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## Original Article

## Single-Stage Revision for Chronic Fungal Periprosthetic Joint Infection: An Average of 5 Years of Follow-Up

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## ABSTRACT

**Background:** Periprosthetic infections caused by fungal pathogens are a rare entity, and there exist no definite guidelines according to which these infections can be successfully managed. In these situations, we wondered whether patients could be treated successfully for their fungal infections with single-stage revision.

**Methods:** A retrospective analysis between January 2004 and October 2014 included 11 patients (4 hips and 7 knees) with chronic fungal periprosthetic joint infection who underwent single-stage revision, including aggressive soft-tissue debridement, thorough removal of infected components and cement, pouring powdered vancomycin into the medullary cavity and direct intra-articular injection of fungus-sensitive antibiotics, and a reasonable combination of antifungal agents and antibacterial medications. Recurrence of infection and clinical outcomes were evaluated. The average follow-up was 5 years (range, 2–10 years).

**Results:** There were 3 failures during the study period; 1 patient died during the perioperative period because of acute heart failure on the eighth postoperative day. Of the 11 patients, 7 patients had satisfactory outcomes and required no additional surgical or medical treatment for recurrence of infection. The mean postoperative Harris hip score and Hospital for Special Surgery knee score was 77 points (67–88 points;  $P < .05$ ) and 78 points (73–84 points;  $P < .05$ ), respectively, at the most recent assessment.

**Conclusion:** Treatment of chronic fungal periprosthetic joint infection with single-stage revision can be fairly effective for achieving acceptable functional outcomes, which indicated that this may be a feasible alternative strategy in selected patients.

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Periprosthetic joint infections (PJI) have always represented a serious concern for surgeons. A wide diverseness of pathogens are known to cause PJI, and gram-positive bacteria, especially

staphylococcal species, are the most common pathogens [1,2]. Although fungal pathogens are rare and are estimated to occur in approximately 1% of all cases of PJIs [3,4], they are generally considered more difficult to cure than bacterial infections and present particular challenges for the surgeon, including the diagnosis, providing adequate systemic and topical antifungal treatment, and detecting the organisms for which reliable guidelines have not yet been established.

Several different treatment methods to control fungal infections have been extensively discussed in the past 3 decades, including antifungal drugs, debridement with retained prosthesis, resection arthroplasty, and 2-stage exchange arthroplasty reported with variable outcomes [5–9]. Although a 2-stage revision was preferred by most surgeons [10], controversies still exist with regard to the ideal interval between implant removal and reimplantation, the usefulness of antifungal-loaded cement spacers, and the duration of systemic antifungal treatment. Moreover, the rates of infection

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**Table 1**  
Demographic Factors for 11 Episodes of Chronic Fungal Periprosthetic Joint Infection Treated With Single-Stage Revision.

Patient Number	Age (y)	Gender	BMI (kg/m <sup>2</sup> )	Joint	Comorbidities	Sinus	Duration of Infection Before Revision (mo)	Number of Previous Operations	History of Bacterial PJI Before Fungal PJI
1	74	M	18.5	Hip	HY	No	8	1	No
2	72	M	20.3	Knee	HY, DM, CB	Yes	13	2	Yes
3	66	F	21.4	Knee	HY, PS, AB, CHD	No	4	1	Yes
4	76	F	22.7	Knee	CHD	No	3	2	No
5	49	F	27.3	Knee	None	No	7	2	No
6	76	M	26.8	Knee	HY	Yes	14	3	Yes
7	47	F	28.1	Hip	None	No	10	1	No
8	77	F	28.4	Knee	HY, TAO, CHD	Yes	21	3	No
9	59	M	23.5	Hip	AB, RA, DM	Yes	5	1	No
10	67	F	23.2	Hip	RA, CHD, PS	No	6	4	Yes
11	69	F	19.8	Knee	HY, DM, CB	Yes	20	3	Yes

AB, asthmatic bronchitis; BMI, body mass index; CB, chronic bronchitis; CHD, coronary heart disease; DM, diabetes mellitus; F, female; HY, hypertension; M, male; PJI, periprosthetic joint infection; PS, psoriasis; RA, rheumatoid arthritis; TAO, tumors after operation.

recurrence also vary widely from 0% to 50% [3,4,8,9,11]. Correspondingly, 1-stage revision has been widely used in the treatment of PJIs in recent decades to avoid technical difficulties in staged revision surgery, increase earlier restoration of function, lower morbidity rates, and decrease the total expense [12]. In these situations, we wondered whether patients could be treated effectively for their fungal infections with single-stage revision and hypothesized that fungal PJIs after total joint arthroplasty could be managed successfully by aggressive soft-tissue debridement, pouring powdered vancomycin into the medullary cavity and direct intra-articular injection of fungus-sensitive antibiotics, and a reasonable combination of antifungal agents and antibacterial medications.

## Patients and Methods

Our institutional database was used to retrospectively review 14 patients (5 hips and 9 knees) with chronic fungal PJIs who received a single-stage revision between January 2004 and October 2014. However, 3 patients were excluded for <2-year follow-up and/or having fungal cultures that deemed to be contaminants due to fungal spores, and bacteria were detected only at preoperative aspiration. The excluded patients did not have any symptoms of infection recurrence until the last clinical appointment. Finally, a total of only 11 patients (4 hips and 7 knees) with single-stage revision for chronic fungal PJI were included in the study. Demographic characteristics and a cohort description are presented in Table 1.

Patients with a definitive diagnosis of fungal PJI were identified based on the description by the Musculoskeletal Infection Society [13]. A joint aspiration was performed preoperatively in all patients. Antibiotic therapy was discontinued strictly for a minimum of 2 weeks before aspiration. The sample was sent to the microbiology laboratory and cultured for at least 21 days.

The operations were performed with a posterior approach (infected hip) or a medial parapatellar approach (infected knee) by the same senior surgeon who is experienced in hip and knee revision and infection treatment. Only prophylactic antibiotics such as 0.5 g vancomycin for preoperative culture-negative patients and 0.4 g fluconazole for preoperative culture-positive patients were received intravenously (IV) 30 min before an incision was made. The patients underwent general or epidural anesthesia through an incision along the previous operative scar. The procedure was divided into 2 steps. The first was an aggressive debridement involving the removal of all necrotic and fibrous tissue, bone sequestra, and a large number of proliferative inflammatory synovialis. Aspiration was performed again under direct vision. In addition, several samples (at least 3) were acquired from the areas

with the most florid inflammatory changes, such as pseudocapsules. Then, the samples were sent to a microbiology laboratory for culture, sensitivity tests, and histologic evaluation. After that, all the components and cement debris were removed thoroughly. The surgical area was then exhaustively irrigated with at least 2 L saline and 100–200 mL of 3% hydrogen peroxide and soaked in 400–500 mL of 0.1% aqueous Betadine (Xidebao, Beijing, China) (all soft tissues steeped) for 15 min; the surgical area was then resterilized and redraped, and the surgical team rescrubbed, put on new gowns, and exchanged the entire set of surgical instruments. After a further pulsatile lavage, 0.5 g of dry vancomycin powder was poured into the femoral canal and the bottom of the acetabulum in the infected hip or distal femoral and proximal tibia canal in the infected knee. Second, a new prosthesis was implanted. All patients with infected hips received an uncemented prosthesis, and 0.5 g of gentamicin-loaded commercial cement was received by the patients with infected knee. After that, another 0.5 g of vancomycin powder was poured into the whole joint cavity before closing the deep fascia. The wound was closed over a suction drain, which was retained for 3 days or if the volume of daily drainage was ≤50 mL.

Postoperative antibiotic treatment regimens were performed as the following. Fungus-sensitive IV antibiotics were administered for an average of 18 days (12–23 days); 0.5 g of vancomycin as simultaneous medication was received IV every 12 h by all the patients for not more than 14 days. Direct intra-articular injection of 15-mL fluconazole (2 mg/mL) was also administered with an 18-gauge needle to patients with infected knee every other day for an average of 18 days (12–30 days), which was considered as a large role in the successful eradication of fungal infection. The duration of these injections was based on the value of C-reactive protein (CRP) and turbidity of the synovial fluid. Considering potential contamination of a joint, all patients stayed in the hospital for an average of 29 days (18–65 days) of treatment. According to the Infectious Diseases Society of America clinical practice guidelines [14], quinolones, rifampicin, and fluconazole combinations were simultaneously recommended for general use as an oral switch therapy for at least 3 months until CRP and erythrocyte sedimentation rate (ESR) returned to normal levels.

Clinical evaluations were performed at 1, 3, and 6 months postoperation, and annually thereafter. At each follow-up visit, serum ESR, CRP level, and radiographs were evaluated routinely. The patients were instructed to immediately report if any signs or symptoms of infection were suspected. Preoperative and postoperative functional outcomes were assessed using the Harris hip score (HHS) [15] or the Hospital for Special Surgery knee score [16].

Satisfactory treatment of infection was established by the absence of clinical symptoms and signs of infection until the date of the last follow-up appointment. Failure to treat the infection was

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