Two-stage Reimplantation of Infected Hip Arthroplasties

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Background: Although two-stage reimplantation for infected hip arthroplasty has a high success rate, the protocols of the antibiotic therapy after resection arthroplasty have varied in different reports. The purpose of this study was to evaluate the clinical outcomes of two-stage reimplantation for infected hip arthroplasty using our protocol of combined parenteral and oral antibiotic therapy and the criterion for reimplantation.

Methods: Forty-seven patients (48 hips) with infected hip arthroplasty were treated with two-stage reimplantation using interim antibiotic-impregnated cement beads with an average 2.6 weeks of parenteral antibiotic and 6 weeks of oral antibiotic therapy. The timing for reimplantation was determined using the values of erythrocyte-sedimentation rate (ESR) and C-reactive protein (CRP) with no clinical signs of infection. The average follow-up period was 5.6 years.

Results: Forty-six (96%) hips were free of recurrent infection according to clinical examination and laboratory tests at the latest follow up. All 48 hips had negative tissue culture results obtained at the second-stage reimplantation except one which resulted in a recurrent infection. The average interim period of time from the first-stage procedure to reimplantation was 5.4 months (range, 2-24 months). Two hips had recurrent infections after reimplantation. The mean Harris hip score improved from 26 points preoperatively to 83 points at the latest follow up. Thirty-five patients (74%) achieved excellent or good results.

Conclusions: Two-stage reimplantation of an infected hip arthroplasty can achieve a high success rate using the protocol of aggressive surgical debridement, local antibiotic-loaded cement beads, combined parenteral and oral antibiotic therapy and reimplantation after normalization of ESR and CRP levels.
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Key words: two-stage reimplantation, infected hip arthroplasty, inflammatory markers

Deep infection after hip arthroplasty, either the primary or revision procedure, is a devastating complication. The treatment options include antibiotic suppression only,[1-3] debridement without prosthesis removal,[4,5] one-stage revision to a cemented prosthesis with antibiotic-loaded cement[6-9] and two-stage revision.[10,11] Two-stage reimplantation remains the most popular procedure.[12,13] The rate of success in eradicating infection after the two-stage procedure ranges from 82% to 91%.[12] However, there were

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controversies regarding optimum duration of postoperative parenteral therapy with antibiotics when two-stage revision is performed. The standard procedure throughout North America following the first procedure of debridement and removal of the prosthesis includes a minimum of 6 weeks of parenteral antibiotics is administered.[4,10,13-15] Recently, with the use of antibiotic-loaded cement spacers between stages, a regimen of shorter period of parenteral antibiotic therapy after the first-stage procedure was reported in patients undergoing hip revisions as well as knee arthroplasty because of infection.[16-21]

The protocol at our institution since 1993 has been the administration of combined parenteral and oral antibiotics after aggressive surgical debridement, removal of the infected prosthesis and insertion of antibiotic-loaded cement beads and delayed reimplantation of the hip after normalization of erythrocyte-sedimentation rate (ESR) and C-reactive protein (CRP) levels and disappearance of the infection signs clinically. The parenteral antibiotics are then discontinued and shifted to appropriate oral antibiotics as long as CRP returns to normal levels. The oral antibiotics are discontinued when the ESR levels are ≤ 30 mm/hr. The purpose of the present study was to evaluate the clinical outcomes of two-stage reimplantation of infected hip arthroplasty using this protocol.

METHODS

Between 1993 and 2005, 61 patients (62 hips) with infected hip arthroplasty underwent two-stage reimplantation according to the protocol for short-term parenteral antibiotics therapy at this institution. Four patients with proximal femoral allograft reconstruction in conjunction with a total hip arthroplasty (THA) before infection were excluded from the study. Five patients were lost to follow up and five patients died of unrelated causes. Therefore, 47 patients (48 hips) were available for follow-up study including 34 men and 13 women with an average age of 51.5 years (range, 22 to 74 years) at the time of the first-stage procedure. The types of arthroplasty before diagnosis of infection were primary THA in 18, bipolar hemiarthroplasty in 14 and revision THA in 16 hips. Four hips had undergone revision THA because of septic loosening. Three hips developed infection after open reduction and internal fixation for periprosthetic fractures. Comorbidity was common in this patient group including diabetes mellitus in 11 patients, liver cirrhosis in four, recurrent urinary tract infection in four, chronic osteomyelitis of the affected proximal femur in six, drug abuse in three, chronic gout in three and psoriasis, systemic lupus erythematous and chronic renal failure requiring hemodialysis in one, respectively. The diagnostic criteria for infection were sinus discharge in seven (15%), purulent fluid at operation or aspiration in 30 (62%) and high ESR and CRP with positive pathological finding (acute inflammation) in 11 (23%) hips. The causative organisms in the 48 hips are listed in Table 1. Seven patients had culture results negative for bacteria. Nevertheless, their clinical manifestations indicated infection and blood tests including ESR and CRP were high (ESR > 40 mm per hour, CRP > 10 mg/l) and all seven hips had either positive pathological diagnoses of acute inflammation (more than five polymorphonuclear leukocytes per high power field) or purulent fluid identified in the hip joints during their operations. Therefore, the seven hips were considered infected and they were included in this study.

Table 1. Micro-organisms Isolated during the First-stage Procedure

Micro-organisms	n = 48
MRSA	9
MSSA	6
Escherichia coli	4
Enterococcus faecalis	3
Klebsiella Pneumoniae	2
Pseudomonas aeruginosa	2
Viridans streptococcus	2
Peptostreptococcus	2
Corynebacterium	1
Enterobacter cloacae	1
Salmonella sp.	1
MRSE	1
Mycobacterium tuberculosis	1
Polymicrobial	6
Negative culture result	7

Abbreviations: MRSA: Methicillin resistant Staphylococus aureus; MSSA: Methicillin sensitive Staphylococcus aureus; MRSE: Methicillin resistant Staphylococcus epidermidis.

Each operation was performed in two stages. The first stage consisted of the removal of the prosthesis and all hardware, debridement of all infected and devitalized tissue, and implantation of antibiotic-loaded cement beads. Eleven hips required extended femoral osteotomy to remove the well-fixed femoral components (Fig. 1). For hips with cemented THA, the bone cement was removed in all. The choices of antibiotics in the bone cement varied according to the different time periods and the results of preoperative bacterial cultures. In the early years of this study, only gentamicin-loaded cement beads (Septopal, Merck Darrmstadt, Germany) were used. Subsequently, 2 g of vancomycin was used when the culture results of gram-positive cocci were identified, or 2 g of vancomycin and 4 g of piperacillin per 40-g package of cement when the causative organisms had not been identified preoperatively. Streptomycin at 2 g was used in each hip infected by mycobacterium tuberculosis (Table 2). Postoperatively, the patients were kept in skeletal traction for 2 weeks to relieve pain.

Postoperatively, all patients received intravenous antibiotics for 2 to 6 weeks according to the culture results that were done preoperatively or at the time of the first-stage procedure. Intravenous antibiotic therapy was discontinued when the serum CRP returned to normal (less than 5 mg/l) which usually occurred 2 to 3 weeks after adequate debridement. After discontinuing intravenous antibiotic therapy, the patients were discharged and started taking effective antibiotics in oral form. All patients were followed up at our orthopaedic clinic for clinical examinations and blood tests of ESR and CRP every week for 3 weeks and then every 2 weeks thereafter. An additional 3 to 6 weeks of oral antibiotics was administered until serum ESR was reduced below 30 mm/hr. In the current study, all hips with control of infection had decreased levels of ESR and CRP after the first-stage procedure and antibiotic therapy except for one patient with psoriasis. Because of persistent high ESR and CRP (74 mm/hr and 86 mg/l), the patient with psoriasis underwent a second debridement and histological examination. Bacterial cultures revealed no evidence of persistent infection. The patient with tuberculosis of the hip had antituberculosis therapy for 5 months after the first-stage

Table 2. Antibiotics Used for Cement- impregnation at the First-stage Procedure

Antibiotics (dose, g per 40g bone cement)	n = 48
Gentamicin*	21
Vancomycin (2)	14
Vancomycin (2) and Piperacillin (4)	12
Streptomycin (2)	1

*: Septopal beads (Merck, Darrmstadt, Germany).

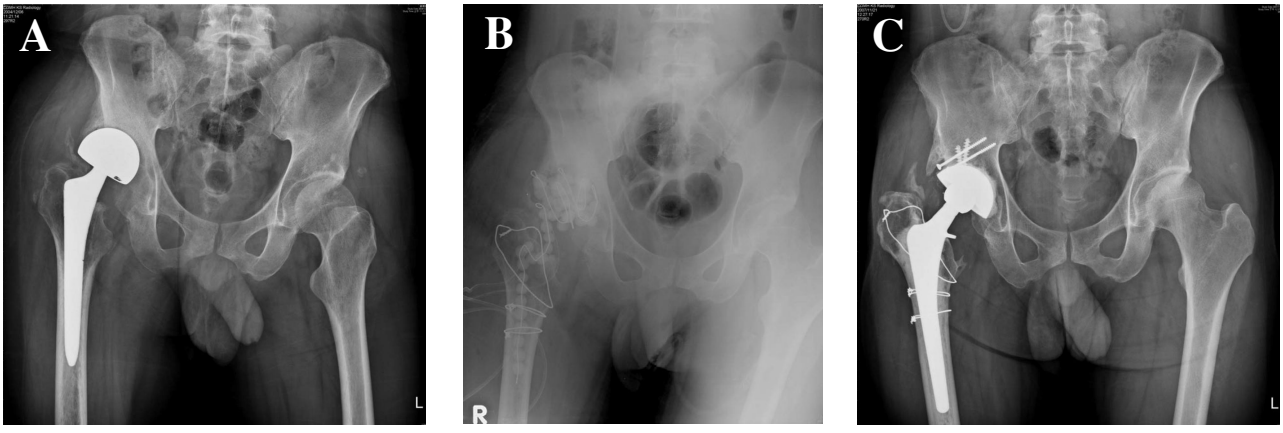

Fig. 1 (A) Radiograph of the pelvis of a 26-year-old man who had a septic loosening of right bipolar hemiarthroplasty. The causative microorganism was methicillin-resistant *Staphylococcus aureus* (MRSA). (B) Radiograph taken immediately after debridement, removal of the hip prosthesis through extensile femoral osteotomy and insertion of vancomycin-impregnated cement beads. (C) Radiograph of the pelvis taken 4 years after the second-stage reimplantation using a bulk acetabular allograft and a cemented prosthesis impregnated with vancomycin showing a well-fixed prosthesis without loosening. He was free of recurrent infection.

procedure before reimplantation. The decision of timing of reimplantation was based on ESR and CRP levels. When the ESR and CRP levels remained low (ESR < 30 mm/hr, CRP < 10 mg/l), and there were no signs of infection clinically, the reimplantation surgery was scheduled. All hips fit the criteria except for the one associated with psoriasis. In the current report, before reimplantation, seven hips had recurrent infections after the first-stage procedures. Of these, three required a second and four required a third debridement of the hip with reinsertion of antibiotic-loaded cement beads to control infection. Three hips required further resection of the femoral bone at the second and third debridements because of chronic osteomyelitis. The recurrent infection was defined as swelling and pain of the hip with drainage or elevated ESR and CRP. Of the seven hips with recurrent infections after the first-stage procedure, two were only in the soft tissues in which the infection developed after discontinuing antibiotics; the other five hips had infections deep in the hip joints with continuing administration of oral antibiotics. In cases 6 and 20, bacterial cultures were negative during the first-stage procedure despite clinical evidence of purulent discharge. Methicillin resistant *Staphylococcus aureus* (MRSA) and *Enterobacter cloacae* were isolated from the recurrent purulent fluid during the second debridement. In case 41, the causative organism was *Pseudomonas aeruginosa* during the first-stage procedure, however; it shifted to MRSA after reinfection (Table 3). Excluding the case with tuberculosis infection and seven hips with recurrent infections after the first-stage procedures, the duration of intravenous antibiotic therapy in the remaining 40 hips was an average of 2.6 weeks (range, 2 to 6 weeks) and the duration of oral antibiotics was an average of 6 weeks (range, 3 to 12 weeks). The only patient who required a 6-week course of intravenous antibiotics after the first procedure was a case with extensive osteolysis of the pelvis after THA superinfected by Viridans streptococcus. Initially 2 g of intravenous oxacillin was administered every 6 hours for 3 weeks. However, due to persistent high CRP level, it was shifted to teicoplanin under the suggestion of an infection specialist to lower the CRP level. The average interval between the first-stage procedure and reimplantation of all hips was 5.4 months (range, 2 to 24 months). Seven hips had intervals longer than 6 months because of previously failed revisions due to infection or recurrent infections after the first-stage procedure. Of them, three hips had aspiration of the hip and one hip had a second look debridement before definite reimplantation to confirm negative bacterial cultures of the aspirate and surgical specimens.

At reimplantation, the hip was approached posteriorly in all patients. The antibiotic-impregnated cement beads which had been inserted during the first-stage procedure were removed, and the scar tissue around the hip was released. Two sets of bacterial cultures of the hip tissue were obtained. If there was any doubt about the condition of the tissues or purulent fluid in the hip joint, the reimplantation procedure was discontinued awaiting the histological and culture results. In our current report, no hips required discontinuation of the operation at the time of second-stage procedure. A noncemented reimplantation was performed in 11 hips, hybrid reimplantation with antibiotic-loaded cement fixation of the femoral component was performed in 21 hips and both components were cemented using antibiotic-loaded cement in 16 hips (Fig. 1). The decision whether to perform cemented or noncemented revision was based on the severity of the bone deficiency, extent of the allograft reconstruction and stability of the acetabular or femoral component at revision. Fresh frozen morsellized allografts were used in 17 hips, both morsellized and bulk allografts were used in 22 hips and bulk only allografts were used in four hips. Forty-three hips (89%) required morsellized and/or bulk allografts to reconstruct the bone deficiencies at reimplantation. Five hips required no allografts. Bulk allografts were used to reconstruct the acetabular segmental defect in four hips, the cortical defect on the femoral shaft in 11 hips and the calcar defect in the remaining 11 hips. The antibiotic and dosage added to the bone cement at reimplantation was 1 g of vancomycin per 40-g package of cement in most of the hips when the causative organism was gram-positive cocci. We administered 2 g of antibiotics when the causative organisms were other than gram-positive cocci. The prosthesis used for reimplantation was Perfecta (Wright, Arlington, TN) in 18, Omnifit PSL microstructured implant (Osteonic, Allendale, NJ) in 18, Porous Coated Anatomic (Howmedica, Rutherford, NJ) in four, Zimmer Modular Revision System (Zimmer, Warsaw Indiana) in three and megaprosthesis (United Ustar

Table 3. Data of Seven Patients Having Repeat Debridements

Case Number	Comorbidity	Original Organisms Antibiotics in cement beads	Second debridement Organisms Location of infection, Antibiotics in cement breads	Third debridement Organisms Location of infection Antibiotics in cement beads	Femoral bone resection	Results
6	Diabetes mellitus Multiple revision THA Chronic osteomyelitis	Negative Gentamicin	MRSA Hip joint None	MRSA Hip joint Vancomycin	No	Recurrent infection Permanent resection arthroplasty
8	Diabetes mellitus Osteomyelitis after proximal femoral fracture	*E. coli* Gentamicin	*E. coli* Hip joint and femur Gentamicin	*E. coli* Hip joint and femur Gentamicin	Yes	Success
9	None	Viridans streptococcus Vancomycin	Viridans streptococcus Muscle None	None	No	Success
11	Diabetes mellitus Urinary tract infection	*E. coli* Gentamicin	*E. Coli* Muscle None	None	No	Success
20	Liver cirrhosis	Negative Vancomycin	Enterobacter cloacae Hip joint Gentamicin	None	No	Success
40	Osteomyelitis of the femur Multiple infected revision THA	MRSA Vancomycin	MRSA Hip joint and femur Vanocmycin	MRSA Femur Vancomycin	Yes	Success
41	Diabetes mellitus Infected periprosthetic nonunion Osteomyelitis of the femur	*Pseudomonas aeruginosa* Gentamicin	MRSA HIP joint and femur Vancomycin + Gentamicin	MRSA Femur Vancomycin + Gentamicin	Yes	Success

Abbreviations: MRSA: Methicillin resistant Staphylococcus aureus; E. Coli: Escherichia coli; THA: total hip arthroplasty.

System, Taipei, Taiwan) in five hips.

Clinical and radiological evaluation

All patients were examined clinically and radiologically preoperatively, at 3 months, 6 months and every year postoperatively and at an average follow up of 5.6 years (range, 2 to 14 years). The clinical status was assessed using Harris hip scores.[22] Anteroposterior and lateral radiographs of the hips were taken at each follow-up examination. Laboratory tests including ESR and CRP were performed at each visit. Free of recurrent infection was defined when the clinical evaluation of the hip did not show any sign of infection and when ESR was less than 30 mm/hr and CRP was less than 10 mg/l. Acetabular loosening was defined when the sum of the acetabular migration in the horizontal and vertical direction was ≥ 4 mm, the change in the acetabular inclination angle was > 5° and there was a radiolucent line of > 1 mm in all three zones as described

by DeLee and Charnley,[23] or breakage of a screw. Radiological assessment of the revised cemented femoral components was performed using the method described by Harris et al.[24] For the noncemented revision of the femoral component, stability was assessed using the method described by Engh et al.[25] Incorporation of the allograft was defined when its density and architecture were equal to those of the surrounding host bone with a continuous trabecular pattern.[26]

RESULTS

Control of infection

All the patients had negative cultures for the tissues obtained during the second stage procedure except for one with a recurrent pseudomonal infection. At the time of the latest follow up, 46 (96%) hips were free of infection using results of clinical examination and laboratory tests. Two (4%) hips in two patients developed recurrent infections after reimplantation. In both patients, allografts were used during reimplantation. The first patient had diabetes mellitus and developed a pseudomonal infection after uncemented total hip arthroplasty at another hospital. At the initial presentation, a chronic drainage sinus in the hip was noted. ESR was 23 mm/hr and CRP was 11.7 mg/l. A 4-week course of parenteral antibiotics (ticarcillin) followed by an 8-week course of oral antibiotic (carbenicillin) therapy was administered after the first-stage procedure. Before reimplantation, ESR was 15 mm/hr and CRP was 12 mg/l. However, a positive isolation of *Pseudomonas aeruginosa* at the time of reimplantation was identified. No further operation was performed because the patient refused to undergo permanent resection arthroplasty. The second failed case (case 6) was also a diabetic patient who developed infection after revision THA caused by MRSA. The cultures were negative until the reinfection developed after the first-stage procedure. A third debridement was performed before the second-stage reimplantation because of recurrent infections. The reimplantation had been delayed for 11 months since the first-stage procedure until patient insisted on undergoing the procedure. The ESR was 20 mm/hr and CRP was 3.44 mg/l before reimplantation. A recurrent infection caused by the same organism developed after the reimplantation and the patient ended up with a permanent resection arthroplasty (Table 3).

Clinical findings

At the time of the latest follow up, 38 hips (79%) hips were free of pain, seven (15%) had slight pain, two (4%) had moderate pain and one (2%) had severe pain. The mean Harris hip score improved from 26 points (range, 7 to 47 points) preoperatively to 83 points (range, 21 to 98 points) at the latest follow up. Twenty-five (53%) patients had excellent results (90 to 100 points), 10 (21%) had good results (80 to 89 points), seven (15%) had fair results (70 to 79 points) and five (11%) had poor results (less than 70 points). Four patients had re-revision procedures, two for aseptic loosening of the acetabular component and two for aseptic loosening of the femoral component at an average of 7.5 years (range, 5 to 12 years) after index operation. They were all satisfied with the re-revision procedures. The causes of the poor results in five patients included recurrent infections in two, severe sciatica in one, aseptic loosening of the cup in one and bedridden because of dementia in one. The causes of fair results in seven patients included medical problems in four and megaprosthesis replacement with poor bone stock in three. The remaining 35 (74%) patients were satisfied with their outcomes.

Radiological findings

At the latest follow up, two patients had incomplete radiolucent lines of 1 mm at the cement-allograft interface of the acetabular component, one at zone 1 and 2 and another at zone 2 and 3. One patient had mild hip pain requiring no support, and another had moderate pain requiring a support for walking. Aseptic loosening of the components was observed in four patients, two on the acetabular side and two on the femoral side at an average of 7.5 years after the index procedures. All were successfully re-revised.

All hips had complete incorporation of the morsellized allografts either in acetabular or femoral side. All the bulk allografts, both acetabular and femoral, were united to the host bone (Fig. 1).

Complications

Two postoperative posterior dislocations of the hip occurred. One was successfully treated with closed reduction and the other required a revision

procedure because of malposition of the acetabular component. Three patients had a periprosthetic fractures of the femur at 1, 8 and 11 years after their index operations, one was Vancouver type C and two were type B1.[27] All were successfully treated with open reduction and internal fixation. Two patients had leg length discrepancies of more than 2 cm because of multiple revisions.

DISCUSSION

Two-stage reimplantation of infected hip arthroplasty is a well-established procedure. As high as 90% of infection eradication was achieved when antibiotic-impregnated cement was used during the second stage.[28] However, there were still some variables in the different reports as to the duration of postoperative antibiotic therapy after the first-stage debridement and removal of the prosthesis. A minimum of 6 weeks postoperative antibiotic therapy regimen is standard orthopaedic practice in the western countries.[13] However, because of limited home nursing care programs for parenteral antibiotic therapy in Taiwan and the expense of prolonged hospitalization required for the 6-week antibiotic regimen, a short-term intravenous antibiotic therapy protocol has been employed since the introduction of gentamicin-impregnated cement beads (Septopal, Merck, Darrmstadt, Germany). Patients received a course of intravenous antibiotics for at least 2 weeks after debridement, removal of the hip prosthesis and implantation of gentamicin-impregnated cement beads or other antibiotics added to the bone cement according to preoperative result of bacterial cultures of the aspirate. Intravenous antibiotics were discontinued when the serum CRP returned to < 5 mg/l and appropriate oral antibiotics were administered for an additional 4 to 6 weeks. An earlier study by Nelson et al. compared the clinical results of the two-stage reimplantation of infected total hip and knee arthroplasty using gentamicin-impregnated cement beads implantation with those of conventional parenteral antibiotic therapy.[29] Patients in the conventional systemic antibiotic group received 6 weeks of intravenous antibiotics, however, in the group using gentamicin-impregnated cement beads, the patients received less than 5 days of systemic antibiotics. The rate of recurrent infection was similar in both groups. Later, with the development of antibiotic-impregnated cement spacers, the reported duration of intravenous antibiotic therapy after the first-stage procedure in infected total joint arthroplasty varied from 4.6 days to 2 weeks.[17-21] The clinical success rate was similar in the different reports. Thus, extended antibiotic therapy in two-stage revision of the infected joint arthroplasty is controversial. This study showed 96% infection control rate of 48 hips at an average follow-up of 5.6 years in two-stage reimplantation of the infected hip arthroplasty with an average 2.6 weeks (range, 2 to 6 weeks) of intravenous antibiotic therapy after the first-stage procedure.

Adequate debridement with thorough removal of all the foreign materials and the devitalized tissue is the key to success of infection control. The antibiotic-impregnated cement spacers or beads implanted in the acetabulum and femoral canal act as spacers as well as antibiotic delivery devices. Both experimental and clinical studies have confirmed the effectiveness in infection eradication in chronic osteomyelitis[30-33] and infected arthroplasty.[7,17,19,34-36] Systemic antibiotic therapy has been used to treat the systemic infection and residual infections around the hip joints; however, it cannot replace adequate debridement.[21] Seven hips in our current study required second or third debridements because of recurrent infections after the first-stage procedure. Of those, two hips developed recurrent infection in the soft tissues, but not in the joint. One hip (case 20) initially had negative culture results and underwent a second debridement because of purulent discharge in which *Enterobacter cloacae* was isolated. Another hip (case 41) grew *Pseudomonas aeruginosa* during the first debridement, however, it shifted to MRSA after recurrence. Both instances were good examples of inappropriate antibiotic therapies. Two hips required second resections of the infected femoral bone to the control infections. The last one hip (case 6) had a recurrent deep infection by the same organism after reimplantation despite two debridements after the first-stage procedure. Inadequate debridement without aggressive resection of the necrotic bones and poor general health which resulted in chronic osteomyelitis of the femur was considered the cause of the failure. Hoad-Reddick et al. reported using a short-term (4.64 days) intravenous antibiotic therapy to treat 59 infected total knee arthroplasties (TKA) with interim antibiotic-impregnated cement

beads and spacer after the first-stage procedure.[21] Repeat debridement was required in six patients. Infection eradication rate was 89% in 38 patients who underwent two-stage reimplantations. They concluded that prolonged course of antibiotic therapy was unnecessary when rigorous debridement was performed and when appropriate antibiotics were added to the bone cement as spacers after debridement.

The articulated spacer impregnated with appropriate antibiotics has been used in treating infected hip arthroplasty to provide proper soft-tissue tension and limb length between stages. Although it was considered to have a reduced surface area compared with that associated with the beads, as high as 95.7% of eradication of infection has been reported.[37] Recently, in a study of 70 patients using cement beads compared with 58 patients using cement prosthesis between stages, showed that the rates of eradication of the infection were similar in both groups, however, the cement prosthesis group gained higher hip scores, reduced hospital stay, and lower rate of hip dislocation.[17]

Inflammatory markers such as ESR and CRP may be non-specific for the diagnosis of infective arthroplasty.[38,39] However, a high negative predictive value at the time of the second-stage procedure for septic TKA has been reported.[19,20] Furthermore, high ESR (> 40 mm/hr) and CRP (> 10 mg/l) in a patient with normal ESR and CRP after treatment for infected joint replacement may be indicative of recurrent infection which would remind surgeons to conduct further investigations before reimplantation. When using ESR and CRP to monitor infections after THA, Shih et al. noted that CRP returned to normal approximately 3 weeks after adequate treatment of infected THA.[40] Our protocol for determining the timing of reimplantation included ESR, CRP, and clinical symptoms and signs. Reimplantation is scheduled when ESR and CRP remain at low levels (ESR < 30 mm/hr and CRP < 10 mg/l) and there are no signs of infection clinically. If ESR increases to > 40 mm/hr and CRP to > 10 mg/l, aspiration of the hip joint is performed. A second debridement is considered when the results of aspirate cultures are positive or obvious clinical signs of recurrent infection are noted. In the current report, seven hips had further debridements, two because of soft tissue abscess and five because of persistent bone and joint infections. All seven hips had ESR levels above 40 mm/hr and CRP levels above 10 mg/l. Infection was eradicated in six of the seven hips after further debridements. Therefore, inadequate initial debridement resulting in soft tissue abscesses or periarticular osteomyelitis is considered a cause of recurrent infections.

In conclusion, two-stage reimplantation of infected hip arthroplasty can achieve successful results when adequate debridement is performed and cement spacer or beads impregnated with appropriate antibiotics are used between the stages.

REFERENCES

1. Goulet JA, Pellicci PM, Brause BD, Salvati EM. Prolonged suppression of infection in total hip arthroplasty. J Arthroplasty 1988;3:109-16.
2. Drancourt M, Stein A, Argenson JN. Oral rifampin plus ofloxacin for treatment of Staphylococcus-infected orthopedic implants. Antimicrob Agents Chemother 1993;37:1214-8.
3. Rao N, Crossett LS, Sinha RK, LeFrock JL. Long-term suppression of infection in total joint arthroplasty. Clin Orthop 2003;414:55-60.
4. Tsukayama DT, Estrada R, Gustilo RB. Infection after total hip arthroplasty. A study of the treatment of one hundred and six infections. J Bone Joint Surg Am 1996;78:512-23.
5. Crockarell JR, Hanssen AD, Osmon DR, Morrey BF. Treatment of infection with debridement and retention of the components following hip arthroplasty. J Bone Joint Surg Am 1998;80:1306-13.
6. Buchholz HW, Elson RA, Engelbrecht E, Lodenlcämper H, Böttger J, Siegel A. Management of deep infection of total hip replacement. J Bone Joint Surg Br 1981;63:342-53.
7. Carlsson AS, Josefsson G, Lindberg LT. Revision with gentamicin-impregnated cement for deep infections in total hip arthroplasties. J Bone Joint Surg Am 1978;60:1059-64.
8. Sanen L, Carlsson AS, Josefsson G, Lindberg LT. Revision operations on infected total hip arthroplasties. Two- to nine-year follow-up study. Clin Orthop 1988;229:165-72.
9. Wroblewski BM. One-stage revision of infected cemented total hip arthroplasty. Clin Orthop 1986;211:103-7.
10. Duncan CP, Masri BA. The role of antibiotic-loaded cement in the treatment of an infection after a hip replacement. J Bone Joint Surg Am 1994;76:1742-51.
11. Ivarsson I, Wahlström O, Djerf K, Jacobsson SA. Revision of infected hip replacement. Two-stage procedure with a temporary-gentamicin spacer. Acta Orthop Scandinavica 1994;65:7-8.

12. Garvin KL, Hanssen AD. Infection after total hip arthroplasty. Past, present, and future. J Bone Joint Surg Am 1995;77:1576-88.
13. Toms AD, Davidson D, Masri BA, Duncan CP. The management of periprosthetic infection in total joint arthroplasty. J Bone Joint Surg Br 2006;88:149-55.
14. McDonald DJ, Fitzgerald RH Jr, Ilstrup DM. Two-stage reconstruction of a total hip arthroplasty because of infection. J Bone Joint Surg Am 1989;71:828-34.
15. Lieberman JR, Callaway GH, Salvati EA, Pellicci PM, Brause BD. Treatment of the infected total hip arthroplasty with a two-stage reimplantation protocol. Clin Orthop 1994;301:205-12.
16. Wang JW, Chen CE. Reimplantation of infected hip arthroplasties using bone allografts. Clin Orthop 1997;335:202-10.
17. Hsieh PH, Shih CH, Chang YH, Lee MS, Shih HN, Yang WE. Two-stage revision hip arthroplasty for infection: comparison between the interim use of antibiotic-loaded cement beads and a spacer prosthesis. J Bone Joint Surg Am 2004;86:1989-97.
18. Haddad FS, Muirhead-Allwood SK, Manktelow ARJ, Bacarese-Hamilton I. Two-stage uncemented revision hip arthroplasty for infection. J Bone Joint Surg Br 2000;82:689-94.
19. Taggart T, Kerry RM, Norman P, Stockley I. The use of vancomycin-impregnated cement beads in the management of infection of prosthetic joints. J Bone Joint Surg Br 2002;84:70-2.
20. Harts WJ, Jones RS. Two-stage revision of infected total knee replacements using articulating cement spacers and short-term antibiotic therapy. J Bone Joint Surg Br 2006;88:1011-5.
21. Hoad-Reddick DA, Evans CR, Norman P, Stockley I. Is there a role for extended antibiotic therapy in a two-stage revision of the infected knee arthroplasty? J Bone Joint Surg Br 2005;87:171-4.
22. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mole arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969;51:737-55.
23. DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. Clin Orthop 1976;121:20-32.
24. Harris WH, McCarthy JC, O'Neill DA. Femoral component loosening using contemporary techniques of femoral cement fixation. J Bone Joint Surg Am 1983;64:1063-7.
25. Engh CA, Bobyn JD, Glassman AH. Porous-coated hip replacement: the factors governing bone ingrowth, stem shielding and clinical results. J Bone Joint Surg Br 1987;69:45-55.
26. Conn RA, Peterson LFA, Stauffer RN, Ilstrup D. Management of acetabular deficiency: long-term results of bone grafting the acetabulum in total hip arthroplasty. Orthop Trans 1985;9:451-2.
27. Duncan CP, Masri BA. Fractures of the femur after hip replacement. Instr Course Lect 1995;45:293-304.
28. Hanssen AD, Rand JA. Evaluation and treatment of infection at the site of a total hip arthroplasty. J Bone Joint Surg Am 1998;80:910-22.
29. Nelson CL, Evans RP, Blaha JD, Calhoun J, Henry SL, Pazakis MJ. A comparison of gentamicin-impregnated polymethylmethacrylate bead implantation to conventional parenteral antibiotic therapy in infected total hip and knee arthroplasty. Clin Orthop 1993;295:96-101.
30. Organ CH. The utilization of massive doses of antimicrobial agents with isolation perfusion in the treatment of chronic osteomyelitis. Clin Orthop 1971;76:185-93.
31. Wahlig H, Dingeldein E, Bergmann R, Reuss K. The release of gentamicin from polymethylmethacrylate beads. J Bone Joint Surg Br 1978;60:270-5.
32. Fitzgerald RH J. Experimental osteomyelitis: Description of a canine model and role of depot administration of antibiotics in the prevention and treatment of sepsis. J Bone Joint Surg Am 1983;65:371-80.
33. Wininger DA, Fass RJ. Antibiotic-impregnated cement and beads for orthopedic infections. Antimicrob Agents Chemother 1996;40:2675-9.
34. Bucholz HW, Elson RA, Heinert K. Antibiotic-loaded acrylic cement: current concepts. Clin Orthop 1984;190:98-108.
35. Lynch M, Esser MP, Shelley P, Wroblewski BM. Deep infection in Charnley low-friction arthroplasty. Comparison of plain and gentamicin-loaded cement. J Bone Joint Surg Br 1987;69:355-60.
36. Hsieh PH, Shih CH, Chang YH, Lee MS, Yang WE, Shih HN. Treatment of deep infection of the hip associated with massive bone loss. Two-stage revision with an antibiotic-loaded interim cement prosthesis followed by reconstruction with allograft. J Bone Joint Surg Br 2005;87:770-5.
37. Evans RP. Successful treatment of total hip and knee infection with articulating antibiotic components: a modified treatment method. Clin Orthop 2004;427:37-46.
38. Levisky KA, Hozack WJ, Balderston RA, Rothman RH, Gluckman SJ, Maslack MM, Booth RE. Evaluation of the painful prosthetic joint. Relative value of bone scan, sedimentation rate and joint aspiration. J Arthroplasty 1991;6:237-44.
39. Roberts P, Walters AJ, McMinn DJW. Diagnosing infection in hip replacement. The use of five-needle aspiration and radiometric culture. J Bone Joint Surg Br 1992;74:265-9.
40. Shih LY, Wu JJ, Yang DJ. Erythrocyte sedimentation rate and C-reactive protein values in patients with total hip arthroplasty. Clin Orthop 1987;225:238-46.

兩階段重置換來治療人工髖關節感染

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背 景： 雖然以兩階段重置換術治療人工髖關節感染可達到高的成功率，然而在第一階段清除人工關節後使用抗生素的療程各家報告並不相同。本文目的在評估全人工髖關節感染後，以合併靜脈及口服抗生素治療，並以 ESR，CRP 加上臨床徵象決定重置換之時機，來進行兩階段重置換術之臨床效益。

方 法： 47 位病人 (48 個髖關節) 因人工髖關節感染以兩階段重置換術，包括使用含抗生素之骨水泥載子及平均 2.6 週的靜脈抗生素注射。第二階段重置換的時機乃根據抽血檢驗 ESR、CRP 及臨床上無感染跡象。平均術後追蹤時間爲 5.6 年。

結 果： 46 個髖關節 (96%) 無感染再發現象。所有關節除了一個關節外其他 47 個關節在第二階段重置換時的組織細菌培養均爲陰性。平均第一次清創直到全人工髖關節重置換的時間爲 5.4 個月。兩個關節 (包括一個重置換時組織細菌培養爲陽性的關節) 在重置換後感染再發。Harris hip score 從術前平均 26 分進步到術後最後追蹤平均 83 分。35 位病人 (74%) 有滿意的結果。

結 論： 如果第一階段徹底清創加上使用合適的含抗生素之骨水泥載子合併靜脈注射及口服抗生素療程以及以 ESR，CRP 回復正常來決定重置換之時機，兩階段重置換術治療人工髖關節感染可達到高成功率。

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關鍵詞： 兩階段重置換，人工髖關節感染，發炎標記

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