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Staged arthroplasty as salvage procedure for deep hip infection following intertrochanteric fracture

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Abstract Deep hip infection is a rare complication of intertrochanteric fractures and an optimal treatment has not yet been reported. Twenty-seven patients who contracted deep hip sepsis following the failed primary treatment of an intertrochanteric fracture were treated with two-stage hip arthroplasty. Antibiotic-impregnated cement beads were implanted following resection arthroplasty in the first 15 patients, and a temporary cement spacer prosthesis was used in the other 12 hips. There was only one recurrence of infection at an average follow-up of 4.8 years. Complications included non-union of the greater trochanter in four patients, intraoperative femoral fracture in two and fracture of the cement prosthesis in one. The use of an interim spacer was associated with better hip function in the interim period; a decreased operative time and less blood loss at the time of arthroplasty; and a higher hip score at final follow-up. Staged arthroplasty is an effective salvage procedure for deep hip infection after the failed treatment of an intertrochanteric fracture. The use of a temporary spacer maintains hip function between stages, makes arthroplasty less complicated, and improves the clinical outcome.

Résumé L'infection profonde est une complication rare des fractures intertrochantériennes. Aucun traitement particulier n'a d'ailleurs été rapporté. 27 patients qui ont contracté une infection profonde à la suite d'un échec du traitement initial d'une fracture inter trochantérienne ont été traités par arthroplastie en deux temps. Premièrement,

ont été mise en place des billes de ciment imprégné d'antibiotiques après la résection arthroplastique chez les 15 premiers patients. Un spacer temporaire de ciment a été utilisé pour les 12 autres hanches. Il y a eu une seule récurrence d'infection avec un délai 4,8 ans. Les complications sont les suivantes, pseudarthrose du grand trochanter chez 4 patients, fracture per-opératoire du fémur chez 2 patients, fracture du spacer en ciment chez un patient. L'utilisation d'un spacer temporaire est bien corrélée avec une bonne fonction de la hanche pendant la période d'implantation temporaire. Cette période d'implantation permet une diminution du temps opératoire, de reprise, une moindre perte sanguine durant l'arthroplastie et un meilleur score final après l'implantation. La réalisation d'une arthroplastie en deux temps pour un échec de traitement de fracture inter trochantérienne donne un résultat satisfaisant, l'utilisation d'un spacer temporaire maintient une bonne fonction de la hanche entre les deux temps opératoires et permet la réalisation d'une arthroplastie avec moins de complications et un meilleur résultat à long terme.

Introduction

Open reduction and internal fixation has been widely accepted as an effective treatment for intertrochanteric hip fractures. With contemporary surgical technique and fixation devices, most intertrochanteric fractures can be treated successfully [6, 16]. Nevertheless, treatment of intertrochanteric fractures can occasionally fail because of deep infection. Theoretically, infection following an extracapsular fracture does not involve the hip joint. Aggressive debridement, bone grafting and revision fracture fixation with proper antibiotic treatment may be considered to preserve the patient's femoral head [17]. Sometimes, however, the dynamic hip screw may cut out of the femoral head, there may be a comminuted fracture pattern with an intraarticular fragment, or damaged articular cartilage due to excessive reaming, any of which can compromise the chance of keeping the infection process away from the hip joint. Under these circumstances, a resection arthroplasty,

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removal of foreign materials, thorough debridement and proper antibiotic treatment, followed by replacement arthroplasty performed in a staged fashion, should be considered [5].

This study was performed to evaluate the clinical outcomes of salvage of deep hip sepsis following the failed treatment of intertrochanteric fractures with two-stage arthroplasty and specifically compared the results with and without use of an interim antibiotic-loaded cement spacer.

Patients and methods

Between 1990 and 2002, 31 consecutive patients who had deep hip infection following the failed treatment of an intertrochanteric fracture were treated with a two-stage hip arthroplasty. Institutional review board approval and consent were obtained for the retrospective review. Four patients died before a minimum 2-year follow-up of problems unrelated to the hip disease, leaving 27 patients available for evaluation. Twenty-six patients had had failure of a previous internal fixation procedure (23 with a sliding hip screw, three with a cephalomedullary nail), and one had deep hip sepsis following non-union of a fracture that initially had been treated nonoperatively. Sixteen patients had had more than one operation before referral. Six had had revision of the sliding hip screw, four had undergone extra-skeletal fixation to achieve fracture union, and six had had debridement surgery with retention of the fixation devices in an attempt to eradicate infection. From 1990 to 1995, 15 patients had the traditional antibiotic-impregnated cement beads and between 1996 and 2002, 12 patients had the cement prosthesis as an interim spacer. The demographics of the two groups are shown in Table 1. Age, gender, and number of patients with multiple prior surgeries are matched.

The diagnosis of infection was based on the presence of at least one of the following clinical signs: (1) a chronic discharging sinus communicating with the hip; (2) frank purulent fluid or pus found during the operation; (3) high serum level of C-reactive protein (CRP; ≥ 20 mg/l), as well as acute inflammation on histological examination of

tissues obtained at the time of operation, according to the criterion of more than five polymorphonuclear leukocytes per high-power field [14]. Intraarticular involvement of infection was diagnosed preoperatively by the absence of joint space on the X-ray and confirmed by operative exploration with positive cultures of biopsy specimens in all hips. The mean interval between fracture and resection arthroplasty was 7 (1–18) months.

The beads were made manually from bone cement (Surgical Simplex, Limerick, Ireland) mixed with antibiotics. For patients whose infecting micro-organism was sensitive to gentamicin, we used commercial gentamicin-containing beads (Septopal, Biomet Merck, Darmstadt, Germany). The technique of fabricating the spacer prosthesis was described previously [9]. In brief, we used custom-made metal moulds with several large Kirschner wires as an endoskeleton to form the femoral components (Fig. 1). The cement prosthesis was cemented to the host proximal femur with a collar of antibiotic-loaded cement. The acetabular component was made from a bolus of cement inserted into the acetabular cavity and then shaped into a hemisphere using a retrieved unipolar cup. The cement contained 8 g antibiotic powder in each package of 40 g cement polymer. The choice of antibiotics in the bone cement depended on the results of bacterial cultures obtained from the draining sinuses or preoperative joint aspirations. If the infecting microorganism could not be found preoperatively, we used a combination of 4 g vancomycin and 4 g piperacillin per 40-g pack of cement.

All patients were given intravenous antibiotics for 2 weeks. An additional 4-week oral antibiotic treatment was prescribed when an appropriate antibiotic was available in oral form. The patients were encouraged to walk with toe-touch weight-bearing. The serum level of CRP was checked every 2 weeks to evaluate the control of infection.

The second-stage procedure was carried out when the wound had healed, the CRP level had returned to normal, and the surgery was medically feasible, usually 6–12 weeks after the first stage. A cemented stem was used in 11 hips, an uncemented long stem without calcar build-up in 14

Table 1 Patient information

Variables	Beads	Spacer
Patients (<i>n</i>)	15	12
Age, years (range)	69 (36–82)	66 (55–87)
Gender	9 M / 6 F	7 M / 5 F
Follow-up, years (range)	5.8 (2–8)	3.7 (2–6)
Multiple prior surgeries ^a	8	8
Diagnosis of infection ^a		
Discharging sinus	4	3
Purulent fluid or pus	9	7
High CRP with positive pathology	13	12

^aNumber of hips

CRP, C-reactive protein

Fig 1 a The metal mold used to make the cement prosthesis; b the femoral component of the cement prosthesis

Fig 2 **a** An AP radiograph of an 81-year-old man with septic nonunion of an intertrochanteric fracture shows cutout of a hip screw and loosening of the side plate with broken screws. **b** A radiograph shows the hip 4 months after the first-stage surgery. An antibiotic-loaded cement prosthesis was used to maintain leg length and hip function. **c** A radiograph 2 years after total hip arthroplasty shows stable uncemented components

hips, and a calcar-replacing long stem in 2 hips. All patients had a porous-coated metal-backed cup inserted without cement (Fig 2).

The patients were examined at 1 month, 3 months, 6 months and 1 year after operation and annually thereafter. Presence of pain at rest with elevation of serum level of CRP was monitored as an indicator of recurrent infection. The function of the involved hips were evaluated using the Merle D'Aubigne and Postel hip scoring system [13]. Serial radiographs were used to assess component fixation. Loosening of the acetabular components was defined as implant migration, a complete radiolucent line at the metal-bone interface, or breakage of screws [8]. Loosening of the cemented femoral stems was evaluated according to the criteria described by Harris [7], and loosening of the uncemented femoral stems was evaluated according to the system of Engh et al [4].

For categorical data, a Chi-square analysis or a Fisher's exact test was used when appropriate. For numerical data, a two-tailed Student's *t* test or a nonparametric Mann-Whitney U test was used for comparison between the two groups. Statistical significance was defined as $p < 0.05$.

Results

The infecting microorganisms in both patient groups were similar, predominantly Gram-positive species. At the second-stage operation, there was no visible evidence of infection and the cultures were all negative. Recurrence of infection was detected 6 months after replacement arthroplasty in one patient who had been treated with cement beads. The recurrent infection was caused by coagulase-negative *Staphylococcus* instead of the original *Staphylococcus aureus*. He underwent re-resection arthroplasty without reimplantation because of advanced cirrhosis of the liver. At the time of review, there was no evidence of infection in any other patient.

The operative details, including antibiotics that were used in bone cement are listed in Table 2. There was no significant difference between the two groups with regard to the operative time, blood loss, and transfusion requirement at the time of the first-stage operation. The duration between stages was similar in both groups of patients. At the time of the second-stage procedure, patients treated with a spacer prosthesis had a shorter operative time, less loss of blood, and lower transfusion requirements.

Table 2 Operative details (mean values with ranges in parentheses)

	Beads	Spacer	<i>p</i> value
First stage			
Operative time (min)	140 (85–215)	153 (95–220)	0.37
Blood loss (ml)	983 (450–2150)	1150 (550–2200)	0.43
Blood transfused (units)	1.9 (0–4)	2.1 (0–4)	0.77
Antibiotics used in bone cement (number of patients)			
Vancomycin + piperacillin	10	6	
Gentamicin (Septopal)	3	0	
Vancomycin	2	2	
Vancomycin + aztreonam	0	4	
Duration of interim period (weeks)	13.3 (9–22)	15.1 (7–23)	0.29
Second stage			
Operative time (min)*	201 (115–290)	146 (95–215)	0.002
Blood loss (ml)*	1833 (950–3150)	988 (450–2650)	< 0.001
Blood transfusion (units)*	3.4 (1–6)	1.5 (0–4)	< 0.001

*Significant difference

Table 3 Function (mean values with ranges in parentheses)

	Beads	Spacer	<i>p</i> value
Preoperative			
Hip score (points)	9.1 (5–13)	10.3 (6–14)	0.17
Interim period			
Hip score (points)*	8.4 (6–14)	12.8 (7–16)	< 0.001
Ambulation (number of patients)*	0	9	< 0.001
Final followup			
Hip score (points)*	14.1 (10–17)	15.6 (12–18)	0.03

*Significant difference

The preoperative Merle D'Aubigne and Postel hip scores were similar in the two groups (Table 3). During the interim period, patients with a spacer prosthesis had significantly higher hip scores and better mobility. No patient with beads was able to walk between the two stages. On the other hand, although weight-bearing on the involved limb was restricted, most patients (9/12) who had a temporary prosthesis could ambulate with various aids in the interim period. At the time of the latest follow-up, the average hip score was higher in patients who had been treated with an interim articulating spacer.

Radiographically, progressive subsidence of the cemented femoral stem was seen in two patients at 3 and 5 years; both needed revision surgery after the index arthroplasty. All the other stems appeared stable. In one patient, a broken screw used for fixation of the acetabular cup was seen 1 year postoperatively. However, the patient had minimal discomfort when followed up at 4 years and revision surgery was not required.

The most common complication was non-union of the greater trochanter, which was seen in four patients. Open reduction and fixation of the ununited greater trochanter with a cable grip was required in two of them because of persistent symptoms. Two patients who had been treated with cement beads had femoral fractures at the time of prosthesis implantation; both were treated successfully by fixation with cable wires. Two patients who had been treated with a spacer prosthesis had a fracture of the cement femoral stem before hip arthroplasty. They were treated conservatively with immobilization and skin traction, followed by an earlier second-stage surgery.

Discussion

This study is the first to report the outcome of two-stage arthroplasty performed as a salvage procedure for deep hip infection following intertrochanteric fractures. We have shown that a high rate of success can be achieved with this technique. Of 27 hips followed up for an average of 4.8 years, 26 had no recurrence of infection and all had significant improvement in functional scores.

Total hip replacement for complications of intertrochanteric fractures is difficult [5, 15]. A two-stage hip arthroplasty for infection after a failed internal fixation of

an intertrochanteric fracture poses even more challenges to the orthopaedic surgeon due to the presence of the fixation device, non-union of the fracture, and bone loss. Without proper management, the patients are almost always painfully disabled between stages. The subsequent prosthetic implantation can be technically complicated [2]. In a previous study, Hsieh et al. [9] compared the results after interim use of cement beads and a spacer in two-stage revision for periprosthetic infections. They found better clinical outcomes when a temporary spacer was used. Our study analysed the results of treatment for infection following intertrochanteric fractures, finding that use of a spacer was associated with a significantly higher hip score and better mobility in the interim period; a less complicated total hip arthroplasty; and a better functional recovery.

The patients with an interim articulating spacer, with shorter follow-up, had no re-infections at the time of writing but it is too early to speculate on the longer-term re-infection rate in the patients with the spacers. However, since the CRP level had returned to normal before prosthesis replacement and cultures obtained at the time of the second-stage surgery were all negative in these patients, it is reasonable to expect a similar re-infection rate in both study groups with comparable follow-up.

The strengths of the present study include a relatively large number of consecutive patients with a high rate of follow-up, and the fact that two surgeons (P.-H.H. and C.-H.S.) as a team treated all the patients using a similar technique. Limitations of the study are its retrospective methodology, the lack of randomisation of the treatment for each patient, and the fact that the type of prosthesis used for implantation was not standardised. Additionally, because the selection of the interim management was determined on a chronological basis, some may be concerned that the better clinical outcome documented in the latter patients is a reflection of the better implant design of more recent years. Nevertheless, we do not think that these limitations undermine the conclusion, because the use of an articulating spacer was associated with significantly better interim hip function and resulted in less complicated second-stage surgery, which would logically be expected to result in an improved ultimate clinical outcome.

The use of a temporary spacer in management between stages has been reported in several studies [3, 10, 12]. The spacers can be prepared in the operating room by the surgeons, but also can be supplied pre-formed. The method used in this study is a simple and inexpensive way to fabricate the antibiotic-loaded cement prosthesis with a cement-on-cement articulation. We prefer a total-hip type spacer rather than a hemiarthroplasty type because the latter may cause pain and further bone loss in the acetabulum if ambulation is envisaged.

Some authors have advocated a one-stage arthroplasty in the treatment of deep hip infections as an alternative [1]. A one-stage procedure is conceptually attractive to obviate repeated surgery, decrease medical costs, and avoid technical difficulties. However, few cases meet the strict criteria for this type of surgery and currently it has a limited role [11].

The patients in this series represent a selected cohort who had deep intraarticular infection after failed treatment of intertrochanteric hip fractures. At the authors' institution, patients who had an intact articular cartilage, good remaining proximal femur and high physical expectations were treated by debridement, bone grafting, and revision of fixation to achieve union. Wu and Chen [17] reported on infected non-union of 12 intertrochanteric fractures previously treated with a sliding hip screw. At a median follow-up of 4 years, all hips were salvaged successfully by one-stage debridement, reinsertion of a new sliding hip screw and bone grafting.

In summary, we found that two-stage arthroplasty is very effective in eradicating infection and restoring function in patients with deep hip sepsis after failed treatment of intertrochanteric fractures. The antibiotic-loaded cement prosthesis offers the benefits of two-stage surgery without the functional disadvantages of a resection arthroplasty. It can be produced by a simple moulding method and maintains joint function between stages, makes prosthesis implantation less complicated, and improves the clinical outcome.

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