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ORIGINAL STUDY

Re-revision of failed revision Total Hip Arthroplasty acetabular components

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While revision of total hip arthroplasty (THA) is being performed with increasing frequency, outcomes of repeated revisions have been rarely reported in the literature. The purpose of this study was to report mid-term outcomes of re-revision of failed revision THA acetabular components. We performed at least two revisions of the failed acetabular component in 57 patients (57 hips) between August 1996 and April 2008. Of these, 15 patients with infection were excluded and one died before 4-year evaluation. The final study cohort consisted of 41 patients (41 hips) with a mean age of 55.5 years (range, 37 to 82). Preoperative acetabular bone defects was classified as Paprosky Type IIA in 4 hips, Type IIB in 6, Type IIC in 9, Type IIIA in 16, and Type IIIB in 6. The mean duration of follow-up was 7.2 years (range, 4 to 15). Mean Harris hip score improved 45 points preoperatively to 83 points postoperatively. Six hips (14.6%) required additional revision procedure : 3 for aseptic loosening, 2 for deep infection, and 1 for recurrent instability. Complications included 2 dislocations and 1 peroneal nerve palsy. Kaplan-Meier survivorship with an end point of reoperation for any reason was 88.5% (95% CI, 78.0% to 100%) at 7.2 years. For aseptic loosening of the acetabular component, the survival was 91.8% (95% CI, 80.8% to 100%) at 7.2 years. Re-revision with contemporary uncemented cup or antiprotrusio cage for failed revision THA acetabular components showed encouraging mid-term outcomes for this technically challenging condition.

Keywords : re-revision total hip arthroplasty ; failed revision total hip arthroplasty ; acetabular cups ; cementless cup ; antiprotrusio cage.

INTRODUCTION

The success of primary total hip arthroplasty (THA) is well-documented in the related literature, with survival rates of over 90% at 15-year follow-up (*19*). However, as the number of patients receiving primary THA continues to increase, cases that require revision surgery increase accordingly. Recent projections indicate that the burden of revision THA is expected to increase substantially over the next several decades (*13*). Generally, the longevity of revision THAs is lower than that of primary THAs (*14*). In a large-scale study by Springer *et al* on 1100 revision THAs, the survivorship following revision THA, using the second revision as the endpoint, was 82% at 10 years (*19*). Re-revision of failed revision THA can be a complex and technically challenging procedure with substantially different resource requirements primarily in cases of

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bone loss (*10*). While revision THAs are being performed with increasing frequency, the outcomes of multiple revisions have rarely been reported in the literature. Kavanagh and Fitzgerald (*11*) reported the outcomes of 45 patients who underwent repeat revisions of THA that had failed but were not associated with infection. The results of the second or third revision for failed revision THA were satisfactory in only about half of the patients, and significant postoperative complications were noted in 42% patients. The high failure rate might be attributed to the use of conventional non-metal-backed acetabular components in most procedures during the study period. Currently, acetabular bone loss can be addressed by using a cementless porous-coated acetabular component combined with bone graft in most situations. In cases of significant bone loss, the use of various designs of acetabular reinforcement devices or porous metal augments have been introduced (*17*).

The purpose of this study is to report the midterm outcomes of repeat revisions of the failed revision THA acetabular components with use of contemporary cementless hemispheric porous-coated sockets or antiprotrusio cages in 41 hips by a single surgeon with a mean follow-up of 7.2 years.

MATERIALS AND METHODS

With approval from the institutional review board, we conducted a retrospective review of 57 patients who had undergone at least two revisions of the failed acetabular component between August 1996 and April 2008. Of these, 15 patients who had undergone multiple revisions because of infection were excluded, 1 died before the four-year evaluation, and no patient was lost to follow up. Thus, the final study cohort of this retrospective review consisted of 41 patients (41 hips). There were 19 male (19 hips) and 22 female (22 hips) patients with a mean age at the time of the index re-revision surgery of 55.5 years (range, 37-82 years). The average body mass index at the time of index surgery was 24.3 kg/m^2 (range, 19-34 kg/m^2). The reason for the primary THA was avascular necrosis of the femoral head in 13 hips (32%), primary and secondary osteoarthritis in 10 hips (24%), septic hip sequelae in 7 hips (17%), femoral neck fracture in 6 hips (15%), post-traumatic arthritis in 3 hips (7%), ankylosing spondylitis in 1 hip (2%), and multiple epiphyseal dysplasia in 1 hip (2%). The mean duration of revision of the acetabular component following primary THA was 8.1 years (range, 1-20 years). The mean duration of re-revision of the acetabular component following revision THA was 7.3 years (range, 1-13 years). The cause of re-revision of the failed revision THA acetabular component was aseptic cup loosening in 39 hips (95%) and polyethylene wear and osteolysis in 2 hips (5%). The index multiple revision procedure performed in our hospital was a second revision in 35 hips (85%) and a third revision in 6 hips (15%). The mean duration of follow-up following the index second or third revision THA was 7.2 years (range, 4-15 years). A summary of the demographic data is provided in Table I.

Table I. — Demographic data

Number of patients (hips)	41 (41)
Age at index re-revision (y)	55.5 (37-82)
Gender (Male/Female)	19/22
Body-mass index (kg/m2)	24.3 (19-34)
Cause of acetabular re-revision	
Aseptic loosening	39 (95%)
Polyethylene wear and osteolysis	2 (5%)
Number of revisions	
Second revision	35 (85%)
Third revision	6 (15%)
Duration of follow-up (y)	7.2 (4-15)

Values are presented as mean (range).

All procedures were performed by a single surgeon. The preoperative acetabular bone defects were classified according to classification systems suggested by Paprosky *et al* (*16*). Of the 41 hips, 4 hips (10%) had Type-IIA, 6 hips (15%) had Type-IIB, 9 hips (21%) had Type-IIC, 16 hips (39%) had Type-IIIA, and 6 hips (15%) had Type-IIIB. 28 hips (68%) underwent isolated cup re-revision surgery and 13 hips (32%) underwent stem revision combined with cup re-revision. Thirty hips (73%) were treated with cementless hemispheric porous-coated sockets and 11 hips (27%) were treated with acetabular reinforcement devices. Five types of cementless hemispheric porous-coated sockets were used (Fig. 1) : 24 Trilogy® cups (Zimmer, Warsaw, IN, USA), 3 Duraloc® cups (DePuy/J&J, Leeds, UK), 1 Arthropor® cup (DePuy/J&J, Leeds, UK), 1 Interlock® cup (Biomet, Warsaw, IN, USA), and 1 SPH-Contact® cup (Lima-Lto, Udine, Italy). All the 11 acetabular reinforcement devices were Kerboull-type antiprotrusio cages (Lima-Lto, Udine, Italy) (Fig. 2). The final decision for use of cementless hemispheric porous-coated socket or acetabular reinforcement device was at the discretion of treating

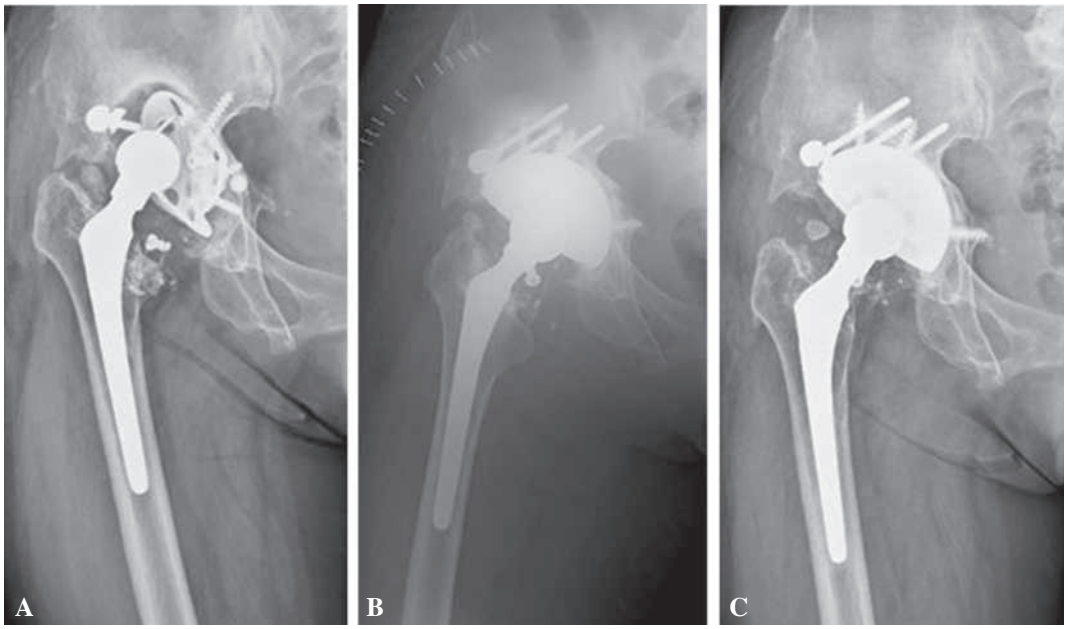

Fig. 1. — (A) A 44-year-old female patient with Paprosky Type-IIIA acetabular defect and failed revision total hip arthroplasty using the acetabular reinforcement ring. (B) Acetabular reconstruction was performed using cementless hemispheric porous-coated jumbo cup and bulk structural allograft. (C) Radiograph made 7 years postoperatively showing a well-fixed acetabular cup.

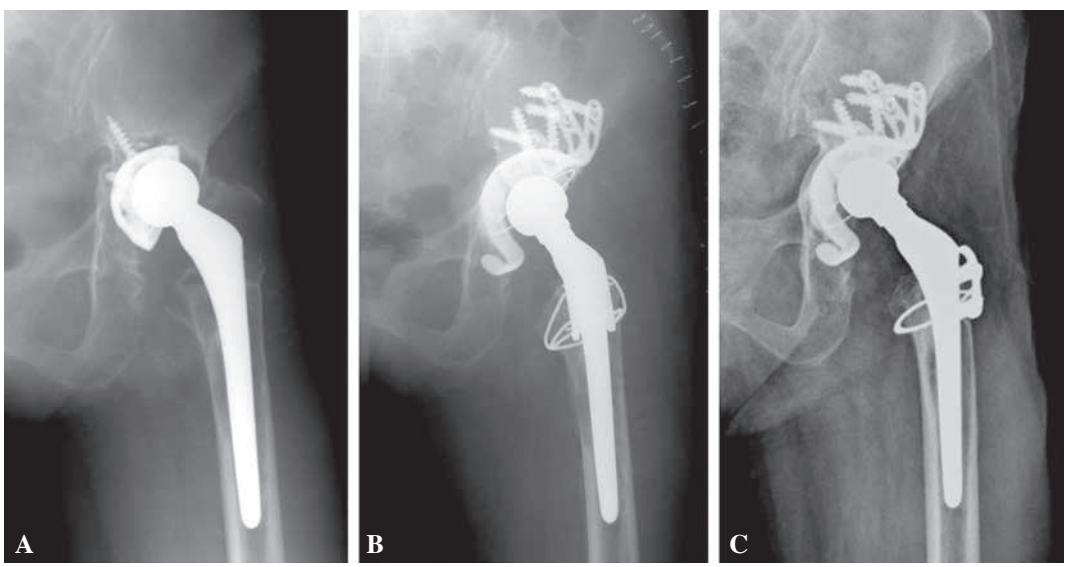

Fig. 2. — (A) A 63-year-old female patient with Paprosky Type-IIIB acetabular defect and failed revision total hip arthroplasty using cementless hemispheric porous-coated cup. (B) Acetabular reconstruction was performed with Kerboull-type antiprotrusio cage and morselized allograft. (C) Radiograph made 12 years postoperatively showing a well-maintained acetabular construct.

Table II. — Components used in index re-revision of failed revision THA acetabular components

	Number of Hips (N = 41)
Acetabular components type	
Cementless hemispheric porous-coated socket	30 (73%)
Trilogy (Zimmer, Warsaw, IN, USA)	24
Duraloc (DePuy/J&J, Leeds, UK)	3
Arthropor (DePuy/J&J, Leeds, UK)	1
Interlock (Biomet, Warsaw, IN, USA)	1
SPH-Contac (Lima-Lto, Udine, Italy)	1
Kerboull-type antiprotrusio cage (Lima-Lto, Udine, Italy)	11 (27%)
Acetabular components size (mm)	
44	1
45	1
46	2
48	1
50	4
52	2
54	3
55	1
56	3
58	2
60	10
62	2
64	2
66	2
68	1
70	4
Femoral head diameter (mm)	
28	36 (88%)
32	5 (12%)
Bearing surfaces	
Metal-on-polyethylene	24 (58%)
Ceramic-on-polyethylene	15 (37%)
Ceramic-on-ceramic	2 (5%)

surgeons who considered the preoperative assessment of acetabular bone defects and quality of the remaining bone at surgical field. There were no standard criteria for selecting one of the cementless hemispheric porous-coated sockets during the period of this study and the rationale for choice of socket could not be ascertained from retrospective review. Actetabular bone defect was filled with morselized femoral head allografts in 26 hips (63%) and, when required to reconstruct large defects, bulk allografts were also used in 3 hips (7%). The average outer diameter of the hemispheric sockets was 58 mm (range, 44-70 mm). Thirty-six hips (88%) had 28-mm femoral head components and 5 hips (12%) had 32-mm head components. Twenty-four hips (58%) had metal-on-polyethylene bearings, 15 hips (37%) had ceramic-on-polyethylene bearings, and 2 hips (5%) had ceramic-on-

ceramic bearings. Components used in the index re-revision procedures are summarized in Table II. A standard protocol of low-molecular-weight heparin was used selectively as a thromboembolism prophylaxis in patients with known risk factors for deep-vein thrombosis. Antibiotic prophylaxis was administered to all patients from 1hour before surgery to 3days after surgery. All patients were allowed to stand by the second or third post-operative day and to progress to partial weight bearing with crutches as tolerated. Patients were allowed full weight-bearing after 6 to 8 weeks.

Clinical and radiographic evaluations were performed preoperatively, and at 6 weeks, 3 months, 6 months, and 1 year postoperatively, and then annually. Clinical evaluations were performed using the Harris hip-scoring system (*9*). 'Excellent' was defined as a score of > 90 points, 'good' as 80 to 89 points, 'fair' as 70 to 79 points, and 'poor' as < 70 points. Radiographic analyses were performed using standardized anteroposterior and lateral radiographs of affected hips taken postoperatively, during hospitalization, and at each follow-up visit. All radiographs were digitized using PathSpeed software (General Electric Inc, Milwaukee, Wisconsin) and were reviewed by a single independent observer who did not participate in clinical care. Radiolucent lines of > 2 mm around the acetabular component were identified and assigned to one of the 3 zones described by DeLee and Charnley (*5*). Acetabular cup loosening was defined as one of the following ; any progression of radiolucent lines, acetabular screw breakage, or more than 2 mm of acetabular cup migration and a change in cup inclination angle of more than 3 degrees (*4,7*). Ectopic ossification following total hip replacement was evaluated as described by Brooker *et al* (*3*). Postoperative complications including dislocation, infection, nerve palsy, and periprosthetic fracture were also documented.

Statistical analysis was performed using SPSS version 15.0 (SPSS, Chicago, Illinois). The paired t-test was used to compare Harris hip scores at the last follow-up with scores prior to index procedures. Statistical significance was accepted for P values < 0.05. Survivorship analysis was performed with the Kaplan-Meier estimator with end points of either reoperation for any reason or for aseptic loosening.

RESULTS

The mean Harris hip score improved from 45 (range, 14-74 points) preoperatively to 83 (range, 41-97 points) at the time of the latest follow-up (P < 0.001). Of the 41 hips, 30 hips (73%) had a good or excellent result, 6 hips (15%) had a fair result, and 5 hips (12%) had a poor result.

On the last follow-up radiographs, a radiolucent line was present at the bone-socket interface in 6 (15%) of the 41 acetabular components, but the progression was minimal and all radiolucencies were 1 mm or less. Acetabular component migration was seen in three hips. In the 26 of the 29 hips in which bone graft was used, the last follow-up radiographs showed complete or partial graft incorporation. In the three other cases in which bulk allograft was used, there was some graft resorption.

At a mean of 7.2 years (range, 4 to 15) postoperatively, a total of 6 hips (14.6%) required additional revision procedure. Three hips had an aseptic loosening of the acetabular component that needed a repeat revision procedure. Of these, two hips had a cementless porous-coated socket and one had an antiprotrusio cage. All these hips had a Paprosky Type IIIA or IIIB acetabular bone defect. Two deep infections were managed successfully by two-stage reconstruction procedures. One recurrent dislocation was treated by modular exchange of the liner and by the use of a large femoral head. Outcomes according to the type of acetabular components are summarized in Table III. Kaplan-Meier survivorship with an end point of reoperation for any reason was 92.7% (95% confidence interval [CI], 85.0% to 100%) at 4 years and 88.5% (95% CI, 78.0% to 100%) at 7.2 years. For aseptic loosening of the acetabular component, the survival was 97.6% (95% CI, 93.0% to 100%) at 4 years and 91.8% (95% CI, 80.8% to 100%) at 7.2 years (Fig. 3).

During follow-up period, other complications were observed in 4 hips. A single episode of dislocation in two hips, which was managed successfully by closed reduction. One patient sustained a peroneal nerve palsy that was resolved partially 24 months after the index re-revision procedure. One patient had a periprosthetic femoral fracture that was managed by femoral stem revision. Ectopic ossification was observed as grade I or II in 4 hips (10%).

Outcomes according to the number of revision surgery are summarized in Table IV.

Table III. — Details on outcomes according to type of acetabular components

	Number of Hips (N = 41)	Additional Revision Surgery (N = 6)
Cementless hemispheric porous-coated socket	30 (73%)	
Trilogy (Zimmer, Warsaw, IN, USA)	24	2 aseptic cup loosening, 1 deep infection, 1 recurrent dislocation
Duraloc (DePuy/J&J, Leeds, UK)	3	
Arthropor (DePuy/J&J, Leeds, UK)	1	
Interlock (Biomet, Warsaw, IN, USA)	1	
SPH-Contac (Lima-Lto, Udine, Italy)	1	1 deep infection
Kerboull-type antiprotrusio cage (Lima-Lto, Udine, Italy)	11 (27%)	1 aseptic loosening

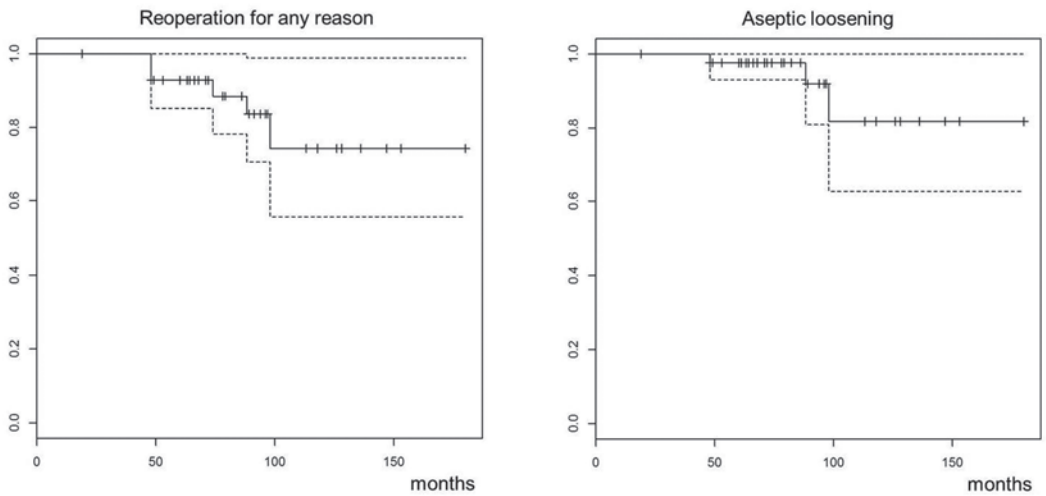

Fig. 3. — Kaplan-Meier survival analysis of the acetabular component. (A) The survival of reoperation for any reason as the end point was 88.5% (95% CI, 78.0% to 100%) at 7.2 years. (B) The survival of aseptic loosening as the end point was 91.8% (95% CI, 80.8% to 100%) at 7.2 years. The dotted lines indicate the 95% confidence interval.

DISCUSSION

Re-revision of failed revision THA can be a complex, time-consuming, and technically challenging procedure because of the variation in the remaining bone quality and bone stock (*17*). The outcomes of re-revisions of the failed revision THA acetabular components are largely unknown. In one study by Kavanagh and Fitzgerald (*11*), the results of the re-revisions of the failed revision THA with use of conventional non-metal-backed acetabular components were satisfactory in only about half of the patients. The present study was designed to evaluate the mid-term clinical and radiographic results of repeat revisions of the failed revision THA acetabular components with use of contemporary cementless hemispheric porous-coated sockets or antiprotrusio cages. In a group of 41 hips, 3 hips (7%) underwent repeat acetabular revision surgeries due to aseptic loosening. Acetabular component survivorship was 97.6% at 4 years and 91.8% at 7.2 years, using aseptic loosening as an end point. A total of 3 hips required an additional revision procedure ; two for deep infection and one for recurrent instability. These results are consistent with other revision series, which demonstrate long-term survivorships between 60% and 81% for cementless revision THA cases (*10,13,14,19*).

In the present study, cementless hemispheric porous-coated sockets were used in 73% of the cases,

Table IV. — Outcomes according to number of revision surgery

	Second Revision (N = 35)	Third Revision (N = 6)
Harris hip score		
Excellent	18	3
Good	8	1
Fair	5	1
Poor	4	1
Aseptic component loosening	2	1
Deep infection	1	1
Recurrent instability	1	0
Dislocation	2	0
Peroneal nerve palsy	1	0

but the remaining 27% (11 hips) cases required antiprotrusio cages due to severe bone defect or pelvic discontinuity. The results of using a reinforcement device has been variously reported (*1,2,6,8,12,15,17,18, 20*). Some authors reported high rates of failure for reconstruction using an acetabular reinforcement device with morselized allografts (*2,8,20*). Recently, the use of cages has decreased because of cage breakage over time and because of increased enthusiasm for the use of porous metal components and augments (*6,15,17,18*). In our series, only 1 (9%) of the 11 antiprotrusio cages failed at 7.2 years postoperatively. The comparatively low failure rate of cages in our series might be attributed to the use of the Kerboull-type acetabular reinforcement device, which is made of titanium to support allografts used in acetabular reconstruction. The Kerboull-type acetabular reinforcement device has a hook inserted under the teardrop and a rounded plate fixed above the acetabulum with iliac screws which restores the appropriate center of rotation for the hip. Using this device in conjunction with bulk allografts, Kerboull *et al* (*12*) reported 92.1% survival at 13 years. Akiyama *et al* (*1*) followed 36 patients (40 hips) for a mean of 6.7 years (range, 4.5 to 9.3 years) and reported 87% survivorship of the Kerboull-type acetabular reinforcement device with allografts constructed at 10 years. Despite the favorable outcomes and high success rate achieved, we believe that the use of the acetabular reinforcement device should be carried out with great caution. Furthermore, patients should be fully informed of the potential risks, which include cage breakage, allograft collapse/resorption, and deep infection.

The present study is limited by its retrospective nature and to some extent by the small cohort size, which may weaken the statistical power of this study. Heterogeneity of causes for re-revision THA and the variety of implants used might be confounding factors. Despite these limitations, given the rarity of outcome data for the re-revision of failed revision THA acetabular components, we believe that the findings of this study are of value, because we report the mid-term results using contemporary cementless porous-coated sockets or antiprotrusio cages by a single surgeon at a single institution.

On the basis of the encouraging mid-term outcomes in this challenging situation, we believe that re-revision with use of contemporary cementless porous-coated sockets or antiprotrusio cages is a viable procedure for failed revision THA acetabular components.

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