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 total hip arthroplasty (THA) with antibiotic-loaded spacer implantation and subsequent THA for the treatment of patients affected by primary advanced septic arthritis (SA) of the hip in adults.

Methods: All of the 20 patients (20 hips) underwent two-stage surgery. Nine patients were submitted to surgical debridement first, and then THA (group 1), while 11 patients were treated with antibiotic-loaded spacer and subsequent THA (group 2). 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 group 1, and 28.22 ± 14.80 months in group 2. Before the THA surgery, the mean leg-length discrepancy was 2.80 ± 2.03 cm in group 1, and 0.50 ± 0.23 cm in group 2 ($P < 0.05$). In the latest follow-up, The Harris hip scores of patients was 90.33 ± 4.85 in group 1 and 94.36 ± 2.34 in group 2 ($P < 0.05$), respectively. There was no statistical significant difference in VAS pain score of the hip between the two groups ($P > 0.05$).

Conclusions: Antibiotic-loaded spacer and subsequent THA 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, the aggressive surgery including joint resection and resection arthroplasty 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. However, it is still not clear which of the two procedures has the advantage or disadvantage for the primary advanced SA

patients. Therefore, it is necessary for us to further demonstrate the comparison of debridement with antibiotic-loaded spacer implantation in the first stage of two-stage THA in adults.

The primary aims of the present study were to compare the outcomes of hip debridement and THA with antibiotic-loaded spacer and subsequent THA for the patients of hip function and infection control. Secondary aims were to assess the treatment-related risk factors for failure. 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 treated with THA for SA of the hip. 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] (**Figure 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 pre-operative samples of 6 cases were positive, including *Staphylococcus aureus* in 3 cases, *Brucella* in 1 case, *Mycobacterium tuberculosis* in 1 case, and *Klebsiella pneumoniae* in 1 case. The advantages and disadvantages of two-stage THA were addressed for the specific patient, and then developed a surgical plan according to patient's willing [11].

Surgical technique

All of the 20 patients (20 hips) underwent two-stage surgery. Nine patients were submitted to surgical debridement first, and then THA (group 1), while 11 patients were treated with antibiotic-loaded spacer

and subsequent THA (group 2). 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 group 1 and femoral head resection with antibiotic-loaded spacer implantation were performed in group 2. The inflamed soft tissues, necrotic bones, abscesses, and sinus tracts were totally debrided during the first stage. Then the 4-5 samples were taken from different parts of the suspicious joint for pathological examination and bacterial culture. For patients undergoing debridement, irrigation tube were placed in operation and continued to be rinsed with gentamicin solution after operation. For patients undergoing femoral head resection and antibiotic-loaded spacer implantation, femoral head were removed and a cement spacer containing gentamicin were installed (**Figure 1**). Until the patient's symptoms disappeared and the serum became negative, the patient was allowed to be discharged, and was required to take oral antibiotics at least two weeks [11,10]. CBC, CRP and ESR were detected for weekly regular monitoring. In general, patient was conducted for traction of the affected limb if the pain (VAS score of 4-6) affected sleep after operation. After surgery for 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. Acetabular impactors were used to perform impaction grafting. Then Titanium Acetabular Reconstruction Cup was used for 2 cases with deficient acetabular wall, which was fixed with screws. 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 impaction grafting 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 14 patients were installed with matching acetabular cup after grinding of the acetabulum. 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.

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. 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**).

In the first stage, the results of bacterial diagnosis 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 group 1 and 29.09 ± 10.80 months in group 2, 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 group 1 (19.00 ± 4.95 days) was significantly longer than that in group 2 (12.09 ± 2.17 days) ($P = 0.001$). The patients had a better recovery of hip joint function in group 2. However, the patients have more complications including irreversible cartilage damage in group 1 (**Figure 2**), high dislocation of hip joint (**Figure 4**) and then needed THA. The mean Harris hip score in group 1 was lower than in group 2 after first stage of two-stage THA (all $P < 0.05$). The duration between the two stages of surgery in group 1 (10.30 ± 8.70 months) was longer than that in group 2 (3.43 ± 1.50 months) ($P = 0.039$). Before the THA surgery, the mean leg-length discrepancy was 2.80 ± 2.03 cm in group 1 and 0.50 ± 0.23 cm in group 2 ($P < 0.05$). In the second stage, the operation time of group 1 (175.00 ± 68.74 min) was significantly longer than that of the group 2 (131.36 ± 30.67 min) ($P = 0.047$).

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

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 was *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 anti-loaded spacer implantation and subsequent THA was superior to debridement and then THA with regard to mean leg-length discrepancy of patients and Harris hip scores.

Previous studies have revealed that the causative microorganism are closely related to SA of hip [16,17]. In our cases which were diagnosed with a specific bacterial infection, *Staphylococcus aureus* accounted for 57.14%. In general, the rate of false negatives is high in the bacterial culture. For example, a previous report has reviewed 133 articles, which summarized the majority of positive rate of bacterial culture in synovial fluid is almost 40%-50% [18]. Our positive culture rate is about 25% (5 out of 20 in the present series) in the intra-operative diagnosis of bacterial culture. We speculated that the reason of low rate may be related to the pre-operative antibiotic therapy, fastidious microorganisms [19], sampling technique, laboratory procedures of culture bacteria. In addition, using antibiotics might be used to control joint infection as well as prevent further septic metastases [20].

The most relevant clinical advantage of using an antibiotic-loaded spacer is that it helps to maintain joint space and minimize the risk of large limb shortening [24,25]. Furthermore, Rissanen *et al.* [26] have demonstrated that THA relieves pain and improves walking ability of patients. Subsequent study has revealed that two-stage THA using interval spacer can improve the Harris hip score. In brief, no complications associated with the use of this novel spacer were found. Average Harris hip score improved from 35.2 preoperatively to 61.6 between the 2 stages to 93.6 in latest follow-up [27]. In addition, 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]. However, the Harris hip score of patients who underwent anti-loaded spacer implantation and subsequent THA were superior to patients who underwent debridement and then THA in our study. The difference of Harris hip score was consistent with the result of operation difficulty and recovery time between the two groups. Compared with reported by Li *et al.* [9], the reason for the difference of Harris hip score in the latest follow-up may be related to short-time of follow-up. Besides, the VAS pain score of the hip had no significant difference. Those abovementioned findings suggested anti-loaded spacer implantation and subsequent THA had good effect on function of the hip.

Conclusion

The present study suggested that for adult patients with advanced SA of the hip, the procedure of treated with antibiotic-loaded spacer and subsequent THA can effectively control infection and significantly improve functional hip. Therefore, treated with antibiotic-loaded spacer and subsequent THA 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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Tables

Table 1 Baseline characteristics in two groups

	group 1 (n=9)	group 2 (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
sWBC (10 ⁹ /L)	112.70 ± 17.87	105.96 ± 13.73	.425
sPMC (%)	90.74 ± 1.93	90.10 ± 3.34	.879
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

CRP, C-reactive protein; ESR, Erythrocyte sedimentation rate; BMI, Body mass index; sWBC, synovial white blood cell count; sPMC, synovial polymorphonuclear cell count.

Table 2 Comparison of perioperative outcomes in two groups

	group 1 (n=9)	group 2 (n=11)	P value
FSH (day)	19.00 ± 4.95	12.09 ± 2.17	.001*
OS (month)	10.30± 8.70	3.43 ± 1.50	.039*
kg/m ²)			
stage	23.05 ± 3.49	23.57 ± 3.13	.595
nd-stage	25.39 ± 4.46	25.13 ± 2.87	.569
ion of operation (min)			
stage operation	137.22 ± 39.06	130 ± 31.06	.879
nd-stage operation	175.00 ± 68.74	131.36 ± 30.67	.047*
l loss (ml)			
stage operation	438.89 ± 119.32	595.45 ± 322.84	.591
nd-stage operation	1211.11 ± 1842.85	754.55 ± 697.66	.697
s hip score			
stage preoperative	29.56 ± 4.00	28.45 ± 3.86	.541
stage out of hospital	61.67± 3.04	73.55 ± 4.16	.000*
nd-stage preoperative	74.44± 3.40	80.64 ± 2.66	.001*
nd-stage out of hospital	81.78 ± 2.22	84.18 ± 2.14	.049*
st follow-up	90.33 ± 4.85	94.36 ± 2.34	.027*
ain score			
stage preoperative	4.67 ± 0.71	5.36± 1.12	.151
stage out of hospital	1.44 ± 0.53	1.36± 0.51	.721
nd-stage preoperative	1.67 ± 0.71	1.18 ± 0.41	.077
st follow-up	0.44 ± 0.53	0.09 ± 0.30	.077
th discrepancy	2.80 ± 2.03	0.50 ± 0.23	.000*
n-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).

Figures

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).