured; and in 4%, knee subluxation could be noted. The second-stage surgery was performed after a mean of 55 days (31–79 days).

This study has shown the benefits of utilizing the cement pedestal technique for the first-stage revision knee arthroplasty. It is associated with fewer complications compared with both fixed and mobile nonpedestal spacers. A longer interval time between first- and second-stage revision surgeries is then possible to observe for recurrent infection in the cases at increased risk of recurrent infection as noted above. In this study, longer followup times before second-stage revision facilitated extended periods of observation for those patients most at risk of recurrence. Where surgical resources are limited, then longevity of a spacer can also be most useful.

A limitation of the study, however, is that knee function scores were not obtained. Nonetheless, the parameters for success in such cases perhaps ought to be lower than after definitive first- or second-stage implantation, and indeed, overall ambulatory status was simply improved by the reduction in overall complications. Another advantage of the technique seems to be that the treating surgeon can afford to wait for any reasonable period of time to allow wounds to heal including plastic surgery procedures while waiting for inflammatory markers to settle.

Conclusions

Two-stage revision for infected TKA remains the gold standard in managing infected knee replacements. Articulating spacers have several advantages including improved range of motion and muscle strength while delivering local antibiotics. However, the high reported risk of mechanical complications including spacer breakage and subluxation puts bone stock at risk and may prompt a premature second stage.

The cement pedestal technique minimizes such complications by optimizing component positioning and balancing. The functional longevity of the spacer is increased allowing an extended monitoring time for any recurrent infection compared to the current literature. Complications, including spacer fracture or dislocation, are much reduced with this technique. In addition, the cement pedestal technique seems to safely extend the indication for an articulated spacer into a set of cases with more extensive bone loss, which previously would have required a fixed spacer.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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