Two-stage total hip arthroplasty for primary advanced septic arthritis of the hip in adults: comparison of debridement versus femoral head resection with spacer implantation

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Abstract

Background

To compare the outcomes of debridement and antibiotic-loaded spacer implantation in primary advanced septic arthritis (SA) of the hip in adults treated with two-stage total hip arthroplasty (THA).

Methods

In the first stage, 9 patients were treated with debridement and 11 patients were treated with antibiotic-loaded spacer implantation. Then, THA was conducted in all patients in the second stage. Patients were evaluated based on the recurrence of infection, Harris hip score, visual analogue scale (VAS) pain score and leg-length discrepancy.

Results

No cases of infection, deep vein thrombosis, death, and loosening of hip prosthesis were observed during follow-up. The mean follow-up time was 29.09 ± 10.80 months in the debridement with THA group, and 28.22 ± 14.80 months in the spacer implantation with THA group. Before the THA surgery, the mean leg-length discrepancy was 2.80 ± 2.03 cm in the debridement with THA group, and 0.50 ± 0.23 cm in the spacer implantation with THA group ($P < 0.05$). In the latest follow-up, The Harris hip scores of patients was 90.33 ± 4.85 in the debridement with THA group and 94.36 ± 2.34 in the spacer implantation with THA group ($P < 0.05$), respectively. There was no statistical significant difference in VAS pain score of the hip between the two groups ($P > 0.05$).

Conclusions

Two-stage THA using antibiotic-loaded spacer implantation is an effective method for the treatment of advanced SA of the hip in adults due to it can control infection and significantly improve functional hip.

Background

Septic arthritis (SA) is a devastating disease in adults with high morbidity and mortality [1], which mainly affect the knee and hip joints [2]. Patients with ineffective treatment may lead to osteonecrosis of the femoral head, osteomyelitis, systemic sepsis, leg-length discrepancy, and later osteoarthritis of the hip joint [3]. Despite the surgical treatment, the occurrence of poor outcomes can still reach to 22% [4]. Primary SA of the hip is defined as infection of the hip joint that developed in the absence of a fracture, insertion of an implant or prosthesis, and surgical procedure. Until now, multiple treatment options are available, such as repeated aspirations, open arthrotomy, arthroscopic drainage and two-stage total hip arthroplasty (THA) [5, 6]. However, treatment for advanced SA of the hip can be confronted with great challenges.

When SA with bone involvement, more aggressive surgery have been conducted. For example, a previous study by Girdlestone et al. [7] has reported that resection arthroplasty is effective treatment for SA of the hip. However, it may be associated with poor function outcomes. Subsequent report has found that the use of antibiotic-loaded spacers in two-stage THA may be considered as a suitable method for the treatment of primary SA in adults [8]. In addition, Li et al. [9] have reported that two-stage THA using debridement or femoral head resection with antibiotic-loaded spacer implantation is effective in the treatment of advanced active tuberculosis of the hip and have demonstrated that the outcomes of two procedures are consistent. Therefore, it is necessary for us to further demonstrate the treatment of between debridement and antibiotic-loaded spacer implantation in two-stage of THA in adults.

The aim of this study was to compare the outcomes of hip using debridement and femoral head resection with antibiotic-loaded spacer implantation in advanced SA of the hip in adults. Our study demonstrated that two-stage THA using antibiotic-loaded spacer implantation is an effective method for the treatment of advanced septic arthritis of the hip in adults. These findings of this study may provide a new treatment for primary advanced SA of hips in adults.

Methods

Patients

We conducted a single-center, retrospective cohort study of patients with follow-up. From January 2014 to December 2017, 21 patients with SA of the hip were eligible for enrolment in our study. Among them, 1 patient decided to leave the hospital and was treated in the local hospital after being diagnosed. A total of 20 patients were finally included. Inclusion criteria were patients who 1) were aged ≥ 18 years; 2) had a definite diagnosis of acute SA of the hip joint; 3) were advanced SA with destruction of hip joint; and 4) had a set of complete medical records (including nursing records), preoperative and postoperative radiographs. Exclusion criteria were patients who 1) were early SA of hip; 2) were multiple arthritis; 3) had incomplete medical records; 4) were not willing to be followed up, 5) had immune deficiency.

Patient diagnosis

Patients with SA of the hip had clinical symptoms of infection including pain, sudden chills and fever; local swelling, and limited range of motion. In addition, complete blood cell count (CBC), C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) were measured. X-ray, CT and MRI were also performed. X-ray showed narrowing of the hip joint space for advanced SA of the hip. CT could detect local edema, osteonecrosis, osteomyelitis, and hip bone destruction. MRI provided good resolution for the detection of joint effusion, bone differentiation, and soft tissue infection. MRI findings of SA patients include joint effusion, cartilage and bone destruction, soft tissue abscess and bone edema [10] (Fig. 1–3). The diagnosis of SA synthesized the results of these tests. If the patient was suspected of having septic arthritis, PPD test, Brucella agglutination test and needle aspiration of the hip were then added. The

patient should accept an procedure according to patient's willing once sepsis is confirmed via aspiration [11].

Surgical technique

All of the 20 patients (20 hips) underwent two-stage surgeries. Among them, 9 cases underwent debridement, 11 cases underwent antibiotic-loaded spacer implantation in the first stage. After a period of time, THA was conducted in all patients in the second stage. Therefore, two procedures were named as debridement with THA group and spacer implantation with THA group, respectively. Patients chose one of two procedures according to patient's willing. All operations were performed by four professional surgeons in our department.

During the first stage, posterolateral approach was performed in all patients. Debridement was performed in 9 patients (9 hips) and femoral head resection with antibiotic-loaded spacer implantation were performed in 11 patients (11 hips). The inflamed soft tissues, necrotic bones, abscesses, and sinus tracts were totally debrided during the first stage. Then the specimens were taken for pathological examination and tissue bacterial culture. For patients undergoing debridement, irrigation tube were placed in operation and continued to be rinsed with gentamicin solution after operation but not in patients with antibiotic-loaded spacer implantation. For patients undergoing femoral head resection and antibiotic-loaded spacer implantation, femoral head were removed and a cement spacer containing gentamicin were installed (Fig. 1). Susceptible antibiotic drugs were given to patients based on the results of bacterial culture until serological results return to normal. Symptoms disappeared 2 weeks later. Empirical antibiotics (ceftriaxone) was used in patients with negative bacterial culture results [11, 10]. CBC, CRP and ESR were detected for weekly regular monitoring. Patients stopped antibiotic usage and discharged once the vital signs and serological indicators was basically normal and the infection was eradicated. If there was pain in the affected limb within 24–48 hours after operation, patient was conducted for traction of the affected limb. After 48 hours, patient strengthened functional exercise [10, 12].

During the second-stage, all procedures were performed via the posterolateral approach, with the patient in a lateral position. When the joint was opened, no pus and no inflammatory edema of soft tissue around the joint was confirmed under the naked eye. Then the hypertrophic soft tissue and scar was removed as thoroughly as possible in the direct visualization. Odophor and hydrogen peroxide were used to immerse the hip joint cavity to reduce the probability of infection. Titanium Acetabular Reconstruction Cup was used for 2 cases with deficient acetabular wall, which was fixed with screws. Then acetabular impactors were used to perform impaction graft. The gap between cup and host bone was completely filled by allogeneic morselized bone. On completion of cage placement and bone grafts, an acetabular polyethylene liner was fixed with high radiopaque bone cement containing gentamicin. In addition, central acetabular defect in 3 patients were performed graft impaction using acetabular impactors, and a larger acetabular cup was implanted. Besides, 1 patient had a high hip dislocation secondary to SA of the hip. Structural autograft obtained from the femoral neck was implanted on the patient's upper acetabular bone and fixed with screws. The remaining 15 patients were operated normal THA. The usage of antibiotics

depended on the susceptibility of the first-stage organism identified in joint fluid culture. Antibiotics were chosen empirically if no organism was identified.

Data collection

The scanning edition of electronic medical records were reviewed in detail to retrieve pertinent information, including demographic data (gender, age, height and weight), the preoperative and postoperative clinical evaluation (CBC, CRP and ESR), imaging evaluation (X-ray, CT and MRI), Harris hip score and VAS pain score. Clinical data were all recorded during follow-up.

Follow up

Anteroposterior and lateral radiographs of the hip, full-length view of the lower extremities, CT and MRI of the hip were taken for the pre-operation. In our department, patients were required to have regular follow-up in the 1st month, the 3rd month, the 6th month and the 12th month after operation. Anteroposterior and lateral radiographs of the hip were taken at each follow-up. All of the 20 patients had adequate preoperative and postoperative imaging examinations.

Statistical analysis

All data were performed using SPSS 19.0 software (IBM, Armonk, NY, USA). Quantitative data were described using means $\pm$ standard deviation (SD). Mann-Whitney U test was used to compare continuous categorical variables, including Harris hip score and VAS pain score between the two groups. A P value of less than 0.05 were considered statistically significant.

Results

All of 20 patients had postoperative follow-up. In our study, 20 hips (9 hips for debridement with THA procedure; 11 hips for antibiotic-loaded spacer implantation with THA procedure) of 20 patients (16 males; 4 females) were analyzed. The mean age was 50.60 ± 10.82 years. There were no significant differences in laboratory indexes, Harris hip scores, VAS pain scores and Body Mass Index (BMI) between the two groups preoperatively (Table 1).

Table 1
Baseline characteristics in two groups

	Debridement with THA group (n = 9)	Spacer implantation with THA group (n = 11)	P value
Age(years)	47.89 ± 10.34	52.82 ± 11.17	.270
CRP (mg/L)	48.44 ± 45.58	67.41 ± 69.39	.569
ESR (mm/h)	68.67 ± 31.23	56.36 ± 23.56	.323
Leucocyte count (10 ⁹ /L)	8.30 ± 2.06	7.26 ± 1.53	.271
Neutrophil count (%)	67.68 ± 5.10	64.30 ± 12.20	.621
BMI (kg/m ²)	23.05 ± 3.49	23.57 ± 3.13	.595
Harris hip score	29.56 ± 4.00	28.45 ± 3.86	.541
VAS pain score	4.67 ± 0.71	5.36 ± 1.12	.151
Time of symptoms pre- operation(day)	44.22 ± 24.45	99.55 ± 81.53	.101

In the first stage, the results of bacterial culture of joint fluid in 20 patients were *Staphylococcus aureus* (4 cases), *Brucella* (1 case), *Mycobacterium tuberculosis* (1 case), *Klebsiella pneumoniae* (1 case) and the rest were negative. In the first stage of surgery, the two groups had similar operation duration and blood loss. BMI increased before the second stage of operation compared with that before the first stage of operation, indicating that the patients recovered using after operation in both groups (Table 2). The mean follow-up time was 28.22 ± 14.80 months in the debridement with THA group and 29.09 ± 10.80 months in the spacer implantation with THA group, respectively. No recurrence of SA occurred after the second-stage of two-stage THA. No loosening or dislocation of prosthesis, thrombosis or death were found in all patients during the follow-up period. The symptoms of the patients were greatly improved. The Harris hip score increased in two groups after two-stage THA surgery (28.45 ± 3.86 , 29.56 ± 4.00 vs 94.36 ± 2.34 , 90.33 ± 4.85), and the VAS pain score decreased after two-stage THA surgery (5.36 ± 1.12 , 4.67 ± 0.71 vs 0.09 ± 0.30 , 0.44 ± 0.53).

We also observed many differences between the two methods in Table 2. For the first stage, the mean duration of postoperative hospitalization in the debridement with THA group (19.00 ± 4.95 days) was significantly longer than that in the spacer implantation with THA group (12.09 ± 2.17 days) ($P = 0.001$). The patients with antibiotic-loaded spacer implantation had a better recovery of hip joint function. However, the patient with debridement has more complications including traumatic arthritis (Fig. 2), high dislocation of hip joint (Fig. 4) and then needed THA. The mean Harris hip score in the debridement with THA group was lower than in the spacer implantation with THA group after first stage of two-stage THA (all $P < 0.05$). The duration between the two stages of operation in the debridement with THA group

(10.30 ± 8.70 months) was longer than that in the spacer implantation with THA group (3.43 ± 1.50 months) ($P = 0.039$). Before the THA surgery, the mean leg-length discrepancy was 2.80 ± 2.03 cm in debridement with THA and 0.50 ± 0.23 cm in spacer implantation with THA ($P < 0.05$). In the second stage, the operation time of the debridement with THA group (175.00 ± 68.74 min) was significantly longer than that of the spacer implantation with THA group (131.36 ± 30.67 min) ($P = 0.047$).

For the latest follow-up, Harris hip score was 90.33 ± 4.85 points in the debridement with THA group and 94.36 ± 2.34 points in the spacer implantation with THA group ($P = 0.027$). There were no significant differences in the mean VAS score between the debridement with THA group (0.44 ± 0.53) and antibiotic-loaded spacer implantation with THA group (0.09 ± 0.30) ($P = 0.077$), but 4 of the 9 patients (44.44%) who received the debridement with THA procedure had occasional hip discomfort or mild aches, compared with 1 of the 11 patients (9.10%) who received the spacer implantation with THA procedure (Fig. 3) (Table 2) .

Table 2
Comparison of perioperative outcomes in two groups

	Debridement with THA group (n = 9)	Spacer implantation with THA group (n = 11)	P value
PODFSH (day)	19.00 ± 4.95	12.09 ± 2.17	.001*
IBTSOS (day)	10.30 ± 8.70	3.43 ± 1.50	.039*
BMI (kg/m ²)			
First-stage	23.05 ± 3.49	23.57 ± 3.13	.595
Second-stage	25.39 ± 4.46	25.13 ± 2.87	.569
Duration of operation (min)			
First-stage operation	137.22 ± 39.06	130 ± 31.06	.879
Second-stage operation	175.00 ± 68.74	131.36 ± 30.67	.047*
Blood loss (ml)			
First-stage operation	438.89 ± 119.32	595.45 ± 322.84	.591
Second-stage operation	1211.11 ± 1842.85	754.55 ± 697.66	.697
Harris hip score			
First-stage preoperative	29.56 ± 4.00	28.45 ± 3.86	.541
First-stage out of hospital	61.67 ± 3.04	73.55 ± 4.16	.000*
Second-stage preoperative	74.44 ± 3.40	80.64 ± 2.66	.001*
Second-stage out of hospital	81.78 ± 2.22	84.18 ± 2.14	.049*
Latest follow-up	90.33 ± 4.85	94.36 ± 2.34	.027*
VAS pain score			
First-stage preoperative	4.67 ± 0.71	5.36 ± 1.12	.151
First-stage out of hospital	1.44 ± 0.53	1.36 ± 0.51	.721
Second-stage preoperative	1.67 ± 0.71	1.18 ± 0.41	.077
Latest follow-up	0.44 ± 0.53	0.09 ± 0.30	.077
Length discrepancy	2.80 ± 2.03	0.50 ± 0.23	.000*
Follow-up (month)	28.22 ± 14.80	29.09 ± 10.80	.518
PODFSH = Postoperative days of first stage hospitalization; IBTSOS = Interval between two stages of surgery. * P < 0.05 (vs. Debridement with THA group).			

Discussion

Primary SA of the hip is rare in adults [13], which lead to serious complications and significant morbidity and mortality if it is not diagnosed and treated promptly [14]. Two-step total hip arthroplasty has been used when the hip suffer from severe destruction [15]. In our study, we found that a main type of microorganism is staphylococcus aureus. Furthermore, we compared the effect of between debridement and femoral head resection with anti-loaded spacer implantation in the first stage of surgery. The finding showed that Two-stage of THA using anti-loaded spacer implantation was superior to Two-stage of THA using debridement with regard to mean leg-length discrepancy of patients and Harris hip scores.

The most common causative microorganism related to SA of hip is Staphylococcus aureus and Streptococcus pyogenes [16, 17]. In our cases which was diagnosed with a specific bacterial infection, Staphylococcus aureus accounted for 57.14%. In the joint with pus, the positive rate of bacterial culture in synovial fluid is about 80% [18, 1]. However in our study, the positive rate of bacterial culture of synovium fluid was 25%. The possibility for low culture positive rate was that patients had been given antibiotics orally or intravenously before admission. The reason for using antibiotics might be used to control joint infection as well as prevent further septic metastases [19].

Generally, physicians typically have 2 tasks consisted of infection control and hip function restore when treating SA of hip. Therefore, surgery and antibiotics are key factors for treating for primary SA of the hip. Previous studies have demonstrated that Two-stage THA is considered as a suitable method for the treatment of primary SA. For example, Bauer et al. [20] have concluded that two-stage THA had a good treatment for the infection in the treatment of evolutive SA. A similar study has also demonstrated that two-stage THA using interval spacer can effective control the rate of infection [21]. In our study, both methods of Two-stage THA using debridement or antibiotic-loaded spacer implantation achieved the goal of eliminating infection. In addition, we observed that the second stage was less difficult and patients had less complications when using antibiotic-loaded spacer in the first stage of hip arthroplasty. However, the patients had more complications including traumatic arthritis and high dislocation of hip joint when using debridement in the first stage of hip arthroplasty. Those data suggested that two-stage THA using antibiotic-loaded spacer implantation had less complications in treating for advanced primary SA of the hip.

Subsequent study has revealed that two-stage THA using interval spacer can improve the Harris Hip Score [22]. In addition, Yoon et al. [23] have reported that two-stage THA could reduce the mean leg length discrepancy from 2.95 to 0.8 cm. Furthermore, two-stage THA using debridement or anti-loaded spacer implantation can treat effectively for patients with advanced active tuberculosis of the hip and there were no significant differences between the two procedures [9]. In our study, patients who underwent debridement had longer hospital stay than patients underwent who anti-loaded spacer implantation after the first stage of surgery. In the second stage of THA, patients in the debridement group had longer operation duration and more blood loss. The recovery of patients in the debridement group was slower than that in the anti-loaded spacer implantation group. In addition, patients who received Two-stage THA

using anti-loaded spacer implantation had higher Harris hip score, smaller mean leg-length discrepancy. During follow-up, several patients who received Two-stage THA using debridement occasionally felt slight pain in the front of the hip or thigh at the latest follow-up, however the VAS pain score of the hip had no significant difference. Those abovementioned findings suggested Two-stage THA using anti-loaded spacer implantation had good effect on function of the hip.

There were several limitations in this study. For example, This study was retrospective and conducted in a single center medical institution with a small sample. Those abovementioned situation may result in sampling error and conclusions may be influence by unrelated factors. Therefore, large randomized controlled study should be carried out in the future.

Conclusion

The present study suggested that for adult patients with advanced SA of the hip, the procedure of two-stage THA using anti-loaded spacer implantation can effectively control infection and significantly improve functional hip. Therefore, Two-stage THA using anti-loaded spacer implantation may be a promising option for the treatment of advanced primary SA of the hip in adults.

List Of Abbreviations

SA, septic arthritis; THA, total hip arthroplasty; VAS, visual analogue scale; CBC, complete blood cell count; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate.

Declarations

Ethical Approval and Consent to participate

The study was approved by the Institutional Ethics Committee of the Third Hospital of Hebei Medical University (2020-004-1) and allowed exemption from informed consent. All procedures were performed in accordance with the World Medical Association's Declaration of Helsinki.

Consent for publication

All of participants were given written informed consent.

Availability of Data and Materials

All data generated or analysed during this study are included in this published article.

Competing Interest

The authors indicated no potential conflicts of interest.

Funding

Not applicable.

Authors' contributions

ZZL and HJL conceived of the study, participated in data collection, analysis, and interpretation of the results and writing of the manuscript. CCW, XKL and MXY contributed to data collection, and interpretation of the results. All authors read and approved the final manuscript and consented to publish this manuscript.

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Figures

A **B** **C**

Figure 1

Radiographs of a 49-year-old man with pain in his right hip. (A) Anteroposterior X-ray and coronal CT images of pelvis showed narrowing of hip joint space and destruction of bone. coronal MRI (cut) of the pelvis showed diffuse edema of the right hip joint involving almost all muscles of the right hip. (B) The femoral head was excised and implanted with an antibiotic cement prosthesis: 5 days, 1 month and 3

months after operation respectively. (C) The postoperative imaging findings of hip replacement at 0 day, 1 month, 3 months and 19 months, respectively.

Figure 2

Radiographs of a 43-year-old man with pain in his right hip joint. (A) Anteroposterior X-ray and coronal CT images of pelvis showed that the space of hip joint became narrow and articular cartilage disappeared (arrow). coronal MRI of the pelvis showed diffuse edema of the right femoral head. (B) X-ray examination

of hip joint at 4 months, 12 months and 15 months after debridement operation. (C) The postoperative images of hip replacement at 7 days, 2 months, 5 months and 15 months, respectively.

Figure 3

Radiographs of a 54-year-old man with right hip joint pain and severe limitation of movement. (A) Anteroposterior X-ray and coronal CT images of pelvis showed that the right acetabulum was invaginated and the acetabulum wall was damaged (arrow). Coronal MRI of the pelvis showed inflammatory changes

in the right hip joint. (B) The postoperative imaging of femoral head resection with antibiotic cement implantation at the same day, 1 month and 6 months, respectively. (C) The imaging findings after THA at 0 day, 1 month and 12 months, respectively.

Figure 4

Anteroposterior X-ray images of the pelvis showed that the left femoral head had been absorbed, and the rest of the femoral neck had been dislocated and formed a pseudarthrosis (arrow).