Original Article

Should well-fixed uncemented femoral components be revised in infected hip arthroplasty? Report of five trial cases

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ABSTRACT

Background: Well-fixed femoral component removal remains difficult and complicated.**Methods:** We report herein the outcomes of two-stage surgery involving retention of bone-ingrown uncemented stems, aggressive soft-tissue debridement, and delayed reimplantation of an acetabular component in 5 patients for infected hip arthroplasty.**Results:** By a mean follow-up point of 4.2 years after the second-stage operation, none of the 5 patients experienced recurrence of infection, and the mean Harris hip score had improved from 63 to 86 points by the latest follow-up evaluation.**Conclusion:** Two-stage revision with retention of well-fixed uncemented stems could be an alternative treatment option in hip periprosthetic infection.

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1. Introduction

Prosthesis infection is a serious complication after total hip arthroplasty (THA). Some authors have advised removing all components to eradicate infection if it occurs more than 3 weeks after the primary THA.¹ Recently, acetabular removal equipment such as the Explant system (Zimmer, Warsaw, IN, USA) has been refined to the point that well-fixed acetabular components can be removed efficiently with minimal bone loss.^{2,3} However, femoral component removal remains difficult and complicated. An extended trochanteric osteotomy or cortical window is often required for removing a well-fixed femoral stem. This may lead to unexpected intraoperative femoral perforation or fracture, increased intraoperative blood loss, and increased duration of surgery. Furthermore, these procedures usually require extensive soft-tissue dissection, which causes devascularization in the proximal femur, which may in turn lead to formation of sequestrum, causing a recurrence of infection.

In these situations, we wondered whether patients could be treated successfully for their infections without removal of well-fixed femoral components by using aggressive debridement and an antibiotic-impregnated cemented femoral head in a two-stage procedure. It has been reported that circumferential bone

ingrowth of uncemented stems prevents polyethylene wear particles from invading the distal portion of the stem.⁴ If circumferential bone ingrowth of uncemented stems acts as a barrier against intrusion by infected joint fluid and microorganisms such as polyethylene wear particles, then infection could be treated without the removal of a well-fixed stem, and the risk of recurrent infection and implant failure would be lower. To our knowledge, there have been only 4 reports on the results of stem-retaining two-stage revision in infected THA.^{5–8} We report herein the outcome of such a procedure in 5 patients monitored for a mean of 4.2 years.

2. Patients and methods

Between January 2009 and April 2014, 9 patients underwent two-stage revision to treat infected hips after THA. Our basic process was two-stage revision: removal of implants, debridement, and insertion of antibiotic-impregnated cement spacers in the first stage, and implantation of new prostheses in the second stage.⁹ In the first stage, we removed acetabular components, heads, and cemented and cementless stems without exception. When an uncemented stem was well fixed and there was radiographic evidence of bone ingrowth, we tried removing the stem, usually by an extended trochanteric osteotomy or cortical window, even if intraoperative femoral perforations or fractures occurred as late as the end of 2008. At the beginning of 2009, we stopped revising well-fixed uncemented stems when we could

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determine that the infection had not reached the femoral side, because we recognized the potential of circumferential bone ingrowth of uncemented stems to prevent not only polyethylene wear particles but also infected joint fluid and microorganisms from invading distally.

By the time of this report, we had treated 5 patients (1 man and 4 women; 5 hips) without removal of their uncemented stems. The average age of patients at the first stage of treatment was 65.8 years (range, 54–70 years). Patients' body mass index averaged 26.5 kg/m² (range, 20.1–33.8 kg/m²). The surgical procedures performed before infection were primary THA in 3 patients and bipolar uncemented hip hemiarthroplasty in 2 patients. The mean follow-up period was 4.2 years (range, 3.5–5 years). A diagnosis of infection was made when there was drainage of pus, positive findings on cultured aspirated fluid and/or tissue, or histological evidence of infection.¹⁰ We determined the extent of the infection after assessing findings for several imaging modalities: plain radiography, computed tomography, magnetic resonance imaging, and bone scintigraphy. In cases for which we found it difficult to judge whether the infection had invaded the femoral component, we also performed fluorodeoxyglucose positron-emission tomography (FDG-PET).

The first procedure consisted of removal of the acetabular components, including the liner and head (inner and outer head in hemiarthroplasty), debridement of dead tissue, and insertion of an antibiotic-impregnated cement spacer. All operations were done using a posterolateral approach. During the procedure, several samples were sent for culturing and sensitivity tests and for histological evaluation. Osteolytic lesions, if present, were curetted. Osteolytic lesions in the proximal part of the femur were curetted radically until we confirmed an area of bone ingrowth between the proximal part of the femur and the porous area of the inserted cementless stem. We impregnated 3 types of antibiotics (vancomycin, tobramycin, and cefotaxime) in the molded cement spacer, using the methods reported by others.^{11–13} We pulverized 6 g of antibiotics (3 × 2 g) and mixed it thoroughly with 2 bags (80 g in total) of polymethylmethacrylate polymer (Simplex-P; Stryker, Kalamazoo, MI, USA). Then we added the contents of 2 ampules of liquid monomer (40 mL in total) to the mixture. During the doughy stage of polymerization, the mixture was molded into a hemispheric shape around the sterilized head. The head, constructed in the cement spacer mold (Biomet, Warsaw, IN, USA), was fitted on the neck portion of the stem. The curetted space in the proximal femur was filled with antibiotic-impregnated alpha-tricalcium phosphate cement (Biopex-R, Pentax Co, Tokyo, Japan). The cement-spacer cup was then reduced into the acetabulum. The bare area of the stem surface was covered as completely as possible with the same antibiotic-impregnated cement. A closed-suction drainage system was inserted, and it was removed 5 to 7 days after surgery, at a point when the amount of daily drainage was <50 mL.

Antibiotics for postoperative treatment were selected on the basis of the sensitivities of the organism identified in cultures. These antibiotics were administered intravenously for 4–6 weeks

after the first procedure. The interval between the 2 procedures was determined on the basis of improvement in clinical and laboratory findings related to infection, including stabilization of medical condition, appropriate response to infection treatment such as a return to near normal levels of serum C-reactive protein (CRP), reduction of serum erythrocyte sedimentation rate (ESR), and satisfactory wound status.

Trilogy cementless acetabular cups (Zimmer) and Longevity highly cross-linked polyethylene-on-metal head articulations (Zimmer) were used for second-stage reconstruction for all 5 patients. Acetabular cups were inserted after being reamed to the same size and were fixed with 2 or 3 screws.

Postoperative clinical and radiographic follow-up evaluations were performed at 2 and 6 weeks; at 3, 6, 9, and 12 months; and every 6 months thereafter. At the time of each evaluation, hematological studies were performed to check for recurrence of infection, and Harris hip scores¹⁴ were recorded. Treatment failure was defined as a recurrence of infection.

3. Results

Our study was approved by our institutional review board. None of the 5 patients had any recurrence of infection during the mean follow-up period of 4.2 years (range, 3.5–5 years) after the second-stage operation (Table 1). The mean Harris hip score had improved from 63 to 86 points (range, 78–93 points) by the latest follow-up evaluation. There were no major complications such as intraoperative fractures, dislocations, deep vein thrombosis, or pulmonary embolism. In addition, no loosening of acetabular or femoral components had occurred by the latest follow-up examination.

3.1. Selected case report

In April 2000, a 61-year-old woman underwent a bipolar uncemented hip hemiarthroplasty for femoral-neck fracture at another hospital. An AML (DePuy, Warsaw, IN, USA) stem was used in that procedure. After surgery, the patient experienced discomfort in her operated hip joint. Furthermore, her CRP-positive state had continued unabated since her operation. A prosthesis infection was diagnosed, and she was then given antibiotics. However, her symptoms did not decrease and hematological findings did not improve, so she was referred to our hospital.

Radiographs obtained at the first office visit at our institution demonstrated no obvious abnormality except for a slight joint-space narrowing between the acetabulum and the outer artificial femoral head (Fig. 1A). However, computed tomography showed osteolytic lesions in the acetabular side even though the uncemented stem was well fixed (Fig. 1B and C). Magnetic resonance imaging revealed abscess formation around the anterior aspect of the proximal femur (Fig. 1D–F). FDG-PET was performed to determine whether the infection had spread to the distal part of the stem (Fig. 1G). Hematological examination showed a mildly elevated CRP level (1.12 mg/dL) and an elevated ESR (72 mm in

Table 1
Patients' characteristics.

Patient number	Age at first-stage revision [years]	Gender	Type of prior arthroplasty	Infectious organism	Femoral implant	Interval between procedures [months]	Duration of follow-up [months]
1	61	F	HA	Coagulase-negative <i>Staphylococcus</i>	AML stem (DePuy)	2	48
2	76	F	THA	<i>Peptostreptococcus micros</i>	Omniflex stem (Stryker)	5	60
3	68	F	THA	<i>Propionibacterium acnes</i>	Anatomic stem (Zimmer)	2.5	48
4	54	M	THA	Coagulase-negative <i>Staphylococcus</i>	Super Secur-Fit HA stem (Stryker)	2.5	59
5	70	F	HA	Coagulase-negative <i>Staphylococcus</i>	Super Secur-Fit HA stem (Stryker)	2.6	42

HA, hemiarthroplasty; THA, total hip arthroplasty.

Fig. 1. Anteroposterior radiograph (a) of the right hip of a 61-year-old woman at her first office visit showing a well-fixed uncemented stem (AML). Multiplanar reconstruction of computed tomography images revealed focal osteolysis in the acetabulum and proximal femur (b); however, no radiolucent line was seen around the stem (c). Magnetic resonance images obtained 1 week after her first visit show abscess formation on the anterior aspect of the proximal femur (white arrows) (d–f). There was negative uptake of fluorodeoxyglucose (FDG) on FDG positron-emission tomography (FDG-PET) at the bone–prosthesis interface surrounding the femoral stem in contrast to increased FDG uptake around the outer head and the stem neck (g).

1 h). Finally, we diagnosed a limited infection within the intracapsular region in addition to the acetabular region and the proximal anterior thigh region and decided to perform isolated acetabular revision, retaining the well-fixed uncemented stem.

We removed the outer and inner head, performed aggressive debridement and irrigation, and installed the antibiotic-impregnated cement head on the neck portion of the stem during the first

stage (Figs. 2 and 3A). By 3 weeks after surgery, the CRP level had become negative. It remained negative for 2 months, so we then performed reimplantation, using a Trilogy cup (Fig. 3B).

At the latest follow-up evaluation, the patient's total Harris hip score was 96.5, her CRP level was <0.1 mg/dL, and her 1-hour ESR was 32 mm. In addition, plain radiographs showed that both acetabular and femoral components were well fixed (Fig. 3C).

Fig. 2. Photographs obtained during the first-stage operation. Radical curettage of the osteolytic lesion in the proximal femur was performed until we confirmed bone ingrowth between the proximal part of the femur and the porous area of the inserted uncemented stem (a). The curetted space was filled with antibiotic-impregnated alpha-tricalcium phosphate cement (Biopex-R, Pentax Co, Tokyo, Japan) (b). The head, constructed in the cement spacer mold (Biomet, Warsaw, IN, USA) was inserted into the neck portion of the stem (c).

Fig. 3. Anteroposterior radiographs obtained just after the first-stage operation (a), just after the second-stage operation (b), and at the latest follow-up evaluation, 4 years after reimplantation (c).

4. Discussion

The aim of our study was to evaluate the outcomes of two-stage reimplantation after retaining bone-ingrown uncemented stems and treatment with aggressive debridement. Specialized instrumentation has been developed to facilitate removal of a well-fixed acetabular component with minimal bone loss. However, removal of a well-fixed uncemented femoral component can result in considerable bone loss, rendering subsequent reconstruction extremely difficult.^{15–18} Although the spacer is a foreign body, is prone to dislocation, and can cause pain, a molded cement head spacer can keep the limb at its correct length and allows partial joint mobility, which is considered one of the benefits of this procedure, in addition to avoidance of secondary complications due to removal of well-fixed stems, such as intraoperative femoral perforation or fracture, increased intraoperative blood loss, increased duration of surgery, and subsequent reconstruction difficulty.

Although the number of patients in our study was small, infection healed in all patients, and our healing rate of 100% is similar to or higher than the rates reported in other series of two-stage revisions.^{11,15,19} Furthermore, our outcomes also were similar to or better than those of 4 similar studies (Table 2). Besides, the mean Harris hip score after revision for infection was reported to average 88 for one-stage revision and 76 for two-stage revision in a single prospective study.²⁰ The mean Harris hip score in our study at the latest follow-up evaluation was 86.

We suggest that for successful eradication of infection with this procedure, the essential components (1) are accurate assessment of the extent of infection through the use of effective imaging tools such as FDG-PET and (2) radical curettage of osteolytic lesions not only on the acetabular side but also on the proximal part of the femur, in addition to debridement of dead soft tissue. Zhuang et al. reported that although increased nonspecific FDG uptake around the head or neck of the prosthesis is seen even in patients who undergo hip prosthesis surgeries without any complications, surgeons should suspect an infection associated with hip arthroplasty if abnormally increased FDG uptake is seen around the prosthesis or adjacent sites.²¹ In addition, it has been reported that FDG-PET is a valid option for diagnosing hip prosthesis joint infection.^{22–24} We now use FDG-PET, according to the method of Zhuang et al., if we find it difficult to accurately determine the extent of the infection through the use of other imaging tools such as magnetic resonance imaging and bone scintigraphy.

Although one-stage revision is an attractive treatment for infected hip arthroplasty, the issue of whether to use one-stage versus two-stage revision is still controversial.^{20,25–27} If the procedure we have described here is eventually established as a standard treatment for infected hip arthroplasty with well-fixed uncemented stems, it will be through proper patient selection (e.g., patients without immunocompromise and who are infected by a low-virulence organism) and precise determination of the extent of infection.

Our study had several limitations. First, our patient cohort was small. However, there were consistent results within the cohort,

and we would expect this consistency to continue in a larger cohort. Second, our follow-up period was short. It is unknown whether the results will persist over time or whether infection will recur because the uncemented stems were retained. Studies of a large number of patients receiving this treatment and monitored for a longer period are required to determine whether this surgical approach for infected hip arthroplasty produces enduring good results. Nevertheless, our data show that two-stage reimplantation after retaining bone-ingrown uncemented stems and using aggressive debridement can be effective in eradicating infection in these difficult cases. Retention of well-fixed uncemented stems preserves proximal femoral bone stock and decreases reconstructive complexity at second-stage revision.

Conflicts of interest

Kiyokazu Fukui and Syusuke Ueda certify that they have no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article. Ayumi Kaneuji states that he has received payments from Zimmer for providing surgical education, workshops, and lectures about total hip arthroplasty. Tadami Matsumoto states that he receives royalties from Zimmer for the APS natural hip implant that he developed for use in total hip arthroplasty, and that he receives payments from Zimmer for giving lectures about total hip arthroplasty. Each author certifies that his institution approved the reporting of this case and that all investigations were conducted in conformity with ethical principles of research.

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Table 2

Outcomes of two-stage revision surgery for infected hip arthroplasty, with retention of well-fixed stems.

Study	Year	Number of hips	Mean duration of follow-up [months]	Infection eradicated [%]
Faroug et al. ⁵	2009	2	39	2 (100)
Anagnostakos et al. ⁶	2010	12	55	11 (91.6)
Lee et al. ⁷	2013	17	48	15 (88.2)
Ekpo et al. ⁸	2014	19	40	17 (89)
Current study		5	50	5 (100)

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