One-stage cementless revision arthroplasty for infected hip replacements

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Abstract We hypothesised that one-stage cementless revision hip arthroplasty may have advantages and a role in the treatment of selected patients with an infected hip replacement. We retrospectively reviewed all patients with an infected hip replacement treated with one-stage revision using cementless implants. Twelve patients were reviewed and followed up for at least three years (average: 7.2 years, range: 3.3–11.3 years) postoperatively. One recurrence of infection and one aseptic stem loosening were detected during follow-up. Grafted bone, which was used in eight patients, appeared to have united to host bone in all patients. The success rate of treatment was 83.3% when infection recurrence or component loosening were regarded as failure. One-stage revision hip arthroplasty using cementless implants appears to have a role in the treatment of carefully selected patients with an infected hip replacement if meticulous débridement is performed and appropriate antibiotics are properly used.

Résumé Notre hypothèse de travail était la suivante: le changement en un temps par une prothèse sans ciment d'une prothèse totale de hanche infectée, est la bonne indication thérapeutique. Matériel et méthode: nous avons revu de façon rétrospective tous les patients présentant une hanche infectée

traitée par une révision en un temps en utilisant un implant sans ciment. 12 patients ont été revus et suivis pendant au moins 3 ans (7,2 ans en moyenne, 3,3 et 11,3 ans post-opératoire). Résultats: nous avons observé une récurrence d'infection et un descellement aseptique durant cette période de suivi. L'os greffé chez 8 patients nous apparaît comme ayant consolidé à l'os hôte chez tous les patients. Le pourcentage de succès thérapeutique est de 83,3% si l'on regarde la récurrence de l'infection ou le descellement aseptique. En conclusion: les révisions en un temps en utilisant un implant sans ciment nous apparaissent comme un traitement de choix chez les patients sélectionnés avec soin et présentant une infection de prothèse totale de hanche.

Introduction

Infection after hip replacement is a serious local complication and generally requires revision arthroplasty [5]. Today, many surgeons recommend two-stage exchange arthroplasty with antibiotic-loaded spacer implantation after the removal of the original components [9, 18]. However, staged treatment of infected hip replacement is prolonged and frequently leads to functional sequelae or impairment. It is also expensive and imposes a heavy health care cost burden [15]. One-stage revision arthroplasty is an attractive therapeutic option, since it only requires one operation, has low morbidity, is free from the technical difficulties associated with delayed reconstruction and, if successful, offers a cost-efficient option [1, 10, 20, 24].

When direct one-stage revision is thought appropriate, the use of strict selection criteria and an antibiotic-impregnated cement for prosthesis fixation has been strongly recommended [10, 21, 22]. However, the intermediate and long-term results of revision hip arthroplasty

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implants inserted with cement have not been encouraging; in particular, failure and loosening rates are unacceptably high [2, 19]. On the other hand, the clinical results of two-stage revision arthroplasty performed with a cementless prosthesis in patients with an infected hip arthroplasty are encouraging and comparable to those of cemented reconstruction [7, 13, 14, 18]. Therefore, we hypothesised that one-stage cementless revision hip arthroplasty may have a role in the treatment of carefully selected patients with an infected hip replacement. To the best of our knowledge, no report has previously been published in an English-language journal on one-stage cementless revision hip arthroplasty in patients with a deep infection around a hip prosthesis.

In 1991, we began to use a one-stage cementless revision protocol in a properly selected series of patients with a deep infection around a hip prosthesis. The purpose of this study was to evaluate the clinical results of one-stage revision hip arthroplasty using cementless implants.

Patients and methods

This study details a retrospective clinical review of all patients that developed an infection at the site of a hip replacement who then underwent one-stage revision arthroplasty with cementless implants. All patients were operated upon by two adult reconstructive surgeons between November 1991 and January 2005. Twenty-two patients underwent one-stage revision arthroplasty with cementless implants with suspected infections; ten patients with

negative intraoperative cultures were excluded. Finally, 12 patients were included in this study. There were eight men and four women with a mean age at index revision arthroplasty of 50 years (29–72) (Table 1). The mean time between previous surgery and the index revision surgery was 3.6 years (1.2–9.8). Of the 12 patients, 11 had suffered from hip pain for more than one year before index revision. Patients were followed up for more than three years (average: 7.2 years, range: 3.3–11.3 years). The study was approved by the Institutional Review Board.

A diagnosis of infection was made if there was chronic hip pain, purulent fluid or pus was found during operative exploration, the erythrocyte sedimentation rate (ESR) was >9 mm/h or the C-reactive protein (CRP) level was >0.5 mg/dl. Infections were confirmed by positive culture findings for biopsy specimens obtained at the time of index revision arthroplasty in all hips.

Treatment protocol

Selection criteria and preoperative evaluation

We performed one-stage cementless revision hip arthroplasty to treat infected hip replacements in selected non-immunocompromised patients (1) without chronic consumptive disease, (2) without a previous history of hip infection, (3) without any sign of acute systemic infection (e.g. fever), (4) without a discharging sinus at index surgery, (5) with adequate soft tissue and bone stock to obtain a closed

Table 1 Data on patients treated

Case	Primary diagnosis	Gender	Age at index op. (years)	Duration of follow-up (years)	Preop. ESR/CRP (mm/h/mg/dl)	Findings on preop. culture	Preop. replacements	Revision performed	Bone graft
1	Osteonecrosis	M	66	8.5	88/6.0	Not performed	Hybrid THA	Total	Allograft on acetabulum
2	Osteonecrosis	M	29	3.5	4/0.1	<i>Enterococcus faecalis</i>	Cementless THA	Cup	None
3	Osteonecrosis	M	43	10.9	47/1.7	MSCNS	Cementless bipolar	Total	None
4	Osteonecrosis	M	38	11.3	28/3.0	Not performed	Hybrid THA	Total	Allograft on acetabulum
5	Infection sequelae	F	38	10.2	21/0.3	MSCNS	Hybrid THA	Total	Allograft on acetabulum
6	Fracture	M	37	9.2	37/1.3	MSCNS	Cementless bipolar	Total	Allograft on acetabulum
7	Osteonecrosis	M	54	7.2	14/1.7	Not performed	Cementless THA	Total	Autograft on femur
8	Fracture	F	64	6.3	84/1.5	Not performed	Cementless bipolar	Cup	Allograft on acetabulum
9	Osteonecrosis	M	67	6.7	54/1.1	Not performed	Cemented bipolar	Total	Allograft on femur
10	Fracture	F	72	6	91/1.1	Not performed	Cemented bipolar	Total	Auto- & allograft on both
11	Fracture	F	56	3.8	37/0.8	Not performed	Cementless bipolar	Cup	None
12	Osteonecrosis	M	40	3.3	42/2.1	No growth	Cementless THA	Cup	None

ESR erythrocyte sedimentation rate, CRP C-reactive protein, THA total hip arthroplasty, MSCNS methicillin-sensitive coagulase-negative *Staphylococcus*

wound or a stable implant during revision, (6) with purulent or grossly inflamed tissue, but with only a negligible amount of pus formation (less than 5 ml) by arthrotomy or aspiration and (7) if carried out, with a low virulent pathogen as determined by preoperative aspiration cultures. During the study period, 14 débridement and prosthesis retentions, six resection arthroplasties and 30 two-stage exchange arthroplasties were performed to treat infected hip replacements.

In five of the 12 patients, preoperative aspiration cultures were performed, and pathogens were identified in four. All of these pathogens were identical to those determined as final pathogens. Preoperative aspiration was only performed when the diagnosis of infection was doubtful. Of the seven patients in whom no preoperative culture was conducted, six had elevated ESR and CRP levels and one had a previous history of a draining sinus at the affected hip five weeks before index revision.

Operative procedure

Index revision surgery was performed in the lateral position using the transtrochanteric (seven hips), posterolateral (three hips) or direct lateral (two hips) approaches. Operative procedures consisted of drainage of all abscesses and removal of implants, cement and any potentially infected tissues. Deep cultures were taken from joint fluid, soft tissue and bone at the time of débridement.

Using the selection criteria mentioned above, we decided to perform one-stage revision arthroplasty using cementless implants. Cup and stem revisions were performed in eight hips and solitary cup revisions were performed in four (Table 1). Stems were not revised when the stem was well fixed and the interface between stem and proximal femur was

preserved. The cups used in this series were Omnifit (Stryker, Mahwah, NJ, USA) in four hips, Trilogy (Zimmer, Warsaw, IN, USA) in four, Morphometric (Medinov, Roanne, France) in two and Plasmacup (Aesculap AG, Tuttlingen, Germany) in two. The stems were Omnifit (Stryker, Mahwah, NJ, USA) in three hips, BiCONTACT (Aesculap AG, Tuttlingen, Germany) in two, S-ROM (DePuy, Leeds, UK) in one, Versys (Zimmer, Warsaw, IN, USA) in one and Wagner (Zimmer, Warsaw, IN, USA) in one.

Morsellised autologous bone grafts, allografts or autografts mixed with allografts were used to reconstruct bone defects in the acetabulum (five hips), in the proximal femur (two hips) or in both (one hip) (Table 1). Unicortical autologous tibial bone grafting was also combined with a morsellised graft in the proximal femur in one hip.

Postoperative care

We started broad-spectrum antibiotic medication intraoperatively after specimens had been collected for culture. Intravenous therapy, which lasted for an average of 4.9 weeks (range: 3–10 weeks), was provided after consultation with an infectious disease consultant in all 12 patients, and in seven patients, this was followed by oral therapy, which continued for an average of six weeks (range: 4–16 weeks). Therefore, all patients were treated for an average of 8.4 weeks (range: 3–24 weeks) with intravenous antibiotics or combined intravenous and oral antibiotics after revision (Table 2). Antibiotic therapy was discontinued when the serum CRP level, which was checked twice per week, was in the normal range on three consecutive occasions. All patients were examined at one, three, six and 12 months, and then annually. Pain at rest and serum CRP level were used as indicators of recurrent infection.

Table 2 Patient data

Findings on introp. culture	Duration of postop. antibiotic therapy		Harris hip score		Control of infection	Revised
	Parenteral (weeks)	Oral (weeks)	Preop.	Follow-up		
MSCNS	8	16	55	74	No	No
<i>Enterococcus faecalis</i>	4	0	42	85	Yes	No
MSCNS	4	6	62	92	Yes	No
MSCNS	3	0	73	87	Yes	No
MSCNS	6	0	44	91	Yes	No
MSCNS	4	4	57	86	Yes	No
MSCNS	3	4	67	93	Yes	Yes, aseptic
MSCNS	3	4	30	87	Yes	No
MRCNS	10	4	48	92	Yes	No
MRCNS	4	0	56	94	Yes	No
MRCNS	4	4	65	91	Yes	No
MRCNS	6	0	43	95	Yes	No

MSCNS methicillin-sensitive coagulase-negative *Staphylococcus*, MRCNS methicillin-resistant coagulase-negative *Staphylococcus*

An investigator, who was not involved in the care of these patients, carried out objective clinical and radiological evaluations. The functions of the involved hips were assessed before operation and at the latest follow-ups using modified Harris hip scores (HHS) [8]. Serial radiographs were examined for component stability [3], migration and loosening. Periprosthetic cystic or scalloped lesions with a diameter of >2 mm that had not been present on the immediate postoperative radiograph were defined as periprosthetic osteolysis [11, 17].

Results

Gram-positive micro-organisms were responsible in 11 of the 12 hips (Table 2). Noticeably, *Staphylococcus aureus*, one of the most common infecting organisms, was not identified in any hip. One patient experienced infection recurrence and another aseptic stem loosening at a mean follow-up of 7.2 years (3.3–11.3). The success rate of treatment was 83.3% when infection recurrence or component loosening were regarded as failure.

Mean HHS improved from 53.5 points (30–73) before operation to 88.9 points (74–95) at latest follow-ups (Table 2) (Fig. 1). The patient that experienced recurrence required a crutch for walking support at the latest follow-up.

In detail, this patient that developed a recurrent infection with a draining sinus at 1.5 years after revision arthroplasty

had undergone morsellised allografting to reconstruct his acetabulum at index revision. He was treated by débridement and given oral antibiotic therapy for four weeks. Even though the organism causing the recurrent infection was not identified, more than five polymorphonuclear leucocytes per high-power field were observed on histological examination. Furthermore, after a quiescent period of five years post-recurrence, the infection re-developed and was then suppressed with oral antibiotic therapy for four weeks. Although there was no evidence of component loosening, we considered that re-revision arthroplasty should be undertaken if infection recurred again. At the second recurrence, the causative organism was again not identified.

Radiographs demonstrated aseptic stem loosening with subsidence in one hip. Although the femoral stem perforated the medial cortex of the femur during index revision arthroplasty, he had been observed without additional surgery. At 3.3 years after index revision, the stem had subsided and loosened and further revision hip arthroplasty was performed with a distal interlocking revision stem. No evidence of recurrent infection was detected by perioperative laboratory tests, intraoperative gross findings or by cultures and histological examination of tissues obtained during further revision (Fig. 2).

In another patient, osteolysis was observed around the acetabular cup at 10.5 years post-revision. However, the patient had an excellent clinical score and further surgery

Fig. 1 Radiographs of a 38-year-old man who had infection of a right total hip arthroplasty showing a loosened stem and cup (a) and 11 years and 4 months after one-stage revision hip arthroplasty with cementless implants (b)

Fig. 2 Radiographs of a 54-year-old man showing septic loosening of a left total hip arthroplasty (**a**) and stem subsidence with perforation of medial femoral cortex at 3 years and 3 months after one-stage cementless revision arthroplasty (**b**). Arrows indicate an incorporated autologous unicortical tibial graft

was not required. All the grafted bone appeared to have united to the host bone in all patients.

Complications other than infection included transient sciatic nerve palsy, from which the patient recovered completely, and a periprosthetic femoral fracture, which required open reduction and internal fixation with plate and cable system. However, none of these complications affected the final clinical results.

Discussion

This study suggests that the absence of antibiotic-loaded cement at the time of one-stage revision arthroplasty does not increase the infection recurrence rate in selected patients. In this study, the reinfection rate was 8.3% (1/12) and even though the study population was small, this compares favourably with 7–17% reinfection rates reported for one-stage exchange with cemented components [1, 10, 20], 5–15% for two-stage exchange with cemented components [4, 6] and 5–13% for two-stage exchange with cementless components [7, 13, 14, 18].

One-stage revision of infected hip replacements is an attractive technique because it potentially reduces morbidity, decreases costs and avoids the technical difficulty of staged revision surgery. However, relatively few cases meet the strict criteria required for this type of surgery, and thus, its role is limited [10, 24]. Ure et al. concluded that they do not

recommend direct exchange for patients who are immunocompromised, who have an infection caused by a known resistant gram-negative or methicillin-resistant organism or who have a major skin, soft tissue or osseous defect [24].

We attribute the success of one-stage cementless revision to several factors. First, we performed the procedure only in strictly selected patients and did not treat the majority of patients with a deep infection in this manner. In addition to the criteria recommended by other surgeons, we considered general health status, a history of hip infection, presence of signs of an acute systemic infection, local evidence of active infection and, if confirmed, the virulence of the suspected organism. Second, we also carried out extensive and meticulous débridement to reduce bacterial loading to an absolute minimum; we consider this step to be an important aspect of successful one-stage revision. Trochanteric osteotomy was performed in seven patients to provide adequate visualisation and to allow access for cement, membrane and dead bone removal. Third, we used antibiotics intraoperatively (beginning after specimens had been collected for culture) and for a long period postoperatively. Intravenous therapy, over a mean period of 4.9 weeks, was provided after consulting an infectious disease consultant, and in seven patients, this was followed by oral therapy, which continued for a mean of six weeks.

It is worthwhile noting the clinical manifestations and causative organisms in our series. Most patients (11/12) had experienced hip pain for more than one year before treatment.

However, no patients showed generalised signs of infection (fever) or evidence of active infection (a persistent draining sinus or massive pus formation). It has been reported that the timing of infection varies by species: *S. aureus* predominates in early infections, whereas bacteria from normal skin flora such as *S. epidermidis* present in delayed infections [12]. We consider that these insidious clinical courses and less severe signs indicate the presence of a low virulent pathogen as a causative organism such as coagulase-negative *Staphylococcus* including *S. epidermidis*. Noticeably, *S. aureus*, the most common infecting organism and a virulent pathogen, was not identified in any hip in our series.

Methicillin-resistant organisms were identified in four of our patients. After confirming culture results using intra-operative specimens at five to seven days after surgery, we changed the antibiotics being administered to an appropriate one (vancomycin), which was then continued intravenously for four to ten weeks, and in two patients, this was followed by oral antibiotics for an average of four weeks. We believe that the prompt choice of an appropriate antibiotic and its administration for a long period helped to prevent subsequent recurrence.

Bone grafting was performed in eight hips and an infection recurred in one. Generally, the use of a bone graft in association with one-stage revision arthroplasty is not recommended because the risk of infection is increased by the bone graft [23]. However, one report concluded that the use of allografts is not associated with an increased rate of failure of one-stage revision of infected hip replacements [16]. We are unable to comment as to whether bone grafting increases the risk of reinfection or not, although we agree that the use of bone grafts during one-stage revision of infected hip replacements remains controversial.

In conclusion, the results of our study demonstrate that one-stage revision hip arthroplasty with cementless implants appears to have a role in the treatment of carefully selected patients with an infected hip replacement if meticulous débridement is performed and suitable antibiotics are properly used.

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