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Infection Control Rate of Irrigation and Débridement for Periprosthetic Joint Infection

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Abstract

Background Irrigation and débridement with retention of prosthesis is commonly performed for periprosthetic joint infection. Infection control is reportedly dependent on timing of irrigation and débridement relative to the index procedure.

Questions/purposes We therefore (1) compared the ability of irrigation and débridement to control acute postoperative, acute delayed, and chronic infections and (2) determined whether any patient-related factors influenced infection control.

Patients and Methods We retrospectively reviewed the records of 136 patients (138 joints) from two institutional databases treated with irrigation and débridement between 1996 and 2007. Mean age at time of treatment was 64 years (range, 18–89 years); 77 (56%) joints were in women. Three subgroups were extracted: acute postoperative infections, occurring within 4 weeks (52 joints), acute delayed infections occurring after 4 weeks with acute onset of symptoms (50 joints), and chronic infections (36 joints). Minimum followup was 12 months (average, 54 months; range, 12–115 months). Failure to control infection was reported as the need for any subsequent surgical intervention and/or use of long-term suppressive antibiotics.

Results Infection control was not achieved in 90 joints (65%; 82 requiring return to surgery and eight remaining on long-term suppressive antibiotics). Failure rates were 69% (36 of 52), 56% (28 of 50), and 72% (26 of 36) for acute postoperative, acute delayed, and chronic infections, respectively. Of the 10 variables considered as potential risk factors, only Staphylococcal organisms predicted failure.

Conclusions Irrigation and débridement is unlikely to control periprosthetic joint infection, including acute infections. Our data suggest surgeons should be cautious using this procedure as a routine means to address periprosthetic joint infection. For most patients, we recommend irrigation and débridement be reserved for an immunologically optimized host infected acutely with a non-Staphylococcal organism.

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

Introduction

The use of irrigation and débridement (I&D) for periprosthetic joint infection (PJI) of the hip and knee is becoming a source of controversy among orthopaedic

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surgeons [4]. This simple procedure entails reopening the joint through the original incision, removal of unhealthy tissues, thorough lavage with antibiotic-laden saline, and exchange of modular components, while retaining fixed components. This procedure continues to be performed at relatively high rates despite an inability to consistently control infection, with rates of infection control ranging from 12% to 80% [13, 21, 26]. Considering the large investment both patients and physicians make when a total joint arthroplasty (TJA) is performed, it is not surprising both continue to be in favor of a less invasive procedure to avoid the morbidity and cost associated with two-stage reimplantation [3].

The ability of I&D to control infection appears to be related to its timing relative to the index TJA [7, 15, 26]. Infections are classically categorized into one of three groups based on timing: acute postoperative, acute hematogenous, and chronic. Acute postoperative infections are generally thought to occur within 4 to 6 weeks after the index procedure, yet there is no agreement with regard to the exact cutoff. These infections are presumably due to the entry of organisms into the joint either at the time of surgery or through the incision during the postoperative period. Acute hematogenous infections are believed to occur at a later time, after the incision has healed and the joint is thought to be otherwise normal. In these cases, organisms enter the bloodstream of the host and seed the joint. Usually, the patient presents with acute onset of symptoms (ie pain, erythema, swelling, fevers) and a source may be identified (ie cellulitis, urinary tract infection, pneumonia). The term acute delayed, however, is emerging as a new category and often replaces the term acute hematogenous, as many cases deemed acute hematogenous do not actually have positive distant cultures confirming a causal relationship between source infection and PJI. Finally, chronic infections usually occur months after the index procedure and present with persistent signs and symptoms of infection, often without a definitive source.

The gold standard for treating chronic, deep infections is two-stage reimplantation since these infections are very difficult to control with I&D [5, 13, 16]. However, controversy is emerging as to whether I&D should be performed for acute postoperative and acute delayed infections, as this treatment does not appear to be effective [7, 21, 22]. Investigations have determined the variables that adversely affect the outcome of surgical treatment of PJI. For example, in 2006, Marculescu et al. [18] reported a failure rate of 54% in 99 patients who underwent I&D for PJI, with presence of a sinus tract infection and duration of symptoms for 8 days or more before débridement acting as independent risk factors for failure.

We therefore (1) compared the ability of I&D to control infection for acute postoperative, acute delayed, and chronic infections and (2) determined whether any patient-related factors influenced infection control.

Patients and Methods

We retrospectively reviewed the records of 153 patients (155 joints) from two institutional databases treated with I&D and retention of prosthesis for PJI of the knee or hip between 1996 and 2007. We diagnosed an infection based on clinical symptoms and signs (ie pain, erythema, swelling, fevers) and presence of any one of the following three parameters: (1) a positive joint aspirate culture, (2) an erythrocyte sedimentation rate (ESR) of greater than 30 mm/h and a C-reactive protein (CRP) of greater than 1.0 mg/dL [27], or (3) a joint aspirate white blood cell count of greater than 2000/μL and a neutrophil differential of greater than 70% [23]. There is currently no gold standard diagnostic criteria for diagnosing PJI and these criteria have been published by our group in the past [1]. If the patient was believed to have an acute postoperative infection, a positive fluid culture, positive tissue culture, or purulence was necessary for diagnosis of PJI. We followed patients for a minimum of 1 year, until failure or death. Seventeen patients were lost to followup, leaving 136 patients (138 joints) with a minimum followup of 12 months (average, 54 months; range, 12–115 months). The final cohort consisted of 78 knees (57%) and 60 hips (43%). The mean age of patients at the time of I&D was 64 years (range, 18–89 years); 77 joints (56%) were in female patients. No patients were recalled specifically for this study; we obtained all data from medical records or institutional database. We obtained the institutional review board approval before this study.

To provide an understanding of overall health of the patient, we utilized the Charlson comorbidity index [8]. Due to lack of pertinent medical records, the Charlson comorbidity index was available for 105 (76%) joints with a mean of 2.36 (range, 0–10). We collected patient demographics, along with data related to infection, and reported them in three subgroups based on timing of infection (Table 1).

I&D entailed reopening the joint, débridement of tissue appearing unhealthy, and irrigation with 9 L of antibiotic-laden saline. Surgeons confirmed the stability of the prostheses in all cases, placed an intra-articular drain, and closed the joint. Postoperatively, all patients were followed by an infectious disease consultant and remained on intravenous antibiotics for 6 weeks. Surgeons administered antibiotics preoperatively for cases in which an organism was already identified and waited until cultures were obtained for those not yet identified. In cases in which cultures were positive, they tailored antibiotics to best

Table 1. Patient demographics

Variable	Acute postoperative infections (n = 52 joints)	Acute delayed infections (n = 50 joints)	Chronic infections (n = 36 joints)
Age (years)*	65 (61.5–68.4)	63.5 (60.6–66.3)	63.2 (58.1–68.2)
Women	30 (57.7%)	22 (44%)	25 (69.4%)
Body mass index (kg/m^2)*	30.7 (27.8–33.6)	34.2 (30.5–37.8)	32.7 (29.1–36.2)
Hip	33 (63.5%)	16 (32%)	11 (30.6%)
Methicillin-resistant	28 (53.8%)	6 (12%)	13 (36.1%)
Culture-negative	3 (5.8%)	8 (16%)	8 (22.2%)
Staphylococcus organism	42 (80.8%)	20 (40%)	22 (61.1%)
Staphylococcus aureus	26 (61.9%)	17 (85%)	13 (59.1%)
Staphylococcus epidermis	16 (38.1%)	3 (15%)	8 (36.4%)
Staphylococcus capitis	0 (0%)	0 (0%)	1 (4.5%)
Gram-negative organism	5 (9.6%)	6 (12%)	6 (16.7%)
Charlson comorbidity index*	2.45 (1.99–2.91)	2.24 (1.65–2.83)	2.38 (1.7–3.06)

* Values are expressed as mean, with 95% confidence intervals in parentheses; the remaining values are expressed as number of joints, with percentages in parentheses.

cover the organism isolated before discharge from the hospital. Otherwise, they prescribed broad-spectrum 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. The joints were aspirated if there was a concern for infection. Patients also had radiographic examinations during each visit. We reviewed the patients' charts and relevant demographic information and collected historical and clinical data, including age, gender, knee versus hip, side, type of arthroplasty (primary versus revision), culture results, and sensitivity of isolated organisms.

To assess the outcome of treatment of I&D regarding PJI acuity, we divided the joints into three groups: (1) acute postoperative infections, defined as occurring within 28 days postoperatively (n = 52); (2) acute delayed infections, defined as occurring after postoperative day 28 with sudden onset of symptoms and/or an identifiable distant source of infection (n = 50); and (3) chronic infections, defined as occurring after postoperative day 28, insidious onset of symptoms, and no specific source (n = 36). We determined the infection control rate of I&D for each group and compared the groups to each other. We defined failure to control infection as the need for any subsequent surgeries for infection or the need for oral antibiotics to be maintained at last followup.

We used descriptive statistics to report the demographics of the study group and proportions (recurrent versus eradicated) to report the outcomes for each subgroup. We encountered missing data only in analyzing Charlson comorbidity index and body mass index (BMI). We excluded patients without values for Charlson comorbidity index from the analysis involving that independent variable. We used chi square analysis to compare these proportions. In further determining the importance of acuity and other factors in the outcome of I&D treatment for PJI, we assessed multiple factors, including acuity, type of joint, age, gender, BMI, organism variables (culture positive versus negative, Gram-positive versus Gram-negative, methicillin-resistant versus methicillin-sensitive, and Staphylococcus versus non-Staphylococcus), and host quality assessed by Charlson comorbidity index (Table 2). In assessing the potential factors in predicting outcome of I&D, we analyzed continuous variables using Student's t test and categorical variables using the chi square test. We then entered all significant ($p < 0.05$) variables into a multivariable logistic regression analysis carried out in a reverse stepwise manner. We performed statistical analysis using PASW Statistics 18.0.0 (SPSS Inc, Chicago, IL).

Results

Of the 138 joints included in this analysis, 48 (35%) were successfully managed with I&D, with success rates of 33.3% (16 of 52), 45.8% (22 of 50), and 20.8% (10 of 36) for acute postoperative, acute delayed, and chronic infections, respectively. Infection control was not achieved in 90 joints (65%; 82 requiring return to surgery and eight remaining on long-term suppressive antibiotics), with failure rates of 69% (36 of 52), 56% (28 of 50), and 72% (26 of 36) for acute postoperative, acute delayed, and chronic infections, respectively. Of the 52 joints in the acute postoperative group, 32 required reoperation for

Table 2. Results of statistical analysis of risk factors for failure

Variable	Success (n = 48 joints)	Failure (n = 90 joints)	p Value
Infection presentation			0.22
Acute postoperative	16 (33.3%)	36 (40%)	
Acute delayed	22 (45.8%)	28 (31.1%)	
Chronic	10 (20.8%)	26 (28.8%)	
Body mass index (kg/m^2)*	33.7 (30.6–36.7)	31.7 (29.3–34.1)	0.35
Age (years)*	63 (59.1–66.9)	64.5 (62–66.9)	0.53
Methicillin-resistant	12 (25%)	35 (38.9%)	0.10
Staphylococcus infection	19 (39.5%)	65 (69.2%)	< 0.001
Staphylococcus aureus	11 (57.8%)	45 (50%)	0.14
Staphylococcus epidermis	7 (36.8%)	20 (22.2%)	
Staphylococcus capitis	1 (5.2%)	0 (0%)	
Methicillin-sensitive	8 (30.7%)	29 (50%)	0.10
Gram-negative infection	9 (18.8%)	8 (8.8%)	0.09
Culture-negative	11 (22.9%)	8 (8.8%)	0.02
Hip	18 (47.5%)	42 (46.6%)	0.30
Women	27 (30%)	50 (55.6%)	0.93
Charlson comorbidity index*	2.3 (1.7–2.9)	2.4 (2–2.8)	0.71

* Values are expressed as mean, with 95% confidence intervals in parentheses; the remaining values are expressed as number of joints, with percentages in parentheses.

recurrent infection and four remained on long-term oral antibiotics at last followup, compared to 26 of the 50 joints requiring further surgery and two on long-term oral antibiotics in the acute delayed group. In the chronic infection group, 24 of the 36 joints required further surgery and two were on long-term oral antibiotics. We found no differences regarding control of infection with I&D for acute postoperative, acute delayed, or chronic infection.

Among the 10 risk factors studied, only Staphylococcal infections independently predicted failure (odds ratio = 3.96; 95% confidence interval, 1.89–8.32) (Table 2).

Discussion

I&D as a treatment modality for both acute postoperative and acute delayed PJI remains a controversial issue. When faced with an "acute" infection, most surgeons and patients prefer to perform the less invasive procedure and retain the prosthesis. Some studies report reasonable success rates, especially when performed early after the onset of symptoms [7, 15, 18, 26]. However, most reports have small numbers of patients, and few divide patients based on time of presentation and type of infection. Traditionally, I&D is thought to be the most appropriate surgical procedure for treatment of acute PJI; however, the success of this procedure has been questioned recently [4]. We therefore (1) compared the ability of I&D to control infection for acute postoperative, acute delayed, and chronic infections and (2) determined whether any patient-related factors influenced infection control.

Our study suffers from some limitations. First, although a protocol for I&D existed in both institutions, multiple surgeons performed the surgeries at two different institutions, which would introduce variability in treatment protocols. Furthermore, while we presume all surgeons considered their I&D thorough, the thoroughness with which each surgeon carried out I&D cannot be confirmed. However, since our study was carried out by multiple, experienced, fellowship-trained surgeons, our findings may be more generalizable. Second, despite detailed review of the medical charts and search for the cause and timing of PJI, recall bias may have been introduced, given the patients may have misidentified the timing of symptoms in some cases. If so, this would lead to some errors in categorizing the acuity of the infections. However, all patients were thoroughly educated on signs and symptoms concerning infection, so while recall bias may have occurred, we believe, in educating our patients, it was kept to a minimum. Third, we reported those patients on oral antibiotics at most recent followup only, and there was no universal protocol in deciding whether to place patients on oral antibiotics after completing a course of intravenous antibiotics. However, the focus of this article is not oral antibiotic use and we believe patients placed on oral antibiotics who failed would have failed anyway. Hence, while

we were unable to determine the number of patients initially placed on oral antibiotics after completing an intravenous course and while the reason for oral antibiotics varied, we believe it does not affect the message of the article. Finally, while the sample size was large compared to other studies, it is possible our study is underpowered and subject to Type II errors.

It is well established that chronic infections do not respond well to I&D, so our infection control rate of 36% in that subgroup corroborates the literature [5, 7, 12, 13, 16, 17, 20, 25, 29]. Of more relevance though is the ability of I&D to control acute infections, since this procedure continues to be used routinely. Our infection control rate with acute infections was 40%, lower than the rates in the literature. Segawa et al. [25] achieved a rate of infection control of 78% (18 of 23) for infections identified and treated within 4 weeks. Mont et al. [21] and Tsukayama et al. [29] achieved rates of infection control of 100% (10 of 10) and 68% (28 of 41), respectively, for infections occurring within 4 weeks of arthroplasty. Several studies show the success rate drops drastically when I&D is performed after 4 weeks, but the time points in these studies vary greatly, so it is not clear what the exact cutoff should be [7, 9, 13]. Our study should caution surgeons that a cutoff of 4 weeks might be too long. Our infection control rate for acute delayed infection was 48%. Most prior reports have small sample sizes [2, 7, 9–11, 14, 19, 24, 28–30]; therefore, it is difficult to reach a consensus as to the role of I&D. For example, Cook et al. [10], Grogan et al. [14], and Tsukayama et al. [29] all had six or fewer patients in their acute hematogenous cohorts and showed infection control rates of 50%, 33%, and 50%, respectively. The slightly larger cohort of Bengston et al. [2] showed an 8% (two of 25) control rate. While our infection control rate is not good per se, it does imply there may still be a role for I&D in acute delayed infections.

We identified Staphylococcal infection as an independent risk factor for failure to control infection. Only 31% (26 of 84) of patients infected with Staphylococcal species were infection-free at most recent followup. This corroborates the results of Deirmengian et al. [13], which showed a 35% (11 of 31) infection control rate for patients with acute infections (both postoperative and hematogenous) with Staphylococcal species. Similarly, Brandt et al. [6] showed a failure rate of 64% (21 of 33) when I&D and liner exchange were performed for infections with Staphylococcus aureus.

In conclusion, our data suggest chronic infections should not be treated with I&D, call into question the effectiveness and timing of I&D for acute postoperative infections, indicate there may still be a role for I&D in acute delayed infections, and bolster the claim that Staphylococcal organisms are an independent risk factor for failure of I&D. Thus, I&D should ideally be reserved for an immunologically optimized host infected with a non-Staphylococcal organism with acute onset of symptoms in a previously normal TJA.

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