Outcome of One-stage Cementless Exchange for Acute Postoperative Periprosthetic Hip Infection

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Abstract

Background Acute postoperative infection after total hip arthroplasty (THA) is typically treated with irrigation and débridement and exchange of the modular femoral head and acetabular liner. Given a rate of failure exceeding 50% in some series, a one-stage exchange has been suggested as a potential alternative because it allows more thorough débridement and removal of colonized implants. To date, most studies published on the one-stage exchange have used microbe-specific antibiotic-laden bone cement with

only one small single-institution series that reported outcomes after a cementless one-stage exchange.

Questions/purposes We determined whether a one-stage cementless exchange for treating acute postoperative infection after THA would result in infection control with component retention and normalization of infection markers.

Methods We retrospectively identified 27 patients who underwent a one-stage exchange performed for an acute (≤ 6 weeks) postoperative infection after THA from April 2004 to December 2009. Primary cementless components were used both at the time of the index arthroplasty and the revision in all patients. Surgery was followed by a 6-week course of culture-specific antibiotics in all patients and a variable course of oral antibiotics. Our primary outcome was retention of the implants at most recent followup and our secondary outcome was normalization of erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) at most recent followup. Patients were followed until failure or a minimum of 2 years.

Results At a minimum followup of 27 months (mean, 50 months; range, 27–89 months), 19 of the 27 patients (70%) retained their implants but four required further operative débridement with component retention at a mean of 3 weeks (range, 2–6 weeks) to obtain control of infection. Thus, an isolated single-stage exchange was successful in 15 of the 27 patients (56%). Eight patients (30%) ultimately had a two-stage exchange for persistent infection; seven of these patients required no further surgery, whereas one patient required a second two-stage exchange. Of those patients retaining their prosthesis after one-stage exchange and tracked with ESR and CRP, four (33% [four of 12]) had elevated values without other signs or symptoms of recurrent infection.

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

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Each author certifies that his or her institution approved the human protocol for this investigation that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Conclusions For acute postoperative infection after primary THA, a one-stage cementless exchange allowed 70% of patients to retain their implants at most recent followup. Of those patients who ultimately went on to a two-stage exchange, only one required a second two-stage exchange. **Level of Evidence** Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Acute postoperative infection after THA, defined as occurring within 4 to 6 weeks after surgery, has frequently been treated with irrigation and débridement with exchange of the modular femoral head and acetabular liner [15, 28]. By decreasing the intraarticular bacterial load and exchanging the modular parts, one could potentially control the infection, retain the prior implants, and minimize morbidity to the patient. However, several publications have demonstrated a failure rate, as defined as recurrent infection, component removal, or need for additional surgery resulting from infection, of 12% to 86% in series ranging from 20 to 138 patients [1, 8, 13, 18, 20, 29]. In response to the unpredictability of this approach to control the infection, some have suggested a one-stage exchange arthroplasty as an alternative because it allows more thorough surgical débridement and removal of biofilm-colonized implants [2, 4, 16, 34].

One-stage exchange arthroplasty was originally described by Buchholz et al. [10] in the 1970s and is still widely used in several centers, particularly in Europe. The ability of the procedure to control infection is believed to rely on strict surgical indications, preoperative identification of the infecting organism, aggressive surgical débridement, and implantation of components with antibiotic-laden bone cement [11, 30, 32]. Several authors [6, 33] have proposed cementless fixation for both primary and revision THA [6, 33]. Currently, although there are some studies that support a one-stage exchange as a reasonable alternative for treating an acute postoperative infection [4, 32, 34], it is unclear whether a single-stage exchange arthroplasty for acute postoperative infection performed without antibiotic-laden bone cement will allow for component retention.

The purposes of this study were to (1) determine whether the single-stage cementless exchange THA can control acute postoperative infection as defined by retention of implants at most recent followup; (2) determine whether the single-stage cementless exchange THA can control acute postoperative infection as defined by normalization of erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) at most recent followup; (3) determine the ability to use primary type hip arthroplasty components during reconstruction; and (4) to identify potential risk factors for failure to retain implants.

Patients and Methods

We conducted a multicenter, retrospective observational study at three centers after institutional review board approval at all sites. From our prospective databases, we identified 27 patients who had undergone a planned one-stage exchange for the treatment of an acute postoperative infection in which both the index and the revision components included a cementless acetabular and femoral component. There were no cases in which initial “polyethylene liner” exchange was planned and implants were discovered to be insecure and directly exchanged. We defined acute postoperative infection as those occurring within 6 weeks of the index procedure [5]. We excluded patients treated with a hybrid cemented technique ($n = 7$) and patients whose index procedure was a revision arthroplasty ($n = 6$). The cohort included eight women (30%) and 19 men (70%) with a mean age of 58 years (range, 42–85 years) at the time of the index arthroplasty. The mean body mass index (BMI) was 28 kg/m² (range, 21–51 kg/m²), the mean American Society of Anesthesiologists (ASA) score was 2 (range, 1–2), and the mean Charlson Comorbidity Index (CCI), which is a weighted index of classifying prognostic morbidity and mortality that is based on the number and seriousness of comorbid disease, was 2 (range, 0–5) [12]. The mean time between the index primary arthroplasty and the single-stage exchange was 20 days (range, 4–41 days). The most common infecting microorganisms were Staphylococcal species with the majority being methicillin-sensitive *Staphylococcal aureus* (63%) and coagulase-negative Staphylococcus (11%), although there were 7% infections resulting from methicillin-resistant *S aureus* (MRSA) (Table 1). No patients were lost to followup. Patients were followed until failure or a minimum of 2 years. No patients were recalled specifically for this study; all data were obtained from medical records and radiographs.

The surgical indications, surgical approach, and choice of implant varied and were at the discretion of the senior surgeons (WJH, CDV, JP, FH, RB). The generally agreed-on indications for one-stage exchange were (1) healthy host; (2) absence of sinus tract; and (3) healthy soft tissue envelope. The contraindications were (1) patient with multiple comorbidities; (2) presence of sinus tract; and (3) compromised soft tissue envelope. All patients were considered to have Paprosky Type I femoral and acetabular defects [24, 25]. The surgical technique after removal of the primary implants included a complete synovectomy as well as an aggressive débridement of nonviable tissue and the prior bone-implant interfaces, including the femoral intramedullary canal. After component removal and surgical débridement, new drapes were placed, new instruments used, and the surgical team donned new gowns and gloves.

Table 1. Demographics and relevant patient-related, perioperative, and microorganism variables and clinical outcomes*

Patient number	Age (years)	Sex	Indication	BMI (kg/m ²)	Interval between Index and one-stage (days)	Infecting microorganism	Outcome	Time to further surgery	CRP (reference†)	ESR (reference†)	Infection-free followup (months)
1	67	M	DJD	36.4	19	MSSA	2-stage	10 months	8.2 (< 1.0)	99 (< 30)	N/A
2	56	F	DJD	21.8	14	MSSA	2-stage × 2	7 days, 18 months	0.9 (< 1.0)	42 (< 30)	N/A
3	68	M	DJD	31.5	18	MSSA, <i>Klebsiella pneumoniae</i>	Retention	N/A	N/A	N/A	41
4	53	M	DJD	26.6	21	MSSA	Retention	N/A	N/A	N/A	35
5	47	M	DJD	31.0	21	MSSA	Retention	N/A	0.5 (< 1.0)	58 (< 30)	51
6	76	M	DJD	27.6	14	MSSA	Retention	N/A	N/A	N/A	50
7	45	M	AVN	30.4	14	MRSA	2-stage	20 months	N/A	N/A	N/A
8	52	F	DJD	25.0	19	MSSA	Retention	N/A	< 5 (< 8)	16 (< 27)	49
9	44	M	DJD	23.0	17	MSSA	Retention	N/A	7.9 (< 8)	14 (< 17)	46
10	72	M	DJD	28.6	31	MSSA	Retention	N/A	0.7 (< 1)	32 (< 20)	30
11	57	M	AVN	23.0	26	MSSA	Retention	N/A	6.4 (< 8)	1 (< 17)	27
12	45	M	DJD	27.4	14	MSSA	I&D	2 weeks	7.3 (< 8)	8 (< 17)	52
13	56	M	DJD	29.4	26	MSSA	2-stage	5 months	< 5 (< 8)	12 (< 17)	N/A
14	39	F	DDH	20.8	41	Group A Streptococcus	I&D	1 month	< 5 (< 8)	6 (< 27)	42
15	51	M	DJD	36.5	30	MSSA	I&D	2 weeks	< 5 (< 8)	2 (< 17)	40
16	56	M	DJD	28.7	24	CNS	Retention	N/A	6 (< 5)	12 (< 30)	89
17	82	M	DJD	30.1	36	CNS	2-stage	3 months	18 (< 5)	31 (< 30)	N/A
18	48	M	AVN	25.4	12	Streptococcus	Retention	N/A	4 (< 5)	18 (< 30)	41
19	61	F	DDH	24.9	38	Group C Streptococcus	Retention	N/A	5 (< 5)	9 (< 30)	62
20	71	M	DJD	25.7	6	<i>Escherichia coli</i>	I&D	3 weeks	21 (< 5)	25 (< 30)	32
21	72	F	DJD	37.5	15	<i>E coli</i>	Retention	N/A	19 (< 5)	23 (< 30)	72
22	44	F	DDH	31.5	4	Enterococcus	Retention	N/A	2 (< 5)	15 (< 30)	69
23	74	F	DJD	28.9	5	Bacteroides	Retention	N/A	3 (< 5)	12 (< 30)	88
24	49	M	SCFE	31.7	41	CNS	2-stage	6 weeks	6 (< 5)	15 (< 30)	N/A
25	45	M	AVN	30.9	4	MSSA	Retention	N/A	6 (< 5)	20 (< 30)	36
26	85	M	DJD	26.5	33	MRSA	2-stage	4 weeks	9 (< 5)	12 (< 30)	N/A
27	42	F	DDH	24.6	9	Acetabacter	2-stage	5 weeks	9 (< 5)	35 (< 30)	N/A

* Time to latest infection-free followup or repeat surgery for recurrent infection is reported; †reference institutional serologic values; BMI = body mass index; CRP = C-reactive protein; ESR = erythrocyte sedimentation rate; M = male; F = female; DDH = degenerative joint disease; AVN = avascular necrosis; DDH = developmental dysplasia of the hip; SCFE = slipped capital femoral epiphysis; MSSA = methicillin-sensitive *Staphylococcus aureus*; CNS = coagulase-negative *Staphylococcus aureus*; MRSA = methicillin-resistant *S aureus*; I&D = irrigation and debridement; N/A = not applicable.

The postoperative course of antibiotics was decided in consultation with the institutional infectious disease specialists. All patients received a minimum of 6 weeks of culture-specific antibiotics. There was substantial variability per institution in the subsequent use of extended courses of oral antibiotics. A total of six patients from a single institution received further courses of oral antibiotics that ranged from 6 months to 1 year. Of these six patients, two had undergone subsequent irrigation and débridement after the one-stage exchange, whereas one patient had undergone a two-stage exchange arthroplasty. For the other two institutions, after the 6-week course of intravenous antibiotics, no further antibiotics were prescribed. No patient with retained components was on lifelong suppressive antibiotics.

Patients returned for routine followup at 6 weeks, 3 months, 6 months, annually, or earlier if there was concern for recurrent infection. At the time of followup, a surgeon examined the operated (infected) joint and in most visits performed serologic markers for infection, including ESR and CRP. Patients also had radiographic examinations at each visit. Of this cohort, there were four patients from a single institution who did not have complete ESR and CRP data at most recent followup.

Our primary outcome was retention of components at most recent followup. We collected data on multiple variables believed to influence the success or failure of the procedure. Patient-related variables investigated included age, sex, BMI, ASA class, and CCI. Perioperative variables analyzed included time from the index procedure and the occurrence of inpatient complications. Data regarding the infecting microorganism species and antibiotic resistance profile were also collected. Our secondary outcome was infection control as determined by normalization of ESR and CRP at most recent followup. Patients without followup ESR and CRP were excluded from this secondary analysis. There were no other missing data points.

Unadjusted statistical analysis was performed to assess the differences in clinical and surgical variables between patients who retained their implants and those who had not. Fisher's exact test was used for categorical variables; a Wilcoxon rank sum t-test with continuity correction was used for continuous variables. Statistical analyses were done with R 2.14.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Nineteen of the 27 patients (70%) retained their components at a minimum followup of 27 months (mean, 50 months; range, 27–89 months). Four of these patients (15%) underwent a single subsequent irrigation and

débridement with wound revision after the one-stage exchange but successfully retained their implants and thus an isolated single-stage exchange was successful in 15 of the 27 patients (56%) (mean, 52 months; range, 27–89 months). The mean time to irrigation and débridement was 3 weeks (range, 2–6 weeks), and the organisms isolated during the irrigation and débridement were the same bacteria isolated from the index procedure and are considered persistent infections. Eight patients were considered failures and required a two-stage exchange for persistent infection. These patients failed at a mean of 7 months (range, 1 week to 20 months). Seven of the eight patients who failed a one-stage exchange (88%) and went on to a two-stage exchange required no further surgery, whereas one patient required a second two-stage exchange.

At most recent followup, both ESR and CRP data were available for 23 of 27 (85%) patients (Table 1). The four patients who did not have most recent ESR and CRP data were from the same institution; three had retained their implant, whereas one had undergone a two-stage exchange arthroplasty. Of the cohort of 23 patients with serologic data, two patients had elevated ESR and CRP, four patients had an elevated ESR only, and five patients had an elevated CRP only. Of the group of 12 patients that had no further surgery after the single one-stage exchange arthroplasty and had postoperative serology, four (33% [four of 12]) had elevated inflammatory markers (two had elevated ESR and two had elevated CRP). Of the four patients who required irrigation and débridement after one-stage exchange arthroplasty, one had elevated ESR at most recent followup. Of the seven patients undergoing subsequent two-stage exchange arthroplasty with serology, six had elevated inflammatory markers (two patients had both elevated ESR and CRP, two had elevated ESR only, and two had elevated CRP only). The single patient who underwent repeat two-stage exchange arthroplasty had elevated ESR.

All of the revision procedures were performed using the prior surgical incision (none required an extensile approach or extended trochanteric osteotomy) and all reconstructions were performed using primary type hip arthroplasty components. On the femoral side, in 16 patients (59%), the same femoral stem design was used, but the size was increased one size in 81% (13 of 16) of these patients. Of the 11 patients (41%) who had a change in femoral stem, 10 were from the same institution and were switched from a hyaluronic acid proximally coated wedge taper type stem to a fit and fill primary type stem. The other patient was a switch from a “mini” proximally coated wedge taper stem to a standard proximally coated wedge taper stem. On the acetabular side, the hemispheric components were upsized in 96% (26 of 27) of patients (mean size 55 mm preoperatively [range, 52–60 mm] and mean size 57 mm [range,

52–62 mm] postrevision) and in 15 (56%) patients in whom no screw fixation was used in the index surgery, they had supplemental screw fixation during the revision. No intraoperative complications occurred during the single-stage revision procedures. The mean estimated blood loss was 739 mL (range, 150–1300 mL) and the mean operative time 98 minutes (range, 66–147 minutes).

With the number of patients available for study, we could not identify any major variables related to the retention or removal of the components after a single-stage procedure as defined by component retention (Table 2). However, both patients associated with MRSA eventually failed the single-stage exchange and required a subsequent two-stage exchange arthroplasty. If we had excluded these patients from the analysis, our component retention rate would have improved to 76% (19 of 25).

Discussion

The best treatment for acute postoperative infection after THA remains to be determined. Although irrigation and débridement with modular component exchange has traditionally been the preferred treatment, a relatively high failure rate has prompted some to suggest that a one-stage exchange may be a viable alternative. Potential benefits of a one-stage exchange include removal of the colonized implants and improved exposure to better access the bony surfaces for débridement. However, we are unaware of any

reports of performing a one-stage exchange in this scenario. Furthermore, control of infection using a one-stage exchange is believed in part to rely on the use of antibiotic-laden bone cement to deliver locally high levels of antibiotics. The purpose of this study was to determine whether a cementless, single-stage exchange arthroplasty could control acute postoperative infection of the hip, to assess whether primary type total hip components could be used, and to define potential variables associated with implant retention.

We recognize there are several limitations to our study. First, this was a retrospective observational investigation and patients were not randomized to débridement or a one-stage exchange making it difficult to directly compare our results with historical results from other studies. Second, as a multicenter collaboration, the variability in the surgical indications, approach, and surgical implants used by the surgeons may have influenced our results; however, this may also make our results more generalizable to general orthopaedic practice. A result of this was the variation in postoperative screening for reinfection. At a single institution, serology screening was only implemented when patients had symptoms concerning for repeat infection. This resulted in four of the patients at that institution being excluded from the secondary analysis as a result of a lack of data. Moreover, we did not collect any functional or patient-centered outcomes. Therefore, it is possible that despite avoiding further surgery and retaining the index implants, patient function and/or satisfaction was less than optimal. Finally, despite representing the cumulative experience of three high-volume arthroplasty centers, we had a limited number of patients and thus were unable to identify variables predicting the failure of this procedure to control or suppress infection.

We found an overall component retention rate of 70% (19 of 27) at a mean followup of 51 months in our series of one-stage exchanges performed with cementless primary implants when used to treat an acute postoperative infection. Although a number of publications have been described the outcomes of irrigation and débridement (I&D) with modular component exchange for periprosthetic joint infection (PJI) [1, 3, 7, 8, 13, 15, 18, 20], the majority of published research on the topic has combined cohorts of patients (eg, hip versus knee and timing of infection) [3, 18, 22, 31], thus making it difficult to tease out the differential success rates of the procedure for periprosthetic hip versus knee infection or type of infection (acute hematogenous versus chronic versus acute postoperative) (Table 3). As well, it is likely that variations of defining treatment success, in this case component retention, contribute to the variation in reported outcomes. To our knowledge, the single published series regarding I&D for PJI in a pure cohort of patients undergoing hip

Table 2. Means (and SDs) of continuous variables, number of patients (%) of categorical variables of 28 patients treated with one-stage cementless exchange arthroplasty, and their Respective p values

Variable	Success* (n = 19)	Failure† (n = 8)	p value (unadjusted)
Demographics			
Age (years)	56.6 (12.6)	60.2 (13.3)	0.69
Female sex	6 (32)	2 (25)	1
Body mass index (kg/m ²)	28.1 (4.0)	28.9 (6.0)	0.69
Degenerative joint disease as diagnosis	13 (68)	4 (50)	0.41
Perioperative variables			
Interval between index and 1-stage surgery	18.9 (11.5)	24 (11)	0.32
Inpatient complication	1 (5)	1 (12.5)	0.51
Microorganism-related variables			
Staphylococcal species	12 (63)	7 (87.5)	0.37
Polymicrobial infection	1 (5)	0 (0)	1
Methicillin-resistant <i>Staphylococcus aureus</i>	0 (0)	2 (25)	0.08

* Component retention at most recent followup; †further surgery entailing removal of implants.

Table 3. Comparative success of open irrigation and débridement for early postoperative periprosthetic hip infection versus current one-stage cementless exchange series

Study	Publication year	Total cohort	Early postoperative PJI cases	Definition of acute postoperative	One-stage cementless exchange	Organism cases (%)	Antibiotics	Success
Current study		27 THA	27	< 6 weeks	One-stage cementless exchange	Staphylococcus spp, 17 (63%); MRSA, 2 (7%)	6 weeks Cx-specific	70% component retention; 56% no further Surgery
Azzam et al. [3]	2010	104 THA/TKA	56 (41*)	< 6 weeks	I&D with component retention	Not specified	6 weeks IV abx	48% (20/41) component retention
Tsukayama et al. [29]	1996	106 THA	35	< 4 weeks	I&D with component retention	Coagulase-positive Staphylococcus, 18; CNS, 13	4 weeks IV abx	72% (26/36) component retention; 71% (25/35) no further surgery
Abolins et al. [1]	2007	20 THA/TKA	16	< 3 months	Multiple I&D with component retention (mean 2.2 procedures)	Staphylococcus spp, 100%; MRSA, 50%	Median 12 days IV abx; followed by median 12 months oral abx	88% (16/18) component retention
Crockarell et al. [13]	1998	19 THA	19	< 4 weeks	I&D with component retention	CNS, 11 (26%); polymicrobial, 13 (31%)	Mean 29 days IV abx; followed by mean 70 days oral abx	21% (4/19) component retention; 11% (2/19) suppressive abx
Koyonos et al. [18]	2011	138 THA/TKA	52	< 4 weeks	I&D with component retention	Staphylococcus spp, 42 (81%); methicillin-resistant organism, 28 (54%)	6 weeks IV abx	33% (16/52) component retention
Brandt et al. [8]	1997	33 THA/TKA	10	< 4 weeks	I&D with component retention	Staphylococcus spp, 10 (100%)	Mean 28 days IV abx	50% (5/10) component retention

* Cases in which irrigation and débridement performed within 2 weeks of symptom onset; PJI = periprosthetic joint infection; I&D = irrigation and débridement; MRSA = methicillin-resistant *Staphylococcus aureus*; CNS = coagulase-negative *Staphylococcus*; Cx = culture; IV = intravenous; abx = antibiotics.

arthroplasty reported an overall failure rate as defined as reinfection or need for lifelong suppressive antibiotics of 86% [13]. In their subanalysis of patients with acute postoperative infections of the hip, only four of 19 treated with I&D and component retention were infection free at most recent followup. The dismal ability of I&D to control acute postoperative infections has been reported in larger, mixed cohorts of acute postoperative infections of the hip and knee. Koyonos et al. [18] reported a rate of infection control of 31% (16 of 52) as defined by the absence of further surgery related to infection or need for suppressive antibiotics, whereas Azzam et al. [3] reported a 48% (20 of 58) rate of controlling infection as defined by the absence of signs and symptoms of infection in their cohort with acute postoperative infections. Furthermore, concern has been expressed that an initial I&D may compromise the ultimate ability of a subsequent two-stage exchange arthroplasty to control infection. Sherrell et al. [27] found that 28 of 83 (33%) patients who were initially treated with an I&D failed a subsequent two-stage procedure, as defined by need for further surgery related to infection, suggesting the delay in definitive treatment may have compromised the ability to control infection [27]. In contrast, of the eight patients in our series who ultimately required a two-stage exchange, no further surgery related to infection was observed in seven of eight. Our higher implant retention rate after a subsequent two-stage exchange arthroplasty may be attributable to the removal of colonized implants and a more thorough débridement of implant-bone interfaces achievable with the initial full-component single-stage exchange as compared with an I&D and bearing exchange, but other factors may also be at play.

At most recent followup, we had serologic data including ESR and CRP, which some consider a proxy for infection control, on 23 (85%) of our patients. Interestingly, a total of 11 patients in our cohort had elevated inflammatory markers. Of the group of 15 patients with followup serology that had no further surgery after the single one-stage exchange arthroplasty, four (26% [four of 15]) had elevated inflammatory markers at most recent followup but the explanatory importance of these findings relative to the arthroplasty was unclear. Whereas it may indicate persistence but subclinical PJI, it is also possible that their inflammatory markers were elevated for separate, unrelated reasons [9, 26, 35]. Although we had a minimum followup of 2 years and mean followup of 50 months, it is possible that these patients with elevated inflammatory markers will manifest signs and symptoms of recurrent infection and require subsequent surgery. Therefore, our results on component retention rates should be interpreted in this light.

With an increasing trend toward using cementless fixation for both primary and revision hip arthroplasty, we

sought to determine whether the one-stage exchange arthroplasty could be performed without antibiotic-laden bone cement. To date, only one other study has reported outcomes after cementless single-stage exchange arthroplasty for periprosthetic hip infection: in a cohort of 12 patients with chronic PJI, Yoo et al. [34] reported component retention in 10 of 12 patients at a mean followup of 7.2 years. However, they excluded all patients with PJI caused by MRSA. We had two patients with MRSA, both of whom had recurrence of infection necessitating a subsequent two-stage exchange arthroplasty. If we had excluded our patients with MRSA infections, our rate of infection control would increase from 70% (19 of 27) to 76% (19 of 25), and the findings would appear more comparable. Other authors have indicated that regardless of the treatment modality, whether I&D [3, 7] or one-stage [16] or two-stage exchange [17, 19, 21, 36], infections caused by the more virulent organisms have a higher failure rate. Although our study was underpowered to draw definitive conclusions regarding implant retention based on organism, we are also concerned whether cementless single-stage exchange arthroplasty can control MRSA infection supporting prior authors' results [3, 7, 14, 18] that these patients may best be treated with a two-stage exchange arthroplasty.

The ability of a cemented single-stage exchange arthroplasty to control infection is believed to be attributable in large part to the use of microbe-directed antibiotic-laden bone cement. Oussedik et al. reported on the only series using a hybrid cemented technique, in which the acetabular component relied on cementless fixation, whereas the femoral stem was inserted with antibiotic cement. At a mean followup of 6.8 years, the authors reported no recurrent infections and 100% component retention in 11 patients with chronic PJI [23] treated with a single-stage exchange arthroplasty in their total cohort of 50 patients with infected total hips treated with a standardized protocol. In contrast, much has been written in the literature on the outcomes of the one-stage procedure when both components are cemented. The two domestic series with the longest clinical followup (9.9 years and 9.1 years) reported success rates as defined by the absence of signs and symptoms of recurrent infection of 100% (20 of 20) and 91.7% (22 of 24), respectively [11, 30]. Although these findings suggest the ability to control infection is improved with the addition of antibiotic-laden bone cement, the series with the largest patient cohort, consisting of 583 patients published by Buchholz et al., had findings more similar to our own series. Specifically, the authors reported a success rate defined as no recurrent infection, loosening, and useful function of 77% (448 of 583) after an initial one-stage exchange arthroplasty, which improved to 88% (510 of 583) after a subsequent one-stage procedure [10].

Our data suggest one-stage cementless exchange for treating an acute postoperative infection after primary THA results in a reasonable rate of implant retention. Apart from an aggressive surgical débridement, the technical aspects of this procedure are not substantially more challenging than a primary hip arthroplasty, as noted by the absence of intraoperative complications in our series and the ability to use primary type hip components in all patients. Of those patients who ultimately require a two-stage exchange, the results are not compromised by an initial single-stage procedure and we observed “secondary” control of infection in nearly 90% of our patients. Our rate is similar to that of the only other published cementless single-stage series and equivalent or inferior that of cemented one-stage series, which suggests the local depot of supratherapeutic doses of antibiotics may add some benefit in terms of infection control. However, given the 100% failure rate of a cementless single-stage exchange arthroplasty to control MRSA infection, we echo prior authors’ concerns that these patients may best be treated with a two-stage exchange arthroplasty.

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