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The Role of Highly Selective Implant Retention in the Infected Hip Arthroplasty

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Abstract

Background There is debate around how to treat patients with periprosthetic joint infection of the hip. When there is an ingrown component on one side of the arthroplasty and a loose component on the other, treatment is typically revision of the entire construct. There is an argument to retain an ingrown implant in instances in which removal would result in severe bone damage. However, little has been reported on the likelihood of success with this approach.

Questions/purposes Among carefully selected patients presenting with an infected total hip arthroplasty (THA) who were treated with joint débridement and at least partial implant retention: (1) What proportion remained apparently free of infection at a minimum of 5 years of followup? (2) What were the Harris hip scores of patients thus treated?

Methods Between January 2000 and December 2010, a total of 293 patients were treated surgically at one hospital for a periprosthetic joint infection of the hip. Of these, 18 (2.9%) were treated with an approach that retained either the femoral component or the acetabular component (the removed component was exchanged at this same single-stage procedure). During that time, the general indications for this approach were patients who had complex THAs with ingrown femoral stems or complex acetabular components that were well fixed with no evidence of loosening on radiographs and CT. Patients had to be free from chronic debilitating diseases, had not developed a tracking sinus, and had a positive microbial growth from the hip aspirate. In 12 of these patients, the ingrown cementless femoral component was kept in situ and the femoral head and acetabular component were exchanged. In six patients, complex acetabular reconstructions including augments and/or cages were left in situ, and femoral revision with liner exchange was performed. The technique included removal of the loose component, thorough débridement, synovectomy, and extensive lavage. The ingrown component, be it femoral or acetabular, was thoroughly cleaned, lavaged, and scrubbed. Once there was a clear field, redraping was carried out and new instruments were used to reimplant the other side. In all patients, intravenous antibiotics were used postoperatively for a minimum of 5 days and oral antibiotics for a minimum of 6 weeks based on serology, wound healing, and nutritional markers. None of the patients were lost to followup. Minimum followup was 5 years; median followup was 7.1 years (range, 5–9.9 years).

Results Reinfection occurred in three patients at 3, 9, and 10 months; all were treated by two-stage revision. No reinfection was noted in the other cases. At latest followup, the mean Harris hip score was 78 (range, 46–89).

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Conclusions In some patients, staged revision of large and well-fixed components will result in bone damage and compromised function. These results suggest that partial implant retention and joint débridement may be an alternative for those patients who have complex well-fixed acetabular or femoral components, are not immunocompromised, have not developed sinus formation, and we were able to obtain a positive hip aspirate. We caution this technique should not be applied when patients have chronic illness such as diabetes or rheumatoid disease, have a negative hip aspirate for microorganisms, or show any signs of loosening on radiography, CT, or on intraoperative assessment. These results at a minimum of 5 years are reassuring in this small single-center series, but we suggest that the technique not be widely adopted until or unless larger groups of patients with longer term data have been studied.

Level of Evidence Level IV, therapeutic study.

Introduction

Periprosthetic infection occurs in 0.22% to 3% of patients who undergo arthroplasty [3, 4, 8, 9, 15, 21], and it is always devastating. Several techniques have been applied in an attempt to completely eradicate infection [14]. Two-stage revision arthroplasty remains the most commonly adopted method despite promising results from single-stage revision hip arthroplasty [2, 17, 20]. In both of these options, however, there is the potential for substantial bone loss and consequent morbidity from removal of well-fixed components. We present a new method in treating periprosthetic infection in highly selected patients, in which partial implant retention of well-fixed components was performed.

Because of the challenges associated with staged revision, a number of investigators have explored the possibility of retaining well-fixed components in the setting of two-stage treatment [6, 16, 18]. In this approach, the bearing surface is removed and replaced with a provisional bearing of antibiotic-laden PMMA, and all exposed portions of the affected implants are aggressively débrided. The most common scenario is removal of an acetabular component and retention of a long fully porous-coated or cemented femoral stem [8, 14, 16, 25]. In our cohort of patients, who were not immunocompromised, with a known microorganism from hip aspiration and where implants were well fixed, careful assessment of the fixation of the components using radiographs, CT, and intraoperative assessment for stability by a senior fellowship-trained revision arthroplasty surgeon (FSH) and a careful decision to retain that component was taken with a view to allow less bone loss and improve morbidity. To our knowledge, there have been no studies using partial component retention as part of a definitive single-stage revision for periprosthetic joint infection in patients who fulfill strict selective criteria outlined here.

We therefore sought to determine among carefully selected patients presenting with an infected THA who were treated with joint débridement and at least partial implant retention: (1) What proportion remained apparently free of infection at a minimum of 5 years of followup? (2) What were the Harris hip scores of patients thus treated?

Patients and Methods

Patients included in the study had established periprosthetic joint infection and were treated in a specialized arthroplasty center by a single revision arthroplasty surgeon (FSH) who treats 50 infections/year. Two hundred ninety-three patients were treated for periprosthetic joint infection of the hip from January 2000 to December 2010 in our unit. Of these, 18 (2.9%) patients were treated with an approach that retained either the femoral component or the acetabular component (the removed component was exchanged at this same single-stage procedure) (Tables 1, 2). In 12 of the 18 patients, the ingrown cementless femoral component was kept in situ and the femoral head and acetabular component were exchanged. In six patients, complex acetabular reconstruction including augments and/or cages was left in situ, and femoral revision with liner exchange was performed.

Selection criteria included patients who had complex THAs with ingrown femoral stems or complex acetabular components that were well fixed with no evidence of loosening on radiographs and CT. Patients had to be free from chronic debilitating diseases such as renal failure and not be immunocompromised, nor diabetic, nor receive any long-term steroids. A positive microbial growth from the hip aspirate was required, enabling selection of microorganism-sensitive antibiotics. If the patients fulfilled all these criteria, they were candidates to be included in this cohort study. The inclusion criteria depended on the nature of the fixation, history, and the difficulty that was perceived in removing an implant that was well fixed. No distinction was made among acute, chronic, or recurrent periprosthetic joint infections at the time of surgical decision-making. The decision was based primarily on the anatomic factors related to the implant and on the host and whether the host could withstand major surgery.

Once criteria for inclusion into the study were fulfilled, the decision to partially retain components was made according to strict pre- and intraoperative assessments.

Preoperative radiographs and serial radiographs were examined for any signs of loosening. CT scans were

Table 1. Demographic data of patients in the study, types of implants present, and comorbidities

Case number	Age (years)	Gender	Body mass index (kg/m^2)	Femoral component	Acetabular component	Component retained	Preoperative mean Harris hip score	Postoperative mean Harris hip score	Comorbidities
1	70	M	26	S-ROM (DePuy Synthes, Leeds, UK)	Pinnacle	F	70	86	Hip dysplasia, revision THA (aseptic loosening)
2	65	F	32	Restoration Modular + locking screws + cables (Stryker, Berkshire, UK)	Titanium shell	F	68	88	Hypercholesterolemia, periprosthetic fracture (treated with modular femur + locking plate)
3	72	M	28	Echelon (Smith & Nephew, Watford, UK)	Custom-made acetabular cage + allograft + screws	A	62	80	Duodenal ulcer, laparotomy, revision THA (aseptic loosening)
4	58	F	31	Accolade TMZF (Stryker)	Trabecular metal revision shell	A	66	78	Hypertension, mild asthma, revision THA (aseptic loosening)
5	77	M	25	Restoration modular (Stryker)	Titanium shell	F	70	88	Revision THA (aseptic loosening)
6	86	F	22	Revitan (Zimmer, Swindon, UK)	Pinnacle	F	40	46	Peptic ulcer, laparotomy, osteoarthritis, revision THA (aseptic loosening)
7	83	F	26	ZMR (Zimmer)	Trilogy	F	56	79	Revision THA (periprosthetic fracture)
8	69	M	29	ZMR (Zimmer)	Titanium-coated RM cup	F	66	86	Hypertension, irritable bowel syndrome, revision THA (aseptic loosening)
9	59	F	24	Corail revision (DePuy Synthes)	Custom-made acetabular cage + allograft + screws	A	42	52	Hip dysplasia, atrial fibrillation, depression
10	68	M	18	Reef (DePuy Synthes)	Trident	F	66	89	Revision THA (aseptic loosening)
11	67	M	23	Echelon bowed stem + plate + cables (Smith & Nephew)	Reflection	F	42	53	Periprosthetic fracture (treated with modular femur + plate + cables), gout
12	69	F	20	Custom locking stem–cannulock HA-coated ingrown (Orthodynamics, Dorset, UK)	Pinnacle	F	61	80	Spinal stenosis, spinal decompression
13	68	M	25	Solution stem long (DePuy Synthes)	Titanium shell	F	54	86	Revision THA (periprosthetic fracture)
14	63	F	29	HAC Furlong (JRI Orthopaedics, Sheffield, UK)	Trabecular augments + allograft + Reflection	A	55	79	Fibroids, hysterectomy
15	71	F	28	HAC Furlong (JRI Orthopaedics, Sheffield, UK)	Pinnacle + screws	F	63	86	Hip dysplasia, complex primary hip arthroplasty and 2 revisions
16	79	F	27	Restoration (Stryker)	Trident	F	61	89	Osteoporosis
17	75	F	30	Corail revision (DePuy Synthes)	Trabecular augments + allograft + Reflection	A	62	82	Hypertension, hypercholesterolemia, revision THA (aseptic loosening with acetabular protrusio)
18	78	F	24	Corail (DePuy Synthes)	Trabecular augments + allograft + Reflection	A	56	78	Revision THA (aseptic loosening with pelvic discontinuity)

M = male; F = female; F = femoral; A = acetabular.

Table 2. Demographic data of patients in study and treatment times of surgical procedures performed

Demographic data	Value (range)
Mean age at first-stage revision (years) (range)	71 (58-86)
Male:female (ratio)	7:11
Median time from primary procedure to partial single-stage revision (months) (range)	56 (32–145)
Median time from partial single-stage revision to latest followup (months) (range)	61 (24–97)
Mean Harris hip score (range)	78 (46–89)

carefully examined to identify any gaps in the bone-implant interface. In cases of acetabular components, complete fixation was required between the cup/cage and screws on one hand and the pelvic bone on the other. Similarly, in cases in which femoral component retention was planned, no gaps were identified in the bone-prosthesis implant. All scans were inspected in a multidisciplinary meeting in the presence of two revision arthroplasty, fellowship-trained surgeons (FSH, SO, RP), a musculoskeletal radiologist (MH-C), microbiologists (SM-J, VG), a plastic surgeon (IY), and a physiotherapist (BB).

Table 3. Infecting organisms cultured from specimens taken

Organism identified	Number of patients
Methicillin-resistant *Staphylococcus aureus*	3
Methicillin-sensitive *S aureus*	4
Coagulase-negative *Staphylococcus*	4
Pseudomonas	3
Enterobacter	2
Streptococcus	2

Surgical Technique

Intraoperative inspection of the implants and interfaces was carried out by a senior revision arthroplasty surgeon (FSH). Implant fixation was tested by attempting to move the implant in the AP and mediolateral directions and rotating it clockwise and counterclockwise. A component was removed if there were visible gaps at the bone-implant interface, wear damage on the implant, fretting corrosion around the trunnion, or movement of the prosthesis. If the implant was well fixed and showed no signs of loosening or damage, and the risks of excessive bone destruction were deemed to result in more morbidity than to retain implants, the implant was retained.

When partial revision hip arthroplasty was chosen, we performed thorough aggressive débridement and removal of any loose components. For acetabular components, the Explant Acetabular Cup Removal System (Zimmer Ltd, Swindon, UK) was used to extract the shell with specialized carbide drill bits or diamond-tipped burrs as needed to remove screws. In cases in which femoral components were removed, rongeurs were used to increase the gap between the stem and greater trochanter followed by flexible osteotomes (DePuy Synthes, Leeds, UK) to loosen the stem from endosteal bone. After component removal, we performed copious pulse lavage with 6 L normal saline and 1 L povidine-iodine. The wound was then packed with sterile swabs and the skin was closed with interrupted nylon. Occlusive dressings were applied and drapes, surgical gowns, and instruments were discarded.

Redraping and new instruments were used in the second part of the procedure. In cases of contained bone loss on the acetabular side, 4 g vancomycin powder was spread evenly in the acetabulum and a large cementless porous-coated, press-fit acetabular cup was inserted. If this was not possible, antibiotic-loaded bone graft, cages, and augments were also used. The retained femoral trunnion was covered with an adaptor sleeve and a ceramic head was used with a polyethylene liner.

Postoperatively, all patients had intravenous antibiotics administered for at least 5 days during which inflammatory and nutritional markers were closely monitored. Drains were left for 48 hours before removal. The wound was inspected on the fifth day, and if the wound had settled completely, with a downward trend of inflammatory markers, patients were switched to oral antibiotics to which the organism was sensitive for 6 weeks. In cases in which a downward trend of inflammatory markers was not seen, close observation of the wound with continuation of intravenous antibiotics according to culture sensitivities was done in addition to supplementary antibiotics sensitive to grown microorganisms, as advised by the microbiologists until inflammatory markers declined.

Hip aspiration was positive in all patients as the inclusion criteria required (Table 3); three patients had methicillin-resistant *Staphylococcus aureus*, four had methicillin-sensitive *S aureus*, four had coagulase-negative *Staphylococcus*, three *Pseudomonas*, two *Streptococcal*

species, and two *Enterobacter*. None of the patients were lost to followup. Our recurrence rate of infection was 17% (three of 18). There were four cases of mortality at 5 years, three of which were infection-free and none of which were related to periprosthetic infection.

Followup

None of the patients were lost to followup. Minimum followup was 5 years; median followup was 7.1 years (range, 5–9.9 years).

Patients were seen in the outpatient clinic at 6 weeks, 3 months, 6 months, 9 months, 12 months, 18 months, 24 months, and annually thereafter as part of a standard protocol. Patients underwent blood investigations before their appointment and results were available at the consultation. Harris hip scores were assessed at followup. All patients attended their appointments. A research nurse called all patients before their appointments and if they were not able to attend that date, another one was offered. Recurrent infection was defined as failure of inflammatory markers to settle the patients to the patient's baseline or radiographic changes suggestive of infection.

Results

Control of overt periprosthetic joint infection was equivalent with a single-stage partial revision to that of two-stage partial revision arthroplasty [6]. Of our 18 patients, three patients developed recurrent infection. These occurred at 3, 6, and 9 months after the débridement. All three received two-stage revision THA. One of these patients died 31 months after the procedure; there were three other deaths in this series (at 51, 62, and 85 months after surgery), all among patients who were apparently without recurrent infection. None of the deaths were associated with the surgical intervention.

The mean Harris hip score was fair at 78 (range, 46–89) at latest followup with a mean Harris hip score pain component of 36 (range, 10–44) with a higher score representing better pain results.

Discussion

Periprosthetic joint infection remains one of the most challenging complications facing hip arthroplasty, leaving a devastating effect on patients with variable morbidity. Two-stage revision hip arthroplasty involves considerable morbidity and time out of work. Meanwhile, single-stage revision seems an attractive option to reduce cost, morbidity, and prolonged rehabilitation requirements. While centers have tried to retain implants in periprosthetic joint infection, we were keen to explore whether single-stage partial retention of well-fixed implants would yield reasonable outcomes in selected cases. We had 15 patients who had no recurrence of infection out of 18 treated with partial retention of implants and we continue to monitor them closely.

Our study has several limitations. This study did not have a comparison or control group alongside the study group. The cases were selected if they met all inclusion criteria; not immunocompromised, no sinus track, known organism, complex implant that was well fixed with radiography, CT, and with intraoperative assessment by an experienced revision arthroplasty surgeon. Decision-making involved a multidisciplinary team to establish how to best manage each patient. Thus, the inclusion criteria for the described approach were highly selective and subjective. We also note the possibility of assessment bias. Although 15 patients have had no recurrence, they may well do so in the future and are currently under close surveillance. Because the study was carried out before creation of Musculoskeletal Infection Society criteria, and repeat aspirations were not done, some of our patients may harbor covert infection. The small number of cases in this study remains a major limitation. Even with a high volume of periprosthetic joint infection referrals to our center, we could only include 18 patients in this cohort. We were unable to stratify the data to the virulence of the infecting organism, duration of infection, and subdivision of acetabular and femoral components.

Our results cannot be directly compared with other total single-stage [5, 7, 20, 24] and two-stage revision hip arthroplasty studies for infection [1, 11, 12, 19, 22]. We have a highly selected cohort of patients who fulfill different inclusion criteria, and our study size is too small to reach definitive conclusions. A multicenter randomized controlled trial such as the INFORM trial would be of substantial benefit [23]. A recent meta-analysis from that group showed reinfection rates of 8.2% and 7.9% in single-stage and two-stage hip arthroplasty, respectively. They concluded that reinfection rates remained similar when grouped by several study and population-level characteristics [10]. A similar study is required for partial single-stage and two-stage hip arthroplasty. There is a limited scope of bacteriology; surgeon's technique and experience play a role in determining likely cases that can be included. Longer term followup is needed to evaluate the success of this treatment modality.

Several two-stage partial hip arthroplasty case series have been reported recently in the medical literature with recurrence of infection between two of 19 patients and four of 19 patients [6, 13, 16, 18]. Partial one-stage revision

arthroplasty retains bone stock, hence preventing fixation compromise. Extensive soft tissue dissection devascularizes the proximal femur, predisposing to osteomyelitis and further infection. On the other hand, any residual infected tissues left in any débridement procedure represent a catastrophe that can only lead to failure. Use of specialized acetabular removal devices allows minimal bone loss with simple acetabular components. However, complex acetabular components and femoral explant remain a challenge and can be complicated as a result of improved biologic fixation of implants and cementing techniques.

Our study shows recurrence of infection in three of 18 at a minimum of 5 years followup for a highly selected group of patients who fulfilled a strict inclusion criterion. Ekpo et al. [6] retained one component in a two-stage revision arthroplasty procedure, showing recurrence of infection in two of 19 at a minimum of 2 years followup (range, 2–11 years). Morley et al. [18] retained the original well-fixed femoral cement mantle in 15 patients with infected hip arthroplasty. Two patients had positive microbiology results at the second stage requiring 6 weeks of antibiotics. One of these two developed recurrent infection and needed further revision surgery. Their mean followup was 6.8 years. In addition, Lee et al. [11] retained well-fixed cementless femoral stems in 17 patients who underwent two-stage revision hip arthroplasty for infection. Two developed recurrent infection and needed revision procedures. Their mean followup was 4 years (range, 2–8 years).

We assessed the functional outcome in our patients. The mean Harris hip score in our study was fair at 78 (range, 46–89) at latest followup with a mean Harris hip score pain component of 36 (range, 10–44) with a higher score representing better pain results. Ekpo et al. [6] used the mean Harris hip score to assess their patients' function and was 68 (range, 31–100; best score is 100).

Our study shows that partial single-stage partial hip arthroplasty with aggressive débridement and retention of well-fixed femoral or acetabular components can be successful in treatment of highly selected periprosthetic joint infections in patients with well-fixed complex acetabular or complex modular femoral stems, who are not immunocompromised or who have chronic illnesses and who have a positive organism on hip aspiration. Devascularization of adjacent tissues, challenging prolonged fixation revision procedures, may be avoided with less extensive revision surgery, preservation of bone, and less morbidity to the patient. We believe longer followup and multicenter studies are required to validate our results before wider use.

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