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Transfer of Patient Care During Two-Stage Exchange for Periprosthetic Joint Infection Leads to Inferior Outcomes

Matthew J. Dietz, MD [a], Ho-Rim Choi, MD [b], Andrew A. Freiberg, MD [b], Hany Bedair, MD [b]

[a] Department of Orthopaedics, West Virginia University School of Medicine, Morgantown, West Virginia
[b] Department of Orthopaedic Surgery, Massachusetts General Hospital, Yawkey Center for Outpatient Care, Boston, Massachusetts

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ABSTRACT

The two-stage exchange algorithm is the gold standard for managing chronic periprosthetic joint infection (PJI); this study evaluated the impact of having the stages performed at different institutions. Patients with a chronically infected total joint arthroplasty (hip or knee) with initial resection at an outside hospital and subsequent care at our institution (transferred group) were identified then matched with a similar cohort that received both stages at our institution (continuous group). Eighteen patients (transferred group) were compared to 36 matched controls. There were significantly lower rates of successful reimplantation and retention, longer duration of treatment and more procedures in the transferred group compared to the continuous group. Patients transferred during their care for chronic PJI underwent more surgeries, longer treatment times, and less favorable outcomes.

Post-operative infections involving total hip arthroplasty (THA) and total knee arthroplasty (TKA) are devastating complications. Not only are these infections challenging for the surgeon, but there are also significantly increased healthcare costs, as well as dramatic physical and emotional burdens that the patient must endure [1–4]. Despite improvements in the operating room environment and in operative techniques [5–7], infection continues to be a major cause of failure after total hip and knee arthroplasty [2,7–10].

The current gold standard for treating chronic periprosthetic joint infections (PJI) is a two-stage approach. In this approach, all foreign materials including implants, bone cement, and necrotic tissue are removed with or without an antibiotic cement spacer at the first stage. A long course of intravenous antibiotics is then initiated with a goal of eventual joint reconstruction with new implants at the second stage [11–14]. The success rate of a two-stage revision procedure can range from 67% to 100% [14–23]. The wide range of success rates of two-stage revision may be attributable to various factors. Inferior results in more difficult cases may be due to the patient's general medical condition, antibiotic resistance of causative microorganisms, culture-negative infections, and those with increased surgical times during reimplantation [20,24–26].

However, while there are many reports regarding factors that may correlate with the success or failure of this treatment, continuity of patient care is rarely discussed. Specifically, during the course of this prolonged treatment, the patient's care may be transferred to a different institution after the first stage for further treatment or reconstruction. It is unknown what effect this disruption in patient care may have on the outcomes of the two-stage treatment algorithm for chronic PJI. The purpose of this study was to determine whether the transfer of patient care between the stages affects the outcomes of two-stage revision arthroplasty, the total number of surgeries, total treatment time, control of infection, and ultimate reconstruction with a functional joint arthroplasty.

Methods

This investigation was approved by the institutional review board. Records from 2000 to 2010 in the institutional database were reviewed to identify patients with a chronic periprosthetic joint infection who received the first stage (debridement and resection, +/− spacer) of their planned two-stage treatment at an outside hospital and subsequently had their care transferred to our institution between stages (transferred group). These patients were then matched (1:2) by the date of the first stage procedure (±2 years) to control for any variability of patient care over time. The transferred group was also matched with the joint involved to patients that received both stages of their infection treatment at our referral center (continuous group). Patients who underwent an initial irrigation and debridement at the outside institution but received their “first stage” at our center were excluded. Minimum follow-up for inclusion was 2 years.

Demographic data recorded for each group included age at the time of revision surgery, gender, laterality of the procedure, and body mass index (BMI). The presence or history of the following medical comorbidities was identified: myocardial infarction, congestive heart

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Reprint requests: Matthew J. Dietz MD, Department of Orthopaedics, West Virginia University School of Medicine, PO Box 9196, Morgantown, WV 26506-9196.

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failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, ulcer disease, liver disease, diabetes mellitus, hemiplegia, renal disease, leukemia, lymphoma, any tumor, metastatic cancer, or acquired immunodeficiency syndrome. These parameters were analyzed as part of the Charlson Comorbidity Index (CCI) [27]. In addition, the patient's American Society of Anesthesiologists (ASA) physical status classification score was recorded [28].

The identified causative microorganism(s) and their antimicrobial resistance patterns were recorded. Total treatment time (diagnosis of infection to reimplantation), total number of procedures, and reimplantation/retention of a functional joint arthroplasty were recorded for each group. Failure to control infection was defined as any patient requiring reoperation for infection purposes after the second-stage surgery at the time of the latest follow-up. The patients who did not progress to reimplantation and required fusion, amputation, or permanent resection as their definitive treatment were defined as a failure. The two groups were evaluated using chi-square tests for categorical variables. Student's *t*-tests were used to compare continuous variables. Two-tailed values of $P < 0.05$ were considered significant. Statistical analysis was performed using SAS version 9.0 (SAS Inc., Cary, NC).

Results

There were 18 patients in the transferred group (6 THA and 12 TKA) and 36 patients in the continuous group (12 THA and 24 TKA). These groups were not statistically different in terms of age, gender, BMI, ASA, CCI severity, and follow-up period. (Table 1) There was no statistical difference with regard to microorganisms' antimicrobial resistance between the two groups (Table 2). There was a statistically significant difference in the number of polybacterial infections in the transferred versus continuous groups (27% vs. 3%; $P = 0.01$). Sixty-seven percent (8/12) of the transferred patients were treated with an antibiotic spacer, 63% articulating (5/8) and 37% with a static spacer (3/8) and 33% were treated with resection arthroplasty (4/12).

The transferred group was found to have a significantly higher number of infection control surgeries after the primary arthroplasty (3.94 vs. 2.94; $P = 0.03$) (Table 3). The greatest difference existed in the number of surgeries between the first and second stages. Our results showed that the number of surgeries before the first stage did not differ between the transferred group and the continuous group (Table 3; $P = 0.46$).

The duration of treatment from the time of diagnosis of infection to the time of reimplantation was almost twice as long for the transferred group versus the continuous group at 16.6 months versus 8.4 months ($P = 0.02$) (Table 3). The time between stages was the longest for those patients who had their care transferred between institutions (14 months vs. 5 months, $P < 0.01$).

The transferred group had infection control and successful arthroplasty reimplantation with retention of components for greater than 2 years in only 44% (8/18) of cases. The continuous group had a statistically greater success rate of 78% (28/36) ($P = 0.01$). In the second-stage surgery of the transferred group, three patients underwent arthrodesis and two remained in the resection arthroplasty state. In the continuous group, one patient underwent arthrodesis.

Table 1
Comparison of Variables Between Transferred and Continuous Groups.

Variable	Transferred Group ($n = 18$)	Continuous group ($n = 36$)	*P* Value
Age, yrs	65.3 (43–88)	64.9 (39–83)	0.91
Gender			
Male	10 (56%)	17 (47%)	0.56
Female	8 (44%)	19 (53%)	
Body mass index (BMI), kg/m^2, joint	33	30.6	0.28
THA	6 (33%)	12 (33%)	
TKA	12 (66%)	24 (66%)	
ASA			
1 or 2	8 (44%)	20 (55%)	0.44
3 or 4	10 (55%)	16 (44%)	
Charlson Comorbidity Index	1.56	1.36	0.64
Follow-up (months)	57.5 (24–120)	68.8 (24–138)	0.18

Table 2
Microorganisms in Transferred and Continuous Groups.

Microorganisms	Transferred group ($n = 18$)	Continuous Group ($n = 36$)	*P* Value
Gram positive			
Staphylococcus aureus	8 (44%)	22 (61%)	0.25
MSSA	3 (17%)	11 (30%)	0.31
MRSA	1 (6%)	1 (3%)	0.60
Coagulase-negative *Staphylococcus*			
MSCNS		2 (6%)	0.29
MRCNS	2 (11%)	8 (22%)	0.33
Others			
Staphylococcus	2[a] (11%)		
Streptococcus species		4 (11%)	0.15
Enterococcus		1 (3%)	0.46
Propionibacterium acnes		2 (6%)	0.29
Actinomyces		1 (3%)	0.46
Gram negative			
Escherichia coli	1 (6%)	1 (3%)	0.60
Polybacterial	5[b] (27%)	1[c] (3%)	0.01*
Microorganism unknown	4 (22%)	4 (11%)	0.29

MSSA, methicillin-sensitive *Staphylococcus aureus*; MRSA, methicillin-resistant *Staphylococcus aureus;* MSCNS, methicillin-sensitive coagulase-negative *Staphylococcus*; MRCNS, methicillin-resistant coagulase-negative *Staphylococcus.*

[a] Unknown type.

[b] MSSA + *Candida tropicalis*, MRSA + MSCNS, MSSA + *Corynebacterium*, MSSA + MSCNS, MRCNS + *Enterococcus*.

[c] MRSA + *Streptococcus*.

* Statistically significant.

Table 3
Comparison of Outcomes Between Transferred and Continuous Groups.

Variable	Transferred Group ($n = 18$)	Continuous Group ($n = 36$)	*P* Value
Treatment results			
Success	44 (%)	78 (%)	0.01*
Failure#	56 (%)	22 (%)	
Additional procedure between stages			
Yes	10 (55%)	4 (11%)	<0.001*
No	8 (45%)	32 (89%)	
Number of surgeries			
Total number after primary	3.94 ± 1.92	2.94 ± 1.35	0.03*
Before first stage	0.28 ± 0.46	0.39 ± 0.55	.046
Between stages	1 ± 0.97	0.08 ± 0.28	<0.001*
Outside hospital	16		
Our institution	2		
After second-stage reimplantation	0.82 ± 1.24	0.47 ± 1.08	0.29
Treatment duration, months[a]			
From diagnosis of infection to reimplantation	16.6 ± 15.1	8.4 ± 9.8	0.02*
From diagnosis of infection to the latest procedure	29.5 ± 44	14.9 ± 17	0.08
Between stages	14.1 ± 13.1	5.2 ± 3.5	<0.001*

Continuous data are mean ± SD.

#Any type of additional surgery for recurrently infection was considered treatment failure.

[a] Duration from initial diagnosis of infection to second-stage reimplantation.

* Statistically significant, Pearson chi-square test.