

Outcome of Penicillin-Susceptible Streptococcal Prosthetic Joint Infection Treated with Debridement and Retention of the Prosthesis

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Debridement with retention of the prosthesis was the initial treatment modality for 19 cases of penicillin-susceptible streptococcal prosthetic joint infection that occurred in 18 patients who presented to the Mayo Clinic (Rochester, Minnesota) during 1969–1998. All of the cases of prosthetic joint infection occurred >30 days after implantation of the prosthesis, which was well fixed at the time of debridement. The median duration of symptoms before debridement was 4 days (range, 1–10 days). Treatment failure (defined as relapse of infection with the original microorganism) occurred in 2 cases (10.5%) during a median follow-up period of 3.9 years (range, 0.3–21.7 years). The 1-year cumulative risk of relapse was 11% (95% confidence interval, 0%–26%). Relapse of prosthetic joint infection due to penicillin-susceptible streptococci after debridement and retention of the prosthesis is uncommon. For patients who present with a well-fixed prosthesis and a short duration of symptoms, debridement with retention appears to be an effective treatment modality.

Prosthetic joint infection (PJI) is an infrequent complication of total joint arthroplasty, occurring in 0%–15% of cases [1]. It is a serious consequence of joint replacement that leads to pain, disability, and, rarely, loss of limb and life. The mortality rate associated with PJI is estimated to be 2.7%–18% [2–5]. Surgical treatment modalities used to treat PJI include resection arthroplasty, 1- or 2-stage reimplantation procedures, arthrodesis, amputation, and debridement with prosthesis retention. Available data suggest that removal of the prosthesis with 2-stage reimplantation

is associated with the highest likelihood of eradication of PJI and maintenance of limb function [5, 6]. However, this approach may lead to multiple surgical interventions, protracted immobility, and prolonged antibiotic exposure, with the attendant potential complications and expense [7, 8].

Debridement with retention of the prosthesis may salvage some prostheses, particularly if the infection is fulminant, if the infection occurs early after prosthesis implantation, and/or if debridement is performed within 24–36 h after onset of symptoms [1]. Overall, outcomes have been disappointing, with an increased incidence of treatment failure associated with host characteristics, the pathogen, and the medical and surgical therapies used [9, 10].

Previous studies have suggested a better outcome for penicillin-susceptible streptococcal PJI treated with debridement and antibiotic therapy when compared with PJI due to other organisms [10–12]. The small number of streptococcal PJIs reported in these articles limits

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interpretation of these results. Therefore, the aim of this study was to determine the outcome for penicillin-susceptible streptococcal PJI treated with debridement and retention of the prosthesis.

PATIENTS, MATERIALS, AND METHODS

Study design. In this retrospective cohort study, medical and surgical therapies were not standardized. Treatment decisions were made by treating physicians. All patients were observed from the date of initial debridement until loss to follow-up, death, evident treatment failure, reinfection, or prosthesis removal.

Study population. The study population consisted of patients who underwent total hip arthroplasty (THA) or total knee arthroplasty (TKA), who developed PJI with β -hemolytic streptococci or viridans group streptococci, and who underwent debridement and prosthesis retention as initial surgical treatment at the Mayo Clinic (Rochester, MN) during the period of 1969–1998. Cases were identified with use of the Mayo Clinic total joint registry [13], the Mayo Clinic master diagnostic index [14], and data from the Mayo Clinic microbiology laboratory.

Definitions. PJI due to streptococcal organisms was defined by isolation of streptococci from ≥ 2 positive results of cultures of joint aspirate or intraoperative specimens, or 1 such positive culture plus ≥ 1 of the following: (1) purulence surrounding the prosthesis at the time of surgery, (2) acute inflammation consistent with infection on histopathological examination, or (3) a cutaneous sinus tract communicating with the prosthesis. “Treatment failure” was defined as the occurrence of PJI due to the same microorganism isolated at the time of original debridement. PJI due to a microorganism other than the original streptococci that occurred after the completion of intravenously administered antimicrobial therapy was considered “reinfection.”

Risk factors for treatment failure. The following were considered to be potential risk factors for treatment failure: rheumatoid arthritis (diagnosis was based on the 1987 revised criteria for rheumatoid arthritis [15]), steroid use (≥ 20 mg of prednisone per day at the time of debridement or prednisone therapy at any dosage for >3 months in the year before the diagnosis of PJI), evidence of prosthetic loosening (defined as presence of any prosthetic radiolucencies on radiographs obtained before debridement or intraoperative evidence of a loose prosthesis at the time of debridement), duration of intravenously administered antimicrobial therapy (duration of effective antimicrobial therapy from the date of the initial debridement), type of antimicrobial therapy received (a particular antimicrobial agent was considered to be the major component of the regimen if it was used during $\geq 75\%$ of the duration of intravenously administered antimicrobial therapy),

and receipt of long-term, orally administered antimicrobial therapy (defined as orally administered antimicrobial therapy of indefinite duration after completion of intravenously administered antimicrobial therapy; patients were deemed to be receiving long-term immunosuppressive therapy if they were receiving effective oral antimicrobial antibiotics at the date of the last follow-up visit or death) [1].

Statistical analysis. The cumulative probability of treatment failure was estimated using the Kaplan-Meier survival method [16]. Data were analyzed using Fisher’s exact test [17] and the Wilcoxon rank sum test [18].

RESULTS

Study population. A total of 232 episodes of streptococcal PJI were diagnosed at our institution during the study period. Many of these episodes occurred in patients who underwent THA or TKA elsewhere. Patients in 19 episodes underwent irrigation and debridement as the initial surgical procedure.

Demographic characteristics. Thirteen TKA PJIs and 6 THA PJIs occurred in 18 patients, who were observed for a median of 3.9 years (range, 0.3–21.7 years). Eleven PJIs involved men and 8 involved women. The median age of the patients was 70 years (range, 44–86 years). Two patients had rheumatoid arthritis, 3 had malignancy, and 1 had diabetes mellitus. No patient was known to be infected with HIV or to have used steroids before presentation. The median duration of symptoms before debridement was 4 days (range, 1–10 days). Fever (defined as an oral temperature of $>38^{\circ}\text{C}$ recorded on 2 consecutive occasions) was present during 13 PJIs (68%). A potential source of the infection was postulated for 11 PJIs; these included skin infection (4 cases), upper respiratory tract infection (2 cases), urinary tract infection (1 case), mouth sores (1 case), infected groin sheath inserted during percutaneous transluminal coronary angioplasty (1 case), previous THA PJI (1 case), and prior steroid injection for pain relief (1 case). Four patients (who accounted for 21% of infections) had documented bacteremia due to the same organism that caused PJI at the time of presentation.

One of the cases of viridans group streptococcal infection met the Duke criteria [19] for possible infective endocarditis. No patient had a dental source of infection identified in the medical record as the source of PJI.

Microbiological findings. Six PJIs (31.5%) were due to group G streptococci, 7 (37%) were due to group B streptococci, 4 (21%) were due to viridans group streptococci, and 2 (10.5%) were due to group A streptococci. In vitro susceptibility data were not obtained for 2 PJIs due to group A streptococci and for 1 case each due to group B streptococci and group G streptococci. Two of the viridans group streptococci had penicillin MIC breakpoints of ≤ 8 $\mu\text{g}/\text{mL}$ and 1 $\mu\text{g}/\text{mL}$, which, at

Table 1. Details of cases of penicillin-susceptible streptococcal prosthetic joint infection treated with debridement and retention of the prosthesis.

Episode	Patient age, years	Joint involved	Prosthesis age, days	Duration of symptoms, days ^a	Infecting <i>Streptococcus</i> group	Purulence ^b	Surgery type	Intravenous antibiotic therapy (duration, days)	Long-term OAS therapy ^c	Duration of follow-up, days	Treatment failure
1	79	Knee	1460	2	Viridans	Yes	Open	Ceftriaxone (37)	Pen VK	1100	No
2	78	Knee	372	1	G	Yes	Open	Ampicillin (27)	None	3283	No
3 ^d	77	Knee	721	3	B	No	Arthroscopic	Pen G (31)	Pen VK	3090	No
4	72	Knee	4788	4	A	Yes	Arthroscopic	Pen G (16)	None	1384	No
5	72	Knee	4648	10	A	Yes	Arthroscopic	Pen G (16)	None	1547	No
6 ^{d,e}	86	Knee	482	5	Viridans	No	Open	Cefazolin (30)	None	2597	No
7	66	Knee	52	1	G	Yes	Open	Pen G (28)	None	4015	No
8	66	Knee	275	6	B	Yes	Open	Cefazolin (28)	Cephalexin	672	No
9	60	Knee	554	2	G	Yes	Open	Ceftriaxone (30)	Amoxicillin	1337	No
10 ^d	80	Knee	4153	9	Viridans	No	Open	Ceftriaxone (27)	None	1795	No
11	69	Hip	581	2	B	Yes	Open	Pen G (32)	None	204	Yes
12	63	Hip	2190	4	B	Yes	Open	Pen G (26)	Pen VK	1159	No
13	77	Hip	229	2	G	Yes	Open	Cefazolin (33)	None	429	No
14 ^e	70	Knee	439	2	B	No	Open	Ceftriaxone (30)	Cephalexin	1441	No
15	44	Hip	162	10	G	Yes	Open	Pen G (28)	None	7952	No
16	69	Hip	198	5	B	Yes	Open	Cefazolin (14)	None	113	Yes
17	82	Hip	1353	10	B	Yes	Open	Cefazolin (30)	Cephalexin	923	No
18	70	Knee	847	9	Viridans	Yes	Open	Ceftriaxone (28)	Cephalexin	1854	No
19	70	Knee	431	1	G	Yes	Open	Pen G (31)	None	3448	No

NOTE. OAS, oral antimicrobial suppressive; Pen G, penicillin G; Pen VK, penicillin VK.

^a The timing of surgery corresponds to the duration of symptoms (e.g., patient 1 underwent an open procedure 2 days after the onset of symptoms).

^b Noted during surgery.

^c The duration of long-term OAS therapy was the same as the duration of follow-up, as defined in Patients, Materials, and Methods. Dosages are provided in Results.

^d Patient had 2 positive joint culture results.

^e Patient had acute inflammation noted on pathological examination.

the times of treatment (1991 and 1994, respectively), were deemed susceptible by our microbiology laboratory (1991) and NCCLS guidelines (1994) [20].

Surgical treatment. All prostheses were cemented. None of the prostheses were loose at the time of presentation. The median prosthesis age was 1.5 years (range, 0.15–13 years). Five patients who underwent irrigation and debridement of their infected prostheses had undergone a previous revision arthroplasty. None of the patients developed a cutaneous sinus tract due to infection. Patients underwent a median of 1 surgical debridement (range, 1–3). Three of 13 cases of TKA PJI were treated with arthroscopic debridement; the rest of the procedures were open arthrotomies. In 15 cases (78.9%), purulence was noted during surgery. For 5 prostheses (4 TKA prostheses and 1 THA prosthesis), polyethylene liner exchange was performed in addition to debridement.

Medical treatment. The median duration of effective intravenous antimicrobial therapy was 28 days (range, 14–37 days). For 9 cases (47.3%), penicillin or ampicillin was the main antibiotic therapy; the main antibiotic therapy was ceftriaxone

for 5 cases (26.3%) and cefazolin for 5 cases (26.3%). Eight patients (42% of cases) received long-term oral antimicrobial therapy (amoxicillin [500 mg b.i.d.] in 1 case, penicillin VK [500 mg b.i.d.] in 3 cases, cephalexin [500 mg t.i.d.] in 1 case, cephalexin [500 mg b.i.d.] in 2 cases, and cephalexin [500 mg q.i.d.] in 1 case). No significant antimicrobial-associated side effects (hypersensitivity, hepatotoxicity, nephrotoxicity, ototoxicity, or *Clostridium difficile* colitis) were recorded in medical records while patients were receiving antimicrobial therapy.

Treatment outcome. For 17 cases, no relapse of PJI occurred during a median follow-up period of 3.9 years (range, 0.3–21.8 years). Two group B streptococcal THA PJIs relapsed at 3.8 and 6.8 months after debridement. Neither patient was receiving long-term antimicrobial therapy at the time of relapse (table 1). Two patients had reinfection of the prosthesis (1 each with *Staphylococcus aureus* and *Citrobacter diversus*) 3 and 4 years after undergoing initial debridement for streptococcal PJI. These reinfections did not appear to be related to the initial surgery.

Statistical analysis. In this study, the overall 1-year rate

of survival without relapse of streptococcal PJI was 89% (95% CI, 74%–100%). The overall risk of relapse at 1 year was 11% (95% CI, 0%–26%). Given the small number of relapses, it was not possible to perform multivariate analysis to ascertain risk factors for relapse occurring within 1 year after debridement. Patient sex, number of previous revision arthroplasties, prosthesis age, rheumatoid arthritis, steroid use, prosthesis loosening, presence of a sinus tract, duration of antimicrobial therapy, median time to debridement, and receipt of long-term immunosuppressive therapy were not found to be statistically significant risk factors on univariate analysis [17, 18]. The risks associated with patient age and joint location approached statistical significance ($P = .06$ and $P = .065$, respectively).

DISCUSSION

In this study, the overall 1-year rate of survival without relapse of streptococcal PJI was 89% (95% CI, 74%–100%). This result is consistent with reports from earlier investigators that, when treated with debridement and retention of the prosthesis, PJI due to streptococci has a better outcome than does PJI due to other organisms. Burger et al. [10] reported that PJI due to streptococcal organisms was more “susceptible to debridement” than was PJI due to *S. aureus* or coagulase-negative staphylococci. Schoifet and Morrey [11] reported an improved treatment success rate for irrigation and debridement with prosthesis salvage when the PJI was due to a penicillin-susceptible, gram-positive microorganism. The success rate in our study may be attributable to host and pathogen factors. In 1982, Brause [21] put forward criteria that he believed were critical to treatment success when attempting to salvage an infected prosthesis. These included infection with a relatively avirulent pathogen that is susceptible to orally absorbed antibiotics, which the patient can tolerate for life, and the presence of a well-seated prosthesis. In 1991, Burger et al. [10] suggested similar criteria and included the additional criteria of a short duration (<2 weeks) of symptoms before initial debridement and the absence of sinus tract or prolonged postoperative drainage. More recently, Tattevin et al. [22] reported that a short interval (≤ 5 days) from onset of symptoms to debridement of the infected prosthetic joint significantly correlated with a successful outcome when the prosthesis was retained. Fisman et al. [23] state that debridement and retention is a reasonable strategy for treatment of older persons with staphylococcal or streptococcal infection and a well-fixed prosthesis; again, this is in keeping with the findings of our study.

All of the prostheses in this study were well seated, and the median duration of symptoms before debridement was 4 days. On the other hand, none of the cases occurred within 30 days after prosthesis implantation, a feature previously identified as

critical to success when this treatment modality is used [4]. Given the fact that only 2 patients had treatment failure, it was not feasible to perform multivariate analysis to identify factors predictive of relapse. The risks associated with patient age (<70 years) and joint location approached statistical significance on univariate analysis. The occurrence of relapse of infection in cases of THA PJI may reflect the technical difficulty of thoroughly debriding hip prostheses, compared with knee prostheses. The increased risk for patients aged <70 years probably reflects joint location; we do not believe it is, of itself, an independent prognostic factor. We cannot explain why the only relapses occurred in joints infected with group B streptococci.

The available data from retrospective studies of either THA or TKA PJIs suggest that removal of the prosthesis with delayed reimplantation offers the highest likelihood of infection eradication; reported treatment success rates are 85%–100% [4, 9, 24]. A previous review at this institution of *S. aureus* PJI treated with debridement and retention of the prosthesis demonstrated a 2-year probability of treatment failure of 69% [25]. In that study, multivariate analysis demonstrated that symptom duration was an independent predictor of outcome; patients who had symptoms for <2 days were less likely to have relapse of infection. A randomized, placebo-controlled, double-blinded trial that evaluated the role of rifampin in orthopedic implant-related infection also noted that a short duration (4–5 days) of symptoms was critical to the success of salvage treatment [26].

Long-term receipt of orally administered antimicrobial therapy did not appear to affect outcomes in our study, a factor also noted for PJI due to *S. aureus* [25]. This may reflect the short duration of symptoms before debridement and the prolonged duration (median, 28 days) of intravenous administration of antimicrobials for an extremely susceptible organism. We would not recommend withholding long-term treatment in individual cases on the basis of these data, however, given the small sample size.

This study is, to our knowledge, the largest specific retrospective cohort study to date of penicillin-susceptible streptococcal PJI treated with debridement and retention of prosthesis. In conjunction with the study by Brandt et al. [25], our study emphasizes the critical role that specific microorganisms play in the success of debridement with prosthesis retention as a treatment modality.

In conclusion, this study suggests that prompt debridement of a well-seated prosthesis, when it is infected with a penicillin-susceptible streptococcal organism, is a reasonable alternative to excision arthroplasty and delayed reimplantation. The limited number of treatment failures did not permit identification of risk factors for relapse of infection. This is a retrospective study, and results need to be confirmed by prospective studies.

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