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Two-Stage Revision for Prosthetic Joint Infection: Outcome and Role of Reimplantation Microbiology in 107 Cases

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ABSTRACT

Two-stage revision is widely used for the treatment of prosthetic joint infections. However, the duration of antibiotic treatment between stages and role of reimplantation microbiology are controversial. The purpose of this study was to evaluate the outcome and influence of the reimplantation microbiology of two-staged revisions with 6 weeks of antibiotic treatment. We retrospectively reviewed 107 patients treated with two-stage revision between 2001 and 2009. The overall treatment success rate was 94.4%. The reimplantation cultures were positive in 5/97 (5.2%) cases, and only one of them failed. Therefore, we achieved excellent results with a 6-week course of antibiotics between stages in two-stage revision. Positive reimplantation cultures do not seem to be associated with worse outcomes.

Prosthetic joint infection is one of the most serious complications after hip or knee arthroplasty, occurring in approximately 0.3% to 2.22% of primary arthroplasties and up to 5.9% of revision arthroplasties [1–7]. Treatment options for prosthetic joint infections are prosthesis retention, prosthesis exchange, and salvage procedures (e.g., arthrodesis or amputation) [8]. Two-stage revision is widely considered to be the gold standard procedure [9–12]. Published success rates for two-stage revision vary from 65% to 100% [8,12–22]. The reasons for variation in success rates are still unclear, and factors that affect the outcome of two-stage arthroplasty are unknown [12].

Two-stage revision has some controversial aspects, including the optimal duration of antibiotic use between stages and the length of the antibiotic-free period before reimplantation. The role of reimplantation microbiology is also still unclear. Positive cultures have varied from 0% to 28% at reimplantation [19,20,23,24]. The microbes cultured at reimplantation have frequently been reported to be different from those cultured at excision. In addition, positive reimplantation cultures do not seem to be predictive of treatment failure [19,20].

Published studies of prosthetic joint infection treated with two-stage revision are heterogeneous, and the study populations have been small, usually less than 60 cases [12,25]. The purpose of this study was to evaluate the outcome and reimplantation microbiology of prosthetic joint infections treated with two-stage revision and a 6-week course of antibiotics between stages.

Materials and Methods

This study was conducted at Oulu University Hospital, which serves as a tertiary level center in northern Finland, an area comprising 735,000 inhabitants. Prosthetic joint infections managed by two-stage revision between February 2001 and August 2009 were identified retrospectively in the patient databases of the hospital using the International Statistical Classification of Diseases and Related Health Problems — 10th Revision (ICD-10), code T84.5 (infection and inflammatory reaction due to internal joint prosthesis). Data were collected from medical records by a senior orthopedic surgeon (A-P P) and a medical student. Age, gender, co-morbidities (e.g., diabetes or rheumatoid arthritis), body mass index, American Society of Anesthesiologists score, type of implant (i.e., hip or knee prosthesis), time of earlier surgery (implantation of primary prosthesis or revision operation), microbiological culture results, duration of antimicrobial therapy, and time of surgical therapy were recorded. The institutional ethical committee approved the study.

Prosthetic joint infection was defined as the growth of the same microorganism in two or more cultures of synovial fluid or periprosthetic tissue, purulent synovial fluid or purulence at the implant site, acute inflammation upon histopathological examination of the periprosthetic tissue, or the presence of a sinus tract communicating with the prosthesis [26]. We used the McPherson staging system, which classifies infections into three categories: early

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postoperative (<4 postoperative weeks), acute hematogenous (<4 weeks duration), and late chronic (> 4 weeks duration) [27]. Treatment was considered successful if the patient had no symptoms or signs of infection (pain, swelling, erythema, warmth, wound discharge, loosening of the prosthesis) [28] and C-reactive protein, leukocyte count, and sedimentation rate were normal at the end of follow-up, even if a new prosthesis was not implanted. Treatment was considered to have failed if the reimplanted prosthesis was removed because of persistent infection, the patient had symptoms or signs of prosthetic joint infection, the initial microbe was isolated in the synovial fluid or periprosthetic tissue, or if the patient was on suppressive antibiotic treatment. The end of follow-up was defined as the last control visit concerning the treated prosthetic joint infection. The outcome of the joint at the end of the follow-up was classified as prosthesis retention, resection arthroplasty of the hip, arthrodesis of the knee, or amputation.

In the first stage of the two-stage revision, all prosthetic components and foreign materials were removed and extensive debridement performed. Multiple tissue specimens were taken for bacterial culture. Bone cement spacers containing gentamicin (Refobacin Bone Cement R, Biomet, Warsaw, Indiana) or tobramycin (Simplex P with Tobramycin, Stryker, Mahwah, New Jersey) were used routinely. Vancomycin (1–2 g) was added to each 40-g mix of cement. Wounds were closed primarily, and no drains were used. Intravenous antibiotics were started after tissue specimens were taken; these included vancomycin 1 g twice daily and cefuroxime 1.5 g three times daily, with adjustments made once the bacterial cultures (which routinely included enrichment culture) and their sensitivities were available. Antibiotic therapy was continued for 6 weeks, including intravenously for at least for 4 weeks. The antibiotic-free period before reimplantation was at least 4 weeks. If no symptoms or clinical findings of infection were present after the antibiotic-free period, second-stage surgery was performed.

In the second-stage surgery, a new set of tissue specimens was taken for bacterial culture before antibiotic prophylaxis, and debridement was performed before reimplantation of the new components. Vancomycin (1 g twice daily) and cefuroxime (1.5 g three times daily) were started after the specimens were taken. If the original microbes were insensitive to these antibiotics, the antimicrobial treatment was modified according to sensitivity. The antibiotic therapy was continued until bacterial culture results were available. If the results of microbiological enrichment cultures were negative, the antimicrobial treatment was stopped. If at least two cultures were positive, the patient was treated as a case of new early prosthetic joint infection until the total antibiotic treatment time of 3 months for knee infection or 2 months for hip infection was completed [7].

Statistical analysis was performed using SPSS software v.19.0. Categorical variables were compared using the chi-squared test or Fisher's exact test when necessary, and continuous variables were compared using the Students *t*-test or analysis of variance.

Table 1
Clinical Characteristics of the Patients.

Variable	Patients (n = 107)
Age, mean ± SD	69.4 ± 9.7
Males, n (%)	51 (47.7)
Joint, n (%)	
Hip	61 (57.0)
Knee	46 (43.0)
Co-morbidity, n (%)	
Diabetes	17 (15.9)
Rheumatoid arthritis	13 (12.1)
BMI, mean ± SD	29.4 ± 6.1
ASA score, mean ± SD	2.68 ± 0.6
Previous operation before infection, n (%)	
Primary	72 (67.3)
Revision	35 (32.7)
Duration of antibiotics after first stage, median (25th–75th percentile), days	46 (42–67.5)
Follow-up time, median (range), months	15 (6–86)
Type of infection, n (%)	
Early postoperative	18 (16.8)
Acute hematogenous	16 (15.0)
Late chronic	73 (68.2)
Outcome at the end of follow-up, n (%)	
Prosthesis retention	83 (77.6)
Resection arthroplasty of the hip	9 (8.4)
Arthrodesis of the knee	14 (13.1)
Amputation	1 (0.9)

SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists.

Table 2
Microbiological Results.

Microbe	Number (%) (n = 129)
Coagulase-negative staphylococci	35 (27.1)
Staphylococcus aureus	34 (26.4)
Streptococcus species	19 (14.7)
Gram-negative rods	17 (13.2)
Enterococcus species	14 (10.9)
Other	7 (5.4)
Microorganism unknown	3 (2.3)

Results

We identified 113 cases of prosthetic joint infection in 113 patients treated with two-stage revision at our center. Six cases were excluded from further analysis because the outcome was uncertain. Three of these cases were lost to follow-up, two cases died before reimplantation due to non-infectious causes, and a thigh amputation was performed for severe obliterative arteriosclerosis in one case of knee infection. Thus, 107 cases were included in the final analysis. The clinical characteristics of patients with prosthetic joint infections are presented in Table 1. Out of the 107 cases, 48 (44.9%) underwent surgery at our center prior to prosthetic joint infection. The remaining patients underwent surgery at other hospitals.

The overall treatment success rate was 94.4% (101/107). Success was achieved in 94.4% (17/18) of early postoperative, 93.8% (15/16) of acute hematogenous, and 94.5% (69/73) of late chronic infections. The success rate was 98.4% for hip infections, and 89.1% for knee infections ($P = 0.082$). Table 2 summarizes the microbiological characteristics of the 107 prosthetic joint infection cases. Fifteen (14.0%) infections were polymicrobial. Treatment failed in six patients (Table 3). No significant differences were found in any of the variables between patients who had successful treatment and those who experienced treatment failure (data not shown).

The reimplantation microbiology was available in 90.7% (97/107) of cases, and the samples were positive in 5.2% (5/97). The same microbe, *Candida albicans*, was isolated at both excision and reimplantation in one case, and the treatment failed. In the other positive reimplantation cultures, coagulase-negative *Staphylococcus* was isolated in two cases, *Enterococcus faecalis* in one case, and *Escherichia coli* in one case. The treatment was successful in all of these four cases. All patients with positive reimplantation samples were treated as having an acute postoperative prosthetic joint infection [7]. The treatment success rate was 80% (4/5) for patients with positive reimplantation samples and 96% (88/92) for patients with negative reimplantation samples ($P = 0.24$).

Discussion

Our study shows that a 6-week course of antibiotics between stages is sufficient for treating prosthetic joint infections with two-