Compared with Two-Stage Revision, Destination Joint Spacers Have a Similar Infection-Relief Rate and a Higher Complication Rate

Yuanqing Cai
First Affiliated Hospital of Fujian Medical University
Xinyu Fang
First Affiliated Hospital of Fujian Medical University
Yi Lin
Xiehe Affiliated Hospital of Fujian Medical University
Zida Huang
First Affiliated Hospital of Fujian Medical University
Chaofan Zhang
First Affiliated Hospital of Fujian Medical University
Wenbo Li
First Affiliated Hospital of Fujian Medical University
Wenming Zhang (zhangwm0591@fjmu.edu.cn)
First Affiliated Hospital of Fujian Medical University https://orcid.org/0000-0003-1567-7279
Zhenpeng Guan
Peking University Shougang Hospital

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Abstract

Background: Two-stage revision is regarded as the “gold standard” for periprosthetic joint infection (PJI) treatment, in which antibiotic-impregnated spacers play an important role. However, some patients are unable to undergo reimplantation of the prosthesis after spacer implantation. The clinical outcomes of these patients remain unknown. The purpose of this research was to study the infection-relief rate and clinical outcome of these patients.

Methods: From January 2006 to December 2017, data from PJI patients who underwent implantation with antibiotic-impregnated cement spacers in our center due to chronic PJI were collected retrospectively. Age, sex, body mass index (BMI) and laboratory test results were recorded, and the infection-relief rate and clinical outcomes were observed.

Results: A total of 62 patients who were diagnosed with PJI were enrolled, with an age of 65.13 ±9.94 (39-88) years. There were 21 cases in the destination joint spacer group and 41 cases in the temporary spacer group (reimplantation of prosthesis after infection relief). The Charlson comorbidity index (CCI) in the destination joint spacer group was higher than that in the temporary spacer group. Our study showed that the infection-relief rate of destination joint spacers was similar to that of two-stage revision, but the incidence of complications was higher than that of two-stage revision, especially for the type I spacer used in this study.

Conclusions: The infection-relief rate of destination joint spacers was similar to that of two-stage revision, but the complication rate was higher than that of two-stage revision (especially for the type I spacer).

Background

Total joint arthroplasty (TJA) is the main therapeutic method to reconstruct joint function in end-stage osteoarthritis. However, periprosthetic joint infection (PJI) is a serious complication after TJA [1]. It has been reported that the incidence of PJI after primary arthroplasty is 3–5% [2]. Although the incidence is not high, with an increasing number of patients receiving TJA, the number of PJI cases is also increasing [3]. The treatment of PJI often requires multiple revision surgeries and extensive periods of antibiotic administration, which results in substantial physical and mental pain in patients and is an economic burden to society [4,5].

According to Tsukayama classification, PJIs that occur within 4 weeks postoperation are defined as acute PJIs, and most acute PJIs can be cured by debridement, antibiotics, and implant retention (DAIR) [6]. However, chronic PJIs occurring 4 weeks postoperation usually require removal of the prosthesis and thorough debridement combined with systemic antibiotic treatment to eliminate the infection [6]. At present, there are two kinds of revision surgeries for chronic PJI: one-stage revision and two-stage revision [7]. One-stage revision requires removal of the prosthesis and reimplantation of the prosthesis during the

same surgery [8], but two-stage revision requires removal of the prosthesis and implantation of an antibiotic-impregnated spacer. After infection relief, the new prosthesis is replanted again [9]. Currently, two-stage revision is considered the “gold standard” for chronic PJI treatment [7].

In two-stage revision surgery, the implantation of antibiotic-impregnated spacers can 1) release antibiotics to control the infection locally; 2) simultaneously maintain the joint space and reduce soft tissue contracture to facilitate reimplantation of the prosthesis; and 3) maintain joint stability, which provides basic joint functions to meet the needs of daily life [10–12]. In clinical practice, some patients cannot tolerate reoperation after spacer implantation because of complicated underlying diseases, while some patients are satisfied with joint function after spacer implantation, so they refuse reimplantation of the prosthesis [3]. In addition, some patients are unable to undergo prosthesis reimplantation due to economic reasons. These reasons might lead to temporary spacer retention for a long time, namely, a "destination joint spacer", and may even accompany the patient throughout life. At present, the clinical outcomes of these patients with destination spacers are unclear.

Therefore, the purpose of this study was to observe the clinical outcomes of these patients and compare the infection-relief rate between patients with destination and temporary joint spacers (retention time ≤ 2 years and who underwent prosthesis replantation after infection elimination). A destination joint spacer was defined as a joint spacer that had been retained for more than 5 years at the last follow-up, and these patients had no intention of undergoing prosthesis reimplantation.

Methods

1. Patient selection

Approved by the institutional review board, from January 2006 to December 2017, data from PJI patients who underwent implantation with antibiotic-impregnated cement spacers in our center due to chronic PJI were collected retrospectively. Inclusion criteria: 1) Tsukayama type IV PJI cases; 2) patients whose revision surgeries were performed with an antibiotic-impregnated cement spacer and who underwent regular follow-up; and 3) patients with complete medical data. Exclusion criteria: 1) patients without regular follow-up data or timely medication and with poor compliance; 2) patients whose clinical outcomes were affected by infectious diseases in other parts of the body and patients who had immunosuppressive disease or malignant tumors; and 3) patients with non-PJI-related death. A diagnosis of PJI was made according to the American Society for Musculoskeletal Infection (MSIS) criteria for PJI.

1. The process of revision surgery and preparation of joint spacers.

The revision surgeries were performed by the same medical team. Sufficient synovial fluid was obtained pre- and intraoperatively, and white blood cell (WBC) counts, polymorphonuclear (PMN) examinations, microbial cultures and drug sensitivity tests were routinely performed. At least 5 samples of periprosthetic tissues were obtained intraoperatively for microbial culture and intraoperative pathological examination.

After removal of the prosthesis, debridement was performed using hydrogen peroxide, povidone iodine and saline, and then antibiotic-impregnated joint spacers were prepared.

For hips, two types of joint spacers were used [13,14]. For type I, 1–2 Kirschner wires with a diameter of 5 mm that were bent to approximately 130° in advance were used as stents, which were placed in a silicone mold imitating the shape of the joint, embedded with antibiotic-impregnated cement and molded under pressure (Fig. 1AB). For type II, 105 mm femoral stem, 28 mm femoral head and 32 mm femoral neck (CM-CZ; AK Medical, Beijing, China) were used as scaffolds, which were embedded with antibiotic-impregnated cement and molded under pressure (Fig. 1 CD). For knees, two types of spacers were also used [13–15]: for type I, an aseptic silicone mold imitating the joint shape was used, and a joint-like spacer was made intraoperatively (Fig. 1 EF); for type II, the removed femoral end prosthesis was washed, soaked in povidone iodine solution and resterilized, and the resterilized tibial prosthesis was used or replaced with a new polyethylene tibial component (Fig. 1 GH). The antibiotics used in the antibiotic-impregnated joint spacer were selected according to the microbial culture and drug sensitivity test results. For those who had negative microbial culture results, vancomycin + ceftazidime (4.0 g vancomycin + 4.0 g ceftazidime per 40 g bone cement) was empirically used.

For those who underwent prosthesis reimplantation, after infection elimination, the joint was incised along the original surgical incision, and joint spacers were thoroughly removed with necrotic granulation tissue, scar tissue and cement debris. After washing with a large amount of hydrogen peroxide, povidone iodine and saline, the new prosthesis was reimplanted.

1. Follow-up postoperatively

The administration of antibiotics was based on the microbial culture and drug sensitivity test results, while those with negative microbial culture results were empirically treated with vancomycin. After receiving intravenous antibiotic treatment for 2 to 4 weeks, oral antibiotics were replaced. Patients were followed regularly postoperation. The patient's age, sex, BMI, laboratory test results (such as CRP, ESR, synovial fluid WBC, and PMN%), Charlson comorbidity index (CCI), reasons for joint spacer retention, etc., were recorded. The diagnosis of infection recurrence was based on the symptoms, signs, laboratory tests and images, which were judged by at least 2 orthopedic experts and 1 infectious disease expert.

4. Statistical analysis.

All statistical analyses were performed using SPSS 20.0. The enumeration data were expressed as the mean ± standard deviation and compared by Student’s t-test, while measurement data were expressed by rate and compared by the chi-square test. $P \leq 0.05$ was considered statistically significant.

Results

1. Demographic characteristics

With the approval of the Ethics Committee of our hospital, 62 PJI cases were included with an average age of 65.13 ± 9.94 (39–88) years; there were 26 males and 36 females: 38 hips and 24 knees. The mean follow-up time was 45.12 ± 6.31 months. In the destination joint spacer group, 10 patients could not tolerate prosthesis reimplantation because of complicated underlying diseases, 8 patients refused reimplantation due to being satisfied with function, and 3 patients were unable to undergo reimplantation due to economic and other factors. These patients were treated with antibiotics for 76 (48–96) days after joint spacer implantation. The mean age was 67.52 ± 11.61 (45–88) years, and there were 9 males, 12 females, 14 hips (3 cases of type I and 11 cases of type II) and 7 knee joints (5 cases of type I and 2 cases of type II). The mean preoperative CRP level was 38.75 ± 40.11 mg/L, the ESR was 64.19 ± 33.18 mm/h, the SF-WBC count was 36783.24 ± 6737.19 L, the PMN% was 84.16 ± 8.32%, and the CCI was 4.67 ± 1.88%. There were 41 patients in the temporary spacer group, with a mean age of 63.9 ± 8.87 years. There were 17 males and 24 females, with 24 hips (11 cases of type I and 13 cases of type II) and 17 knee joints (9 cases of type I and 8 cases of type II). The mean preoperative CRP level was 35.42 ± 30.74 mg/L, the ESR was 76.49 ± 42.50 mm/h, the SF-WBC count was 23759.12 ± 7038.58 ml, and the PMN% was 81.96 ± 8.16. The mean CCI was 2.15 ± 0.88. The CCI of the destination joint spacer group was higher than that of the temporary joint spacer group, and there were no significant differences in other demographic characteristics between the two groups. The demographic characteristics are listed in Table 1.

Table 1
Demographic characteristics

Parameters	Destination joint spacers (n = 21)	Temporary spacers (n = 41)	*P*-value
Age (years)	67.52 ± 11.61	63.9 ± 8.87	0.085
Sex			0.916
Male	9	17	
Female	12	24	
Joints involved and type of spacers			
Hip	14	24	0.132
Type□	3	11	
Type□	11	13	
Knee	7	17	0.404
Type□	5	9	
Type□	2	8	
BMI (kg/m2)	21.23 ± 4.32	22.64 ± 3.26	0.083
CCI	4.67 ± 1.88	2.15 ± 0.88	<0.001
CRP (mg/l)	38.75 ± 23.11	35.42 ± 30.74	0.718
ESR (mm/h)	64.19 ± 33.18	76.49 ± 42.50	0.252
SF-WBC (10^6/l)	36783.24 ± 6737.19	23759.12 ± 7038.58	0.475
SF-PMN (%)	84.16 ± 8.32	81.96 ± 8.16	0.324

BMI: body mass index; CRP: C-reactive protein; ESR: erythrocyte sedimentation rate; SF: synovial fluid; WBC: white blood cell count; PMN: polymorphonuclear.

1. Comparison of the infection-relief rate and efficacy

The comparisons of infection-relief rates are shown in Table 2.

Table 2
Efficacy evaluation

Parameters	Destination joint spacers (n = 21)	Two-stage revision (n = 41)	*P*-value
Recurrent infection	3 (14.29%)	4 (9.76%)	0.687
VAS preoperation	4.76 ± 1.26	4.78 ± 1.44	0.960
HHS preoperation	39.71 ± 8.62	47.21 ± 11.42	0.56
KSS preoperation	37.71 ± 9.38	43.94 ± 7.89	0.11
VAS postoperation	2.23 ± 1.13	2.09 ± 0.80	0.574
HHS postoperation	50.64 ± 5.47	76.88 ± 10.70	< 0.001
KSS postoperation	47.14 ± 10.07	73.35 ± 8.57	< 0.001
Death postoperation	1 (4.76%)	1 (2.44%)	0.624
VAS: visual analog scale pain score; HHS: Harris hip score; KSS: knee society score.			

In the destination joint spacer group, there were 3 cases of recurrent infection (14.29%). In 2 of these cases, the joint spacers were removed, and antibiotic-impregnated joint spacers were reimplanted after debridement; in another case, the joint spacer was removed with left exclusion after debridement. In the two-stage revision group, there were 4 cases of recurrent infection (9.76%). Among the cases of recurrent infection, 2 patients underwent DAIR, and 2 patients underwent one-stage revision. There was no significant difference in the infection-relief rate between the two groups. There were no significant differences in preoperative visual analog scale (VSA) score, Harris hip score (HHS), knee society score (KSS) or postoperative VSA between the two groups, but the postoperative HSS and KSS in the two-stage revision group (76.88 ± 10.70 and 73.35 ± 8.57, respectively) were higher than those in the destination joint spacer group (50.64 ± 5.47 and 47.14 ± 10.07, respectively). One patient suffered from non-PJI-related death (death of severe liver cirrhosis) in the destination group, and 1 patient died after two-stage revision; the cause of death was unknown.

4. Comparison of complications

The comparison of complications between the two groups is listed in Table 3.

Table 3
Incidence of complications

Parameters	Destination joint spacers (n = 21)	Two-stage revision (n = 41)	*P*-value
Spacer fracture	2	N/A	N/A
Dislocation	3	1	0.108
Periarticular fracture	1	1	0.339
Deep venous thrombosis	3	1	0.108
Overall	9	3	0.001

In the destination joint spacer group, two patients suffered from spacer fractures 3 and 5 years after spacer implantation (both were knees with type I spacers). Infection relief was confirmed after combining the clinical symptoms and signs with the laboratory test results, so the prostheses were reimplanted after debridement. There were 3 cases of dislocation (hip: 2 cases, both with type I spacers; knee: 1 case, type I spacer): 2 cases were successfully reduced, and 1 patient underwent surgery. There was 1 case of a periarticular fracture and 3 cases of deep venous thrombosis, and these patients received oral anticoagulant therapy after joint spacer implantation. Among the patients who underwent implantation of temporary joint spacers and prosthesis reimplantation, 1 patient suffered from a periprosthetic hip joint fracture after an accidental fall, so he received surgical treatment; 1 patient suffered from hip dislocation after reimplantation and was successfully reduced; and 1 patient suffered from deep venous thrombosis of the lower extremity. The total incidence of complications in the destination group was higher than that in the two-stage revision group. Further analysis showed that in the destination joint spacer group, for hips (14 cases), there were 3 cases with type I spacers and 2 cases with dislocations (66.67%), and there were 11 cases with type II spacers (78.57%); however, there have been no complications so far, and there was a significant difference in the incidence of complications between the two types of hip spacers ($P = 0.033$). For knees (7 cases), there were 5 cases with type I spacers and 2 cases of spacer fractures with 1 case of dislocation, and the complication rate was 60%. While there were no complications in cases with type II spacers, there was no difference in the incidence of complications between the two types of knee spacers ($P = 0.429$).

Discussion

PJI is a devastating complication after arthroplasty. At present, there are still many challenges in its diagnosis and treatment [16]. The surgical treatment of PJI includes DAIR and one- and two-stage revision. Two-stage revision is currently recognized as the "gold standard" for PJI treatment. Spacers play an important role in two-stage revision to control infection. In clinical practice, some patients are unable to undergo reimplantation due to many factors, so joint spacers might be retained for a long time, even throughout the whole life of patients. However, the clinical outcomes of these patients are not clear. Thus,

this study reported the clinical outcomes of patients with destination joint spacers in order to provide a clinical reference.

A total of 62 PJI cases were included in this study, with 21 patients in the destination group and 41 patients in the temporary joint spacer group (who underwent prosthesis reimplantation after infection elimination). The CCI of the destination joint spacer group was higher than that of the temporary joint spacer group. In terms of infection relief, the infection relief rate in the destination joint spacer group was 85.71%, while that in the two-stage revision group was 90.24%. There was no significant difference in the infection relief rate between the two groups. In terms of complications, in the destination joint spacer group, there were 2 cases of spacer fracture, 3 cases of dislocation and 3 cases of deep venous thrombosis after joint spacer implantation. However, in the two-stage revision group, there was 1 case of periprosthetic fracture, 1 case of dislocation and 1 case of deep venous thrombosis of the lower extremities. The overall incidence of complications in the destination group was higher than that in the two-stage revision group.

Previously, some studies did not approve of the use of antibiotic-impregnated joint spacers in the treatment of chronic PJI. They showed that spacers were new foreign materials on which bacteria could form new biofilms, affecting the administration of intravenous or systemic sensitive antibiotics and resulting in difficult-to-treat or relapsed infections [17]. However, similar to the study of Valencia et al [18] and Petis et al [3], our study showed that the infection relief rate of destination joint spacers was similar to that of two-stage revision, while the incidence was higher than that of two-stage revision. Therefore, for PJI patients who were unable to undergo reimplantation due to physical conditions or who did not plan to undergo reimplantation of the prosthesis, a spacer (type II spacer is recommended) provided an alternative for prosthesis implantation for infection control and daily activity.

There were some limitations in this study. 1) This study was a single-center study with a small sample size: there were only 21 patients with destination joint spacers and 42 patients with two-stage revision. The sample size should be expanded in further research. 2) In this study, PJI was diagnosed by MSIS criteria, which may have led to selection bias due to error classification. 3) The follow-up time was short, so it is necessary to prolong the follow-up time in order to observe the clinical treatment outcomes of patients with destination spacers.

Conclusions:

In summary, our study showed that the infection relief rate of destination spacers was similar to that of two-stage revision, but the complications were higher than those of two-stage revision (especially for type I spacers in this study). Due to the increasing number of PJIs, this study can be used to guide the treatment of PJI patients with complicated underlying diseases who are unable to tolerate multiple surgeries.

Abbreviations

PJI
periprosthetic joint infection; CCI:Charlson comorbidity index; TJA:Total joint arthroplasty; MSIS:American Society for Musculoskeletal Infection; WBC:white blood cell counts, PMN:polymorphonuclear; BMI:body mass index; VSA:visual analog scale score; HHS:Harris hip score; KSS:knee society score.

Declarations

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Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations:

Ethics approval and consent to participate: This study was approved by the Institutional Review Board of the First Affiliated Hospital of Fujian Medical University. All patients signed an informed consent form approved by the Institutional Review Board.

Consent for publication: All patients signed an informed consent form of publication.

Competing interests: The authors declare that they have no conflicts of interest

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Figures

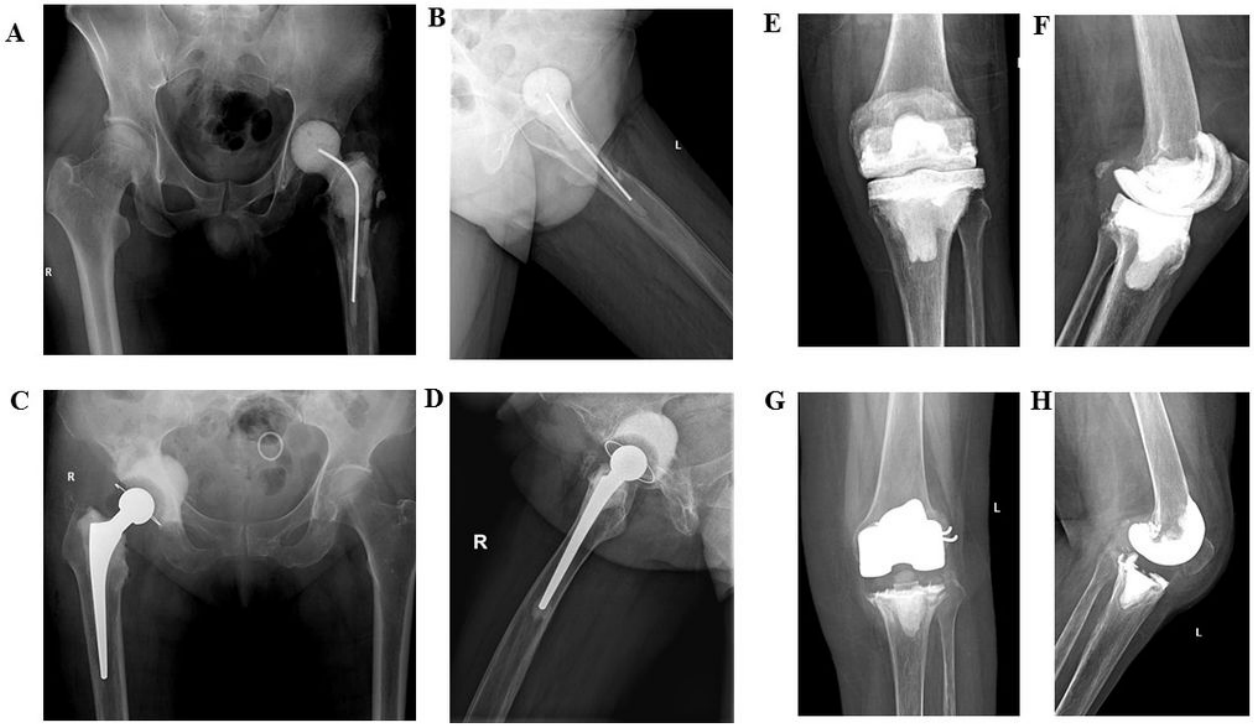

Figure 1

There were two types of joint spacers used in this study for hips(type Ⅰ:AB; type Ⅱ: CD; AC: anteroposterior radiography of hip; BD: lateral radiography of hip) and knees(type Ⅰ:EF; type Ⅱ: GH; EG: anteroposterior radiography of knee; FH: lateral radiography of knee). Fig1 was created by ourselves.