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Partial Two-stage Exchange for Infected Total Hip Arthroplasty: A Preliminary Report

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Abstract

Background One common approach to the infected total hip arthroplasty (THA) calls for a staged revision, including removal of all components. However, removal of well-fixed femoral components can result in bone loss and compromised fixation; it is not known whether it is effective to leave a well-fixed femoral component in situ, remove only the acetabular component, débride thoroughly, place a spacer, and delay reimplantation.

Questions/purposes The purposes of this study were to determine (1) the frequency of infection recurrence; (2) the frequency of death; and (3) the Harris hip scores of patients treated with a "two-stage partial exchange" approach.

Methods A retrospective analysis from 2000 through January 2011 revealed 19 patients with infected THA treated with partial two-stage exchange including complete acetabular component removal, aggressive soft tissue débridement, retention of the well-fixed femoral stem, placement of an antibiotic-laden cement femoral head on the trunnion of the retained stem, postoperative course of antibiotics, and delayed reimplantation. Indications for this treatment included those patients whose femoral component was determined to be well fixed and its removal would result in significant femoral bone loss and compromise of future fixation. During the study period, this represented 7% (19 of 262) of the patients whom we treated for a chronically infected THA. Minimum followup was 2 years (mean, 4 years; range, 2–11 years). None of the 19 patients in this series were lost to followup. We defined failure as recurrence of infection in the same hip or the use of long-term suppressive antibiotics.

Results Two patients (11%), both with prior failure of two-staged treatment of infection, failed secondary to recurrence of infection at an average of 3.3 years. There were no patient deaths within 90 days. The mean Harris hip score was 68 (range, 31–100; best score is 100).

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This work was performed at Joint Implant Surgeons, Inc, New Albany, OH, USA.

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Conclusions Insofar as 89% of patients in this series were clinically free of infection at a minimum of 2 years, we believe partial two-stage exchange may represent an acceptable option for patients with infected THA when femoral component removal would result in significant bone loss and compromise of reconstruction. Further study is required on this approach.

Level of Evidence Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

Periprosthetic infection of total joint arthroplasty is a devastating complication. Deep infection of the hip has been reported to occur in approximately 0.5% to 3% of primary and 4% to 6% of revision THAs [3, 19, 59, 60, 62].

Several treatment modalities have been described for the management of the difficult problem of periprosthetic infection after THA (Tables 1, 2). The standard of care in the United States for treatment of chronic periprosthetic joint infection (PJI) of the hip is two-stage exchange arthroplasty [20, 59, 62]. This technique includes removal of all existing hardware including both the acetabular and femoral components and placement of either a static or mobile antibiotic-laden polymethylmethacrylate cement spacer. Intravenous (IV) antibiotics are administered for a minimum of 6 weeks with delayed reimplantation taking place at 6 to 12 weeks.

Removal of well-fixed components represents a significant technical challenge, especially with respect to the femoral component. Within the past several years, acetabular removal equipment has been refined to the point at which well-fixed acetabular components can be removed efficiently with minimal bone loss. However, femoral component removal remains difficult and complicated. Factors contributing to the complexity of component removal include stem length and the extent of porous coating or remaining cement. Although techniques have evolved to facilitate removal of well-fixed femoral components, in some situations, removal will sacrifice bone stock and compromise fixation of the reconstruction. In these situations, we wondered whether patients could be treated successfully for their infections without removing the well-fixed femoral components by using aggressive débridement and an antibiotic-laden acrylic cement femoral head in the acetabulum as well as a minimum of 6 weeks of IV antibiotics before reimplantation of a new acetabular component. A search of Medline, PubMed, and Medscape revealed one article on the subject of two-stage partial exchange for chronic PJI [39].

Therefore, we sought to determine (1) the frequency of infection recurrence; (2) the frequency of death; and (3) the Harris hip scores of patients treated with the two-stage partial exchange approach.

Materials and Methods

A retrospective search of our institutional database between 2000 and January 2011 revealed 262 hips that were treated for a chronic periprosthetic joint infection. Two-stage exchange was used to treat chronic infection in 243 hips. Partial two-stage exchange was used in the treatment of 19 chronically infected hips in 19 patients. Indications for using a partial two-stage exchange included those patients whose femoral component was determined to be well fixed and its removal would result in significant femoral bone loss and compromise of future fixation. A collaborative decision between the two surgeons was often made regarding these difficult cases.

Minimum followup on these 19 patients was 2 years (mean, 4 years; range, 2–11 years). No patients were lost to followup.

The criteria used for diagnosing an infection were consistent with those identified by the Musculoskeletal Infection Society, including a pathogen identified from culture from at least two separate samples or a sinus tract communicating with the prosthesis. In the absence of either of these criteria, the presence of at least four of the following criteria is required: elevated serum erythrocyte sedimentation rate (ESR) and serum C-reactive protein (CRP); elevated synovial leukocyte count; elevated synovial leukocyte percentage; one positive culture; purulence; and > 5 neutrophils per high-powered field [52].

All surgeries were performed by one of two experienced, fellowship-trained arthroplasty surgeons (AVL, KRB). All patients identified in this study had complete removal of the acetabular component and retention of the femoral component. All patients underwent aggressive débridement of the joint and mechanical cleansing with diluted povidone-iodine of exposed metal and soft tissue as part of the procedure. An antibiotic-laden acrylic cement articulating femoral head was fabricated using a pediatric ear and ulcer syringe (outer diameter: 44 mm; CR Bard, Inc, Covington, GA, USA) (Fig. 1), a bulb-type irrigation syringe (outer diameter: 52 mm; CR Bard, Inc) (Fig. 2), or, more recently, disposable cement spacer molds (StageOne Select; Biomet, Warsaw, IN, USA) (Fig. 3). High-viscosity cement, either Palacos (Zimmer, Warsaw, IN, USA) or Cobalt (Biomet), was used to fabricate the molded spacers. High-dose antibiotics as recommended by several authors, 3 to 4 g of vancomycin and 3.6 to 4.8 g of tobramycin per 40 mg bag, were added to the polymethylmethacrylate (PMMA) [22, 23, 38]. The antibiotic-laden PMMA-encapsulated unipolar femoral head was attached to the

Table 1. One-stage treatment of infected THA

Study	Year	Number of hips	Mean followup (months)	Infection eradicated
Drancourt et al. [11]	1993	10	28	10 (100%)
Raut et al. [54]	1994	57	88	49 (86%)
Raut et al. [55]	1995	183	93	154 (84%)
Raut et al. [53]	1996	15	96	14 (93%)
Mulcahy et al. [47]	1996	15	53	15 (100%)
Callaghan et al. [6]	1999	24	137	22 (92%)
Jackson and Schmalzried* [29]	2000	1299	58	1077 (83%)
García et al. [18]	2005	14	> 24	14 (100%)
Gao and Lv [17]	2008	10	19	10 (100%)
Rudelli et al. [58]	2008	32	103	30 (94%)
Winkler et al. [70]	2008	37	53	34 (92%)
Yoo et al. [72]	2009	12	86	11 (92%)
Darley et al. [9]	2011	4	24–36	4 (100%)
Engesæter et al. [12]	2011	192	> 24	170 (89%)
Klouche et al. [32]	2012	38	35	38 (100%)
Combined results		1942	60	1652 (85%)

* Meta-analysis of 12 earlier studies not included here.

trunnion of the stem and the hip was then reduced. The wound was closed in a standard fashion.

All patients were evaluated and managed perioperatively by the same medical consultants and infectious disease consultants. Organism-specific IV antibiotics were administered for a minimum of 6 weeks for those patients with positive cultures. For those who did not have positive cultures, we generally used a 6-week course of vancomycin as directed by the infectious disease consultant. CRP and ESR were closely monitored. The decision to perform reimplantation was made in collaboration with the medical consultant, the infectious disease consultant, and the orthopaedic surgeon. Criteria for reimplantation included stable medical condition, appropriate response to infection treatment (diminution of the ESR, return to near normal CRP, and satisfactory wound status). After reimplantation, patients were seen in followup at 6 weeks and annually thereafter or earlier if a problem arose. Clinical evaluation was performed by either the treating surgeon or a physician assistant under his direction and included the Harris hip score [21]. No patients were placed on long-term suppressive antibiotics.

In this case series, we defined failure as recurrence of infection in the same hip or the use of long-term suppressive antibiotics.

There were 10 male and nine female patients. Patient age averaged 62 years (range, 32–80 years). Patient body mass index averaged 30 kg/m^2 (range, 18–51 kg/m^2). Surgical procedures before infection were primary hip arthroplasty in seven patients, conversion in one, revision in eight, and reimplantation after two-stage treatment of infection in three. All patients included in this study with the exception of one had at least one medical comorbidity (Table 3). For the femoral stems left in situ with partial two-stage exchange, the design was primary in 11 and revision in eight, and the fixation was cementless in 15 and cemented in four (Table 3). Three patients had a well-functioning TKA with a long intramedullary stem in the ipsilateral femur (Fig. 4).

Profile of Identified Organisms

One or more organisms were positively identified from aspiration in 15 of 19 patients (79%). There was no organism identified in four of 19 patients (21%). Details of the diagnosis of infection in these patients are summarized (Table 4). Gram-positive *Staphylococcus* and *Streptococcus* species accounted for the majority of organisms cultured, present in 13 patients (68%), two of whom were polymicrobial. *Staphylococcus aureus* was present in four (21%), three of which were methicillin-resistant (16%). Nonspecific coagulase-negative *Staphylococcus* was cultured in two patients (11%), *Staphylococcus epidermidis* in four (21%), *Streptococcus* species in four (21%), and one (7%) each *Enterococcus*, *Yersinia enterocolitica,* and *Anaerococcus prevotii*. Organisms identified at the time of partial radical débridement in the two patients who later failed secondary to recurrence were methicillin-resistant *S aureus* and *Streptococcus* species.

This study was approved by our institutional review board. All drugs and devices used have been approved by the US Food and Drug Administration. However, the use of

Table 2. Two-stage treatment of infected THA

Study	Year	Number of hips reimplanted	Mean followup (months)	Number of infections eradicated
McDonald et al. [45]	1989	82	65	71 (87%)
Berry et al. [2]	1991	18	50	16 (89%)
Lieberman et al. [40]	1994	32	40	29 (92%)
Nestor et al. [48]	1994	34	47	28 (82%)
Lai et al. [35]	1996	39	48	34 (87%)
Tsukayama et al. [66]	1996	34	46	29 (85%)
Wang and Chen [68]	1997	22	48	20 (87%)
Younger et al. [73]	1998	56	43	52 (93%)
Fehring et al. [15]	1999	25	41	23 (88%)
Isiklar et al. [28]	1999	10	23	10 (100%)
Koo et al. [33]	2001	22	41	21 (95%)
Magnan et al. [43]	2001	8	35	8 (100%)
Jahoda et al. [30]	2003	64	71	60 (94%)
Karpas and Sponer [31]	2003	18	42	18 (100%)
Yamamoto et al. [71]	2003	15	38	15 (100%)
Evans [14]	2004	23	> 24	22 (96%)
Hsieh et al. [24]	2004	128	59	122 (95%)
Buttaro et al. [4]	2005	30	32	29 (97%)
Hofmann et al. [22]	2005	27	76	26 (96%)
Hsieh et al. [25]	2005	24	50	24 (100%)
Kraay et al. [34]	2005	33	> 24	28 (85%)
Nusem and Morgan [50]	2006	18	108	17 (94%)
Cabrita et al. [5]	2007	56	48	51 (96%)
Scharfenberger et al. [61]	2007	26	> 24	26 (100%)
Walter et al. [67]	2007	40	12	38 (95%)
Stockley et al. [63]	2008	114	74	100 (88%)
Cordero-Ampuero et al. [7]	2009	20	53	20 (100%)
Dairaku et al. [8]	2009	10	18	9 (90%)
Fink et al. [16]	2011	40	35	40 (100%)
Hsieh et al. [23]	2009	99	43	89 (90%)
Incavo et al. [27]	2009	11	NR	9 (82%)
Lim et al. [41]	2009	42	54	35 (83%)
Sanchez-Sotelo et al. [60]	2009	169	84	157 (93%)
Toulson et al. [65]	2009	84	65	80 (95%)
Whittaker et al. [69]	2009	44	49	41 (93%)
Erhart et al. [13]	2010	14	> 60	12 (86%)
Romanò et al. [57]	2010	102	48	98 (96%)
Takigami et al. [64]	2010	8	49	8 (100%)
Engesæter et al. [12]	2011	283	> 24	268 (95%)
Lee et al. [36]	2011	27	98	26 (96%)
Leung et al. [39]	2011	47	58	30 (79%)
Klouche et al. [32]	2012	46	35	45 (98%)
Neumann et al. [49]	2012	43	67	43 (98%)
Romanò et al. [56]	2012	183	60	173 (95%)
Berend et al. [1]	2013	189	53	157 (83%)
Lee et al. [37]	2013	17	48	15 (88%)
Combined results		2476	52	2272 (92%)

NR = not reported.

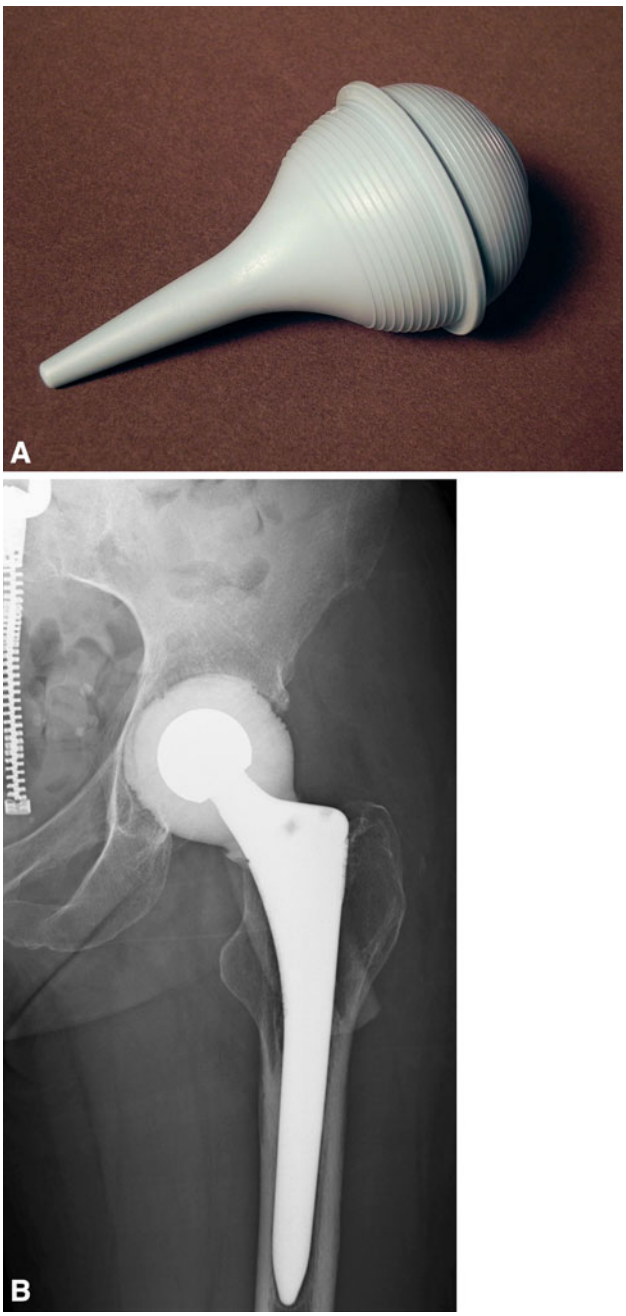

Fig. 1A–B (**A**) One method of fabricating the antibiotic-laden acrylic cement articulating spacer was to use a pediatric ear and ulcer syringe (outer diameter: 44 mm; CR Bard, Inc, Covington, GA, USA) as a mold. (**B**) Radiograph reveals an interim articulating cement spacer molded with a pediatric ear and ulcer syringe.

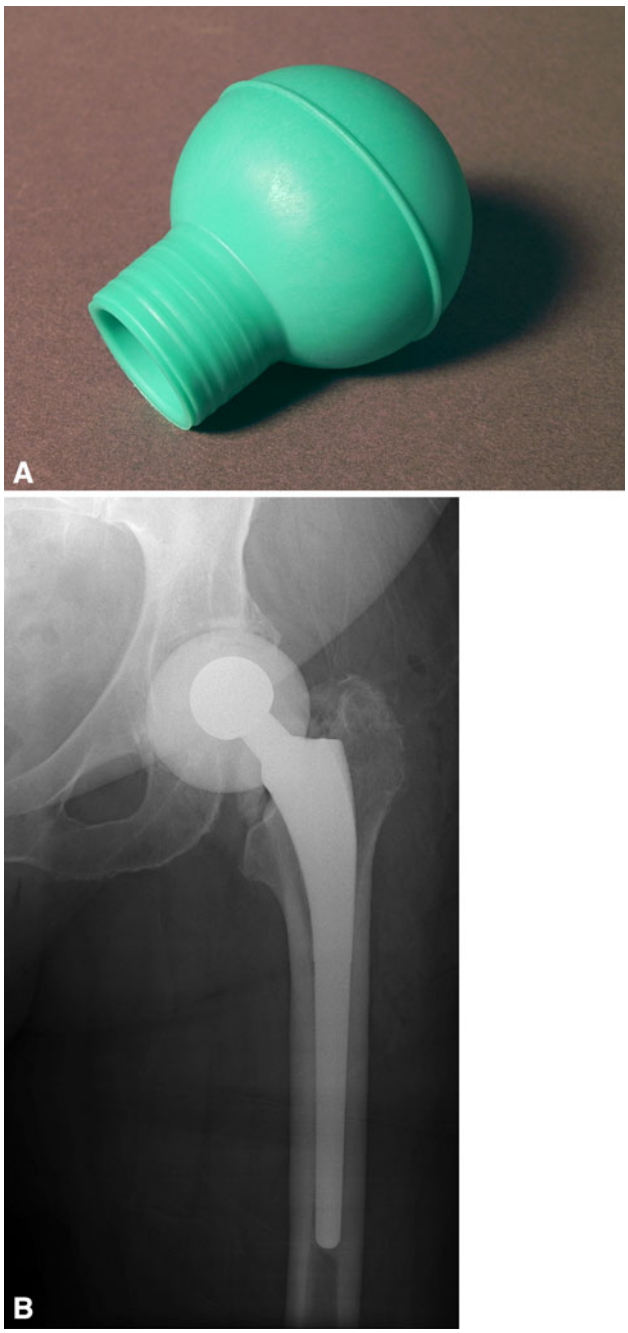

Fig. 2A–B (**A**) To fabricate a larger articulating spacer (outer diameter, 52 mm), a bulb-type irrigation syringe (CR Bard, Inc) may be used to mold the antibiotic-laden cement. (**B**) Radiograph reveals an interim articulating cement spacer molded with a bulb-type irrigation syringe.

high doses of antibiotics added to bone cement to form the femoral head is a clinician-directed application.

Results

Our recurrence rate with partial two-stage exchange after chronic PJI of the hip was 11% (two of 19). There have been two failures at an average time of 3.5 years. Both patients had failed prior two-stage exchange arthroplasty for infection before undergoing partial two-stage exchange. Failure 1, a 43-year-old male patient, had 15 prior hip procedures secondary to trauma and history of methicillin-resistant *S aureus* (MRSA) infection before partial two-stage exchange with intraoperative cultures again positive for MRSA. He required

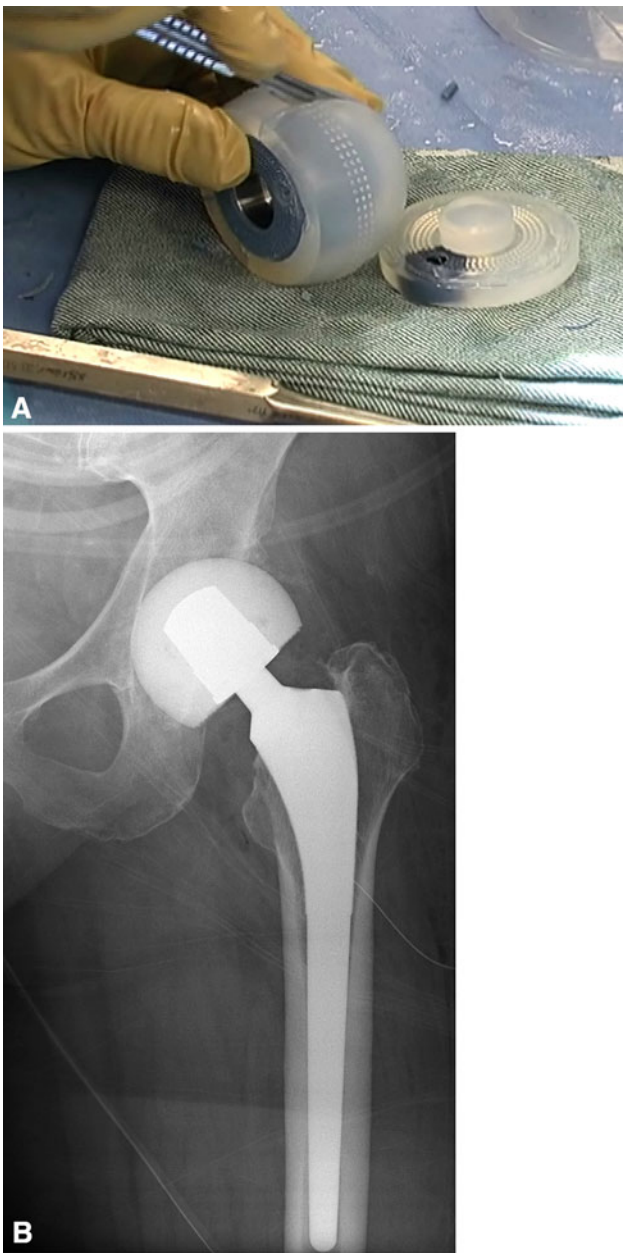

Fig. 3A–B (**A**) More recently, disposable molds adaptable for partial radical débridement (StageOne Select; Biomet, Warsaw, IN, USA) have become available to fabricate the articulating antibiotic-laden cement spacer. (**B**) Radiograph reveals an interim articulating cement spacer fabricated with a disposable mold.

incision and débridement for infection at 1.3 years after reimplantation followed by girdlestone arthroplasty at 3.7 years. He continues on suppressive antibiotics. Failure 2, a 65-year-old man with four prior hip procedures secondary to trauma and infection, had cultures positive for Gram-positive *Streptococcus* species at the time of partial radical débridement. He sustained a periprosthetic femoral fracture 1.8 years after reimplantation that was treated with open reduction and internal fixation. At 3 years postoperatively, he had recurrence of infection that required complete radical débridement and reimplantation with a total femur replacement. Currently, he is doing well without recurrence of infection. There were no additional surgical procedures performed on the remaining 17 patients after reimplantation THA.

There were three patient deaths during the study period at an average of 3.5 years postoperatively (range, 1.4–6.5 years). None occurred perioperatively or within 90 days postoperatively. No patient deaths were believed to be related to the arthroplasty or as a result of infection. The time interval between partial radical débridement and reimplantation averaged 8.4 weeks (range, 5–19 weeks).

The mean Harris hip score (HHS) was 68 (range, 31–100; 0–100 possible) at most recent followup and the mean HHS pain component was 32 (range, 10–44; 0–44 possible, higher scores indicating less pain).

Discussion

Although specialized instrumentation has been developed to facilitate removal of a well-fixed acetabular component with minimal bone loss, removal of a well-fixed cemented or cementless femoral component can result in considerable bone loss rendering subsequent reconstruction extremely difficult [10, 25, 42, 44, 73]. To our knowledge only one other study has evaluated a partial two-stage method of treatment similar to the one we investigated in the current study [38]. In this report, we observed an 11% recurrence rate, no deaths believed to be associated with treatment, and a mean HHS of 68, which is in the qualitative range of "fair."

Our study has several limitations. The first is that this study is a retrospective case series rather than a prospective, randomized comparative trial. This introduces the possibility of several kinds of bias, most notably selection bias. However, we believe that selection bias was minimal. The decision to proceed with partial radical débridement was determined by the two senior surgeons based on criteria of a well-fixed stem in which removal would compromise future fixation. These surgeons are well experienced in both primary and complex revision hip arthroplasty. Complex operative procedures are always reviewed collaboratively before surgical intervention and a treatment protocol is developed. Despite this careful consideration, other reconstructive surgeons could disagree with the difficulty of removing these femoral stems. The second shortcoming of this analysis is that the definition of well fixed and compromise of future fixation secondary to removal of the components was determined by the surgeon at the time of presentation and operative intervention. The definition used by both surgeons was cemented, grit-blasted stems without evidence of prosthetic-cement or cement-bone

Table 3. Patient comorbidities

Patient number	Age (years)	Sex	Comorbidities	Infectious organism	Femoral implant/characteristics
1	78	Female	History of myocardial infarction, coronary artery disease, hypertension, hypothyroid, glaucoma	Nonspecific coagulase-negative *Staphylococcus*	Versys (Zimmer, Warsaw, IN, USA), beaded midcoat, distal splines and flutes
2	57	Female	Hypertension, anxiety, insomnia, sleep apnea	Methicillin-resistant *Staphylococcus aureus*	Versys fiber metal taper (Zimmer), proximal fiber metal, middle grit-blasted
3	62	Female	Breast cancer, diabetes, arrhythmia, fibromyalgia, asthma, osteoporosis, hypothyroid, anxiety, depression	*Staphylococcus epidermidis, Anaerococcus prevotii*	Mallory-Head porous (Biomet, Warsaw, IN, USA), proximal plasma-sprayed, middle grit-blasted
4	69	Male	Hypertension, diabetes, hyperlipidemia, sleep apnea	Culture-negative	Mallory-Head porous, proximal plasma-sprayed, middle grit-blasted
5	61	Female	None	*S epidermidis*	Mallory-Head calcar (Biomet) revision stem, proximal plasma-sprayed
6	68	Male	History of myocardial infarction, coronary artery disease, coronary artery bypass graft, hypertension, hyperlipidemia, sleep apnea, gastroesophageal reflux disease	*Streptococcus bovis*	Mallory-Head calcar revision stem, proximal plasma-sprayed
7	75	Male	Hypertension, diabetes, chronic renal disease, sleep apnea	*S epidermidis*	Mallory-Head porous, proximal plasma-sprayed, middle grit-blasted; ipsilateral long-stem revision knee
8	78	Female	Hypertension, heart murmur, hyperlipidemia, history of acute renal insufficiency (resolved)	Culture-negative	Anatomic Medullary Locking (AML; DePuy, Warsaw, IN, USA), extensively porous coated with Porocoat®; ipsilateral long stem revision knee
9	52	Female	Hypertension, heart murmur, peptic ulcers, gastroesophageal reflux disease	Nonspecific coagulase-negative *Staphylococcus*	Mallory-Head porous, proximal plasma-sprayed, middle grit-blasted; ipsilateral long-stem revision knee
10	44	Male	Hypertension, benign breast mass, gastroesophageal reflux disease	Beta hemolytic *Streptococcus* group B, methicillin-resistant *S aureus*	Mallory-Head calcar revision stem, proximal plasma-sprayed
11	78	Female	Colon cancer, chronic anemia, chronic renal insufficiency, chronic obstructive pulmonary disorder, osteoporosis	Beta hemolytic *Streptococcus* group B	LINK (Lubinus) MP (manufactured by Waldemar Link GmbH, Hamburg, Germany, distributed by Wright Medical Technology, Arlington, TN, USA) modular reconstruction stem, porous coated with 70-μm microporous texture
12	45	Male	Anxiety, shortness of breath with mild exertion	Culture-negative	Mallory-Head modular calcar (Biomet) revision stem, proximal plasma-sprayed
13	80	Male	Hypertension, hyperlipidemia, prostate cancer, gastroesophageal reflux disease	*Yersinia enterocolitica*	Mallory-Head porous, proximal plasma-sprayed, middle grit-blasted
14	72	Male	Hypertension, gastroesophageal reflux disease, hyperlipidemia, sleep apnea, peptic ulcers	Culture-negative	Mallory-Head porous, proximal plasma-sprayed, middle grit-blasted

Table 3. continued

Patient number	Age (years)	Sex	Comorbidities	Infectious organism	Femoral implant/characteristics
15	55	Female	Hypertension, sleep apnea, rheumatoid arthritis, anemia, gastroesophageal reflux disease, remote peptic ulcer, anxiety, depression	Enterococcus	Mallory-Head porous, proximal plasma-sprayed, middle grit-blasted
16	39	Female	Rheumatoid arthritis	*S epidermidis*	Mallory-Head porous, proximal plasma-sprayed, middle grit-blasted
17	32	Male	Juvenile rheumatoid arthritis, gastroesophageal reflux disease	*S aureus*	Mallory-Head calcar revision stem, proximal plasma-sprayed
18	65	Male	Hypertension, hyperlipidemia, abdominal aortic aneurysm, peripheral vascular disease, chronic obstructive pulmonary disorder, asthma, coronary artery disease, coronary artery bypass graft, congestive heart failure, anxiety, depression, gastroesophageal reflux disease, asbestosis	Gram-positive *Streptococcus*	Medallion modular (Biomet) revision stem, proximal plasma-sprayed
19	43	Male	Chronic pain syndrome, chronic bronchitis, anxiety, gastroesophageal reflux disease	Methicillin-resistant *S aureus*	Mallory-Head calcar revision stem, proximal plasma-sprayed

Fig. 4 Three patients in our study presented with a well-functioning TKA with a long intramedullary stem ipsilateral to their infected THA, as shown in this example. In such scenarios, removal of the THA femoral component would create catastrophic bone loss.

radiolucencies or cementless, extensively porous-coated and/or grit-blasted stems with evidence of complete osseointegration. The third limitation of this study is the small sample size. This is a result of the use of strict indications to

Table 4. Diagnosis of periprosthetic joint infection in patients with negative cultures

Patient number	Age (years)	Sex	BMI (kg/m^2)	Comorbidities	Prior hip surgery	Diagnosis of periprosthetic joint infection	Outcome
4	69	Male	39	Smoker, hypertension, diabetes, hyperlipidemia, Sleep apnea	Primary metal-on-metal THA	Elevated ESR, elevated CRP, elevated synovial WBC, elevated synovial PMN%, gross purulence	Success
8	73	Female	33	Hypertension, heart murmur, hyperlipidemia, history of acute renal insufficiency (resolved)	Primary metal-on-polyethylene THA	Elevated ESR, elevated CRP, elevated synovial WBC, elevated synovial PMN%, gross purulence	Success
12	45	Male	31	Anxiety, shortness of breath with mild exertion	Second revision THA	Elevated ESR, elevated CRP, elevated synovial WBC, elevated synovial PMN%, gross purulence	Success
14	72	Male	32	History of peptic ulcers, hypertension, gastroesophageal reflux disease, hyperlipidemia, sleep apnea	Primary metal-on-metal THA	Elevated ESR, elevated CRP, elevated synovial WBC, elevated synovial PMN%, gross purulence	Success

BMI = body mass index; ESR = erythrocyte sedimentation rate; CRP = C-reactive protein; WBC = white blood cell count; PMN% = percentage of polymorphonuclear lymphocytes.

apply this technique; larger studies from other centers would be needed to confirm these results before we could recommend it for wider use. The fourth limitation is that not all patients had positive cultures. Although all patients met the criteria established by the Musculoskeletal Infection Society for a periprosthetic infection, an organism was not identified in four patients. A recent study reported that despite extensive efforts including adequate clinical, radiographic, and intraoperative suspicion for PJI, cultures often have a high false-negative rate, and culture-negative PJI is reported to occur in 7% to 9.5% of all infected arthroplasties [26]. Even if we presume that the four culture-negative patients were not truly infected and eliminate their results, our success rate is 87% versus 89% if included.

Our infection recurrence rate of 11% was comparable to that seen in other accepted techniques for the treatment of periprosthetic joint infection (Tables 1, 2). This recurrence rate compares favorably with our previously published data on two-stage exchange in which the eradication rate at 53 months was 83% [1]. Furthermore, Engesæter et al. [12] summarized the results of treatment of 784 infected THAs as reported to the Norwegian Arthroplasty Register. The reported success rate with the end point of revision for infection was 96% for those treated by two-stage exchange, 92% for one-stage whole exchange, 74% for major partial one-stage exchange, and 80% for minor partial one-stage exchange. Our results compare favorably with their two-stage and one-stage whole exchange results and have a greater success rate than major partial or minor partial one-stage exchange. In another small clinical series by Morley et al., 15 patients underwent removal of both the femoral and acetabular components for PJI with retention of the intact femoral cement mantle [46]. An antibiotic-laden cement spacer was placed within the acetabulum and antibiotic-laden cement beads were placed in the femoral canal. Patients were treated with IV antibiotics and delayed reimplantation. The authors reported success in 14 of 15 patients (93%) and concluded the technique was appropriate and efficacious. Lastly in a recently published study by Lee et al. [37], the authors looked to determine whether infection after hip arthroplasty could be treated without removal of a well-fixed stem. They treated 17 acute hematogenous and chronic hip infections with removal of the acetabular implant and retention of the stem followed by second-stage reconstruction of the acetabulum. At mean followup of 4 years (range, 2–8 years), 15 of the 17 (88%) demonstrated no recurrence of infection. Our results in treating chronic PJI with partial two-stage exchange are comparable with those using similar methods. These studies may suggest that when attempting to eradicate infection by removal of one component, a two-stage procedure is required with local delivery of antibiotics in the soft tissues secondary to the antibiotic-laden acrylic spacer. However, further studies will be required to validate this implication.

The perioperative mortality rate for patients treated with two-stage revision surgery of the hip for periprosthetic joint infection is both underreported and often overshadowed by infection control results after surgery. Few authors have reported the 90-day mortality rate in this subset of patients. Mortality associated with the two-stage treatment of periprosthetic hip infection appears to be high both in the perioperative period and also within the followup interval. Toulson et al. [65] reported a 26% rate of death before 2-year followup in their series of two-stage treatment of 132 infected THAs performed between 1989 and 2003. In a previous study from our center, we retrospectively reviewed and reported our results in 205 patients undergoing two-stage treatment of infected THA [1]. We reported a 90-day mortality rate of 4% with an overall mortality rate of 45% during the study period. In our current study, there were three patient deaths at an average of 3.5 years. None occurred perioperatively or within 90 days. Our 90-day mortality rate was 0% (zero of 19) and overall mortality rate was 16% (three of 19). This is considerably lower than in previously published studies; however, the current study has a smaller sample size.

The HHS is a useful tool for evaluation of outcomes of THA [21]. The mean HHS after revision for infection has been reported to average 88 for single-stage exchange and 76 for two-stage exchange arthroplasty in a single prospective study evaluating outcomes of revision THA for infection using a standard protocol [51]. The mean HHS in the current study after reimplantation was 68. Although this is lower than what is reported in the literature, it is slightly better than the mean HHS of 65 reported from our center for patients treated with full two-stage exchange arthroplasty [1].

Our data show that treatment of chronic PJI with partial two-stage exchange arthroplasty with radical débridement of the acetabular component and retention of the well-fixed cemented or cementless femoral component can be effective in eradication of infection with results comparable to other treatments used for these difficult cases. Retention of the femoral component preserves proximal femoral bone stock, decreases morbidity for the patient, and lessens reconstructive complexity at the time of the second-stage revision. Given our favorable results, we believe partial two-stage exchange may represent an acceptable option for patients with infected THA when femoral component removal would result in significant bone loss and compromise of reconstruction. However, further study is required on this method of treatment.

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