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Journal of Arthroplasty (2010) 25(8):1307-1310.

Porous-Coated Cementless Acetabular Components Without Bulk Bone Graft in Revision Surgery

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POROUS-COATED CEMENTLESS ACETABULAR COMPONENTS WITHOUT BULK BONE GRAFT IN REVISION SURGERY

A FOLLOW-UP REPORT

Abstract

We previously reported the average 9.3-year (range, 5-13 years) results of 74 patients (83 hips) associated the use of porous-coated acetabular components that were placed without bulk bone graft at revision surgery. We now report the average 15.6 year results for 66 patients (75 hips). Of the original cohort of 94 patients (103 hips), 87 patients (96 hips; 93%) retained the shell. Three shells (3%) were revised for infection, two shells (2%) were revised for recurrent dislocation, two shells (2%) were revised for dislodgement of the polyethylene liner from the shell. No shell was revised for aseptic loosening. Decreasing augmentation by the host bone is a concern, however, this simple technique provides reliable stability of the acetabular component at intermediate to long-term follow-up.

Key words: revision total hip arthroplasty, porous-coated acetabular component, intermediate to long-term follow-up

Introduction

The results of massive bulk bone grafts without metallic support ring or cage for acetabular revision were discouraging [1,2]. We previously reported the results of revision total hip arthroplasty after an average duration of follow-up of 9.3 years (range, 5-13 years) for 74 patients (83 hips), from an original pool of 94 patients (103 hips), in whom a porous-coated acetabular component was placed without structural bulk bone graft to avoid problems associated with progressive collapse of the grafted bone. Large porous-coated acetabular components fill many bone defects which reduce the need for the amount of bone grafting and tend to normalize the center of hip rotation reducing impingement between the femur and the pelvis [3-7]. We preferred a large-diameter cup for hips with adequate osseous support, and we placed a standard or small-diameter cup at a high location for hips without sufficient acetabular bone stock to stabilize a large-diameter cup [8,9]. In our previous study, we reported no aseptic loosening and 4 (5%) rerevisions of the shell; 1 for infection, 1 for dislodgement of the polyethylene liner from the metal shell, and 2 for recurrent dislocation. We now report our results in these same patients at an average of 15.6 years.

Materials and Methods

Between January 1989 and December 1996, 103 consecutive revisions (94 patients) using a porous-coated acetabular component were performed by one senior author. Sixteen patients (16 hips) died of causes unrelated to the revision surgery before the minimum follow-up of 10 years, 7 patients (7 hips) were bedridden and too ill to return for follow-up, and 5 patients (5

hips) were lost to follow-up. All these 28 revisions of the acetabular component were well fixed and none of the hips had required reoperation at the time of the latest follow-up. The remaining 75 hips in 66 patients, including 9 patients who underwent bilateral revision, were available for clinical and radiographical review after a minimum follow-up of 10 years. During the study period, there was no other technique used for acetabular revision, therefore, we are reporting a prospective consecutive series.

Sixty-two hips had revision of both the femoral and acetabular component, and 13 hips had isolated acetabular revision. A cemented acetabular component was revised in 51 hips, a bipolar prosthesis in 18, a cementless acetabular component in 1, and unipolar hemiprosthesis in 5. In these 75 hips, 6 had developed chronic infection and any components were removed before revision. The index revision was performed 2 to 15 months after removal of the component.

The average duration of follow-up was 15.6 years (range, 10–20 years). Twenty-five patients were men, and 41 patients were women. The average age at the time of the index operation was 58 years (range, 24–77 years). The average height was 153 cm (range, 138–178 cm), and average weight was 56 kg (range, 40–83 kg). The initial diagnosis was dislocated or subluxated osteoarthrosis in 38 hips, osteonecrosis in 19, fracture of the femoral neck in 9, rheumatoid arthritis in 5, ankylosing spondylitis in 2, pathological fracture of solitary bone cyst in 1, and slipped capital femoral epiphysis in 1.

The indication for revision was painful aseptic loosening in 66 hips, reimplantation after removal of the component due to infection in 6, fracture of a bipolar polyethylene liner

in 2, and recurrent dislocation in 1.

Pre-revision acetabular bone deficiencies were classified retrospectively. According to the system of the American Academy of Orthopaedic Surgeons, the deficiency was categorized as segmental in 14 hips, as cavitary in 27, as combined segmental and cavitary in 34, and pelvic discontinuity in none [10].

Surgical Technique and Implants

All of the procedures were performed through the posterolateral approach without trochanteric osteotomy. The method for reconstruction was selected: (1) for patients with adequate osseous support to allow placement of a large-diameter acetabular component with resulting hip center close to the normal level, this technique was preferred. (2) However, if there was not enough bone to support a large component, we used an approach that resulted in a high hip center, generally using a standard or small-diameter component placed in the superior position of the acetabular cavity. This high hip center technique was performed in hips with extensive loss of osseous support, often with an absent medial wall and anterior or posterior column. When the high hip center technique was used, limb-length discrepancy was corrected using a long-neck or calcar replacement femoral component.

The acetabular bed was prepared with hemispherical reamers in the so-called line-to-line fashion. Fifty-two Harris-Galante Porous (HGP; Zimmer, Warsaw, Indiana) I or II cups, 12 Omnifit (Howmedica Osteonics, Allendale, New Jersey), 7 S-ROM (DePuy Johnson & Johnson, Warsaw, Indiana) cups, and 4 Richards Modular Hip (Smith and Nephew, Memphis, Tennessee) cups were used for the respective femoral component inserted in the

index revisions. These types of cups have multiple screw-holes in the shell, which were used for screw fixation in all hips. Structural bulk bone graft was not performed in any hip. Only non-structural autogenous particulate bone graft retrieved from the hemispherical acetabular reamer or morselized fresh-frozen allograft was used for hips with partial surface defects after final acetabular reaming. An average of 4.4 screws (range, 2–7 screws) were used. An average outer diameter of the acetabular component was 56 mm (range, 42–71 mm). All components were rigidly fixed at the time of revision surgery. The diameter of the femoral head was 22-mm in 69 hips, 26-mm in 2, 28-mm in 1 and 32-mm in 3.

Evaluations

Clinical evaluations were made according to the Harris hip scoring system [11]. A hip center was defined as high in hips with a center of rotation of the femoral head located ≥35 mm proximal to the interteardrop line [8], and as anatomic in those <35 mm proximal to that. Before revision the hip center was an average of 35 mm (range, 10–58 mm) proximal to the interteardrop line, and after revision it was an average of 32 mm (range, 12–55 mm) proximal to that. Twenty-seven acetabular components were placed in the high hip center position with an average of 40 mm (range, 35–55 mm), and the other 48 acetabular components were placed in the anatomic position with an average of 28 mm (range, 12–34 mm) proximal to the interteardrop line. An average outer diameter of the acetabular component was 51 mm (range, 42–64 mm) in 27 hips with a high hip center, and 59 mm (range, 48–71 mm) in 48 hips with an anatomic hip center.

Definite acetabular loosening was defined as acetabular migration of ≥2 mm in

either the horizontal or vertical direction, rotation of the implant, screw breakage, or a radiolucent line of >1 mm in all zones [12]. Radiolucent lines at the prosthesis-bone interface were recorded using the three zones described by DeLee and Charnley [13]. The linear head penetration into the polyethylene liner was measured using the techniques described by Livermore et al [14]. For patients who underwent exchange of the acetabular liner, the final radiograph that had been made before acetabular exchange was used to determine the femoral head penetration.

Statistical analyses

Statistical analyses were performed using SPSS software (version 17 for Windows, SPSS Inc., Chicago, Illinois). Preoperative and postoperative Harris hip scores were compared with use of the Wilcoxon signed-rank test. A probability value less than 0.05 was considered significant. Kaplan-Meier survival curves with end points defined as rerevision for aseptic loosening, rerevision for any reason, and mechanical failure of the shell (rerevision for aseptic loosening or definite radiographic loosening) were calculated.

Results

Of the original cohort of 94 patients (103 hips), 87 patients (96 hips; 93%) retained the shell. Since the previous report, 3 additional acetabular components were removed or revised again; 2 for infection and 1 for dislodgement of the polyethylene liner from the metal shell. Overall 7 (7%) components required removal or repeat revision; 3 (3%) for infection, 2 (2%) for dislodgement of the polyethylene liner and 2 (2%) for recurrent dislocation.

Postoperative infection necessitated removal of the acetabular and femoral components in 3 hips of 3 patients. Two HGP-II components and 1 S-ROM component were removed 80, 140 and 126 months postoperatively. Dislodgement of the polyethylene liner from the shell occurred because of tine breakage of the HGP-II component in 2 hips of 2 patients, and these 2 acetabular components were revised 86 and 198 months postoperatively. Two HGP-II components were revised for recurrent dislocation 12 and 22 months postoperatively. The acetabular component was well fixed in these 4 patients except 3 hips with infection. Exchange of the prosthetic femoral head was simultaneously performed in these 4 hips. There were no acetabular components revised for aseptic loosening. There was no acetabular component categorized as loose.

Eleven femoral components were revised after the index procedure; 7 were revised for aseptic loosening, 3 were removed for infection, and 1 was revised for periprosthetic fracture. At the time of femoral revision of 8 hips without infection, simultaneous exchange of the polyethylene liner was performed with retention of the acetabular shell (Fig. 1).

The Harris hip score increased from a preoperative average of 54 points (range, 34–78 points), to 78 points (range, 48–100 points) at the most recent follow-up for patients who did not have a subsequent revision ($p < 0.001$). The preoperative limb-length discrepancy ranged from 0 to 6 cm. Twenty revisions were performed on the side of the longer limb. Fifteen of 20 hips showed an average 0.8 cm (range, 0.5–5 cm) of residual postoperative longer limb-length discrepancy. Thirty-six revisions were performed on the side of the shorter limb. Thirty shorter limbs were lengthened by an average 1.4 cm using a

femoral component with a longer-neck, and 28 (78%) of the 36 shorter limbs were found to be equal in length to the contralateral limb postoperatively. Eight of the 36 hips showed an average 0.8 cm (range, 0.5–3 cm) of residual postoperative shorter limb-length discrepancy. Nineteen revisions were performed in patients without a limb-length discrepancy. Three of the 19 were noted to be lengthened by an average 1 cm postoperatively.

Periacetabular osteolysis was identified in 3 (4%) of 75 hips. The largest diameter of the osteolytic lesions was 3 mm, 4mm and 4 mm, respectively. The average rate of head penetration into the polyethylene liner was 0.10 mm (range, 0.01–0.28 mm) per year. No component migrated. Seven (9%) hips had thin, non-progressive radiolucent lines in 1 zone, 4 (5%) had radiolucent lines in 2 zones, and 3 (4%) had radiolucent lines in all 3 zones. Of the 3 hips with radiolucent lines in all 3 zones, none had a continuous radiolucent line. There were no broken screws or separation of the mesh from the shell.

Kaplan-Meier analysis revealed that the 15.6-year survival rate was 100% with rerevision for aseptic loosening as the end point, 100% with definite radiographic loosening as the end point, and 92% (95% confidence interval, 89%–95%) with rerevision of the shell for any reason as the end point.

Complications

There were no perioperative deaths. The most frequent postoperative complication was dislocation, which occurred in 12 (16%) hips. Two of these hips underwent repeat revision of the acetabular component combined with exchange of the prosthetic femoral head as described. The remaining dislocations were treated without reoperation. Deep infection

necessitated removal of the acetabular and femoral components in 3 patients as described. There was no nerve palsy, or any other significant complications such as pulmonary embolism.

Discussion

Several options have been reported for the acetabular reconstruction in revision surgery. These include placing a porous-coated hemispheric cementless acetabular component supported by host bone [3-9,15-18], using structural or impaction allografting with or without reinforcement devices [1,2,19-21], or cementless elliptical acetabular components [22]. While bulk autografts and allografts serve well over the early period, they demonstrate increasing failure rates with time [1,2]. Results with use of acetabular cages in the presence of major bone loss have been also disappointing [23]. Acetabular revision using impaction bone grafting or bulk allograft with reinforcement device can provide reasonable intermediate-term results and augment acetabular bone stock [20,21], however, it is a technically demanding procedure and less encouraging results with impaction allografting have been reported [24].

In contrast, porous-coated cementless hemispheric acetabular components have provided stable good intermediate to long-term results [5-9,15-18], and they are the most common choice for acetabular revision in North America [25]. Sufficient contact against biologically active and mechanically supportive acetabular host bone is critical for this procedure. A large-diameter acetabular component allows a large surface area for bone

ingrowth. In this procedure, the hip center is maintained in a more anatomical position, less bone graft is required, and a thicker acetabular liner and a larger femoral head can be used [3-7]. When osseous deficiency of the acetabulum does not allow a large-diameter hemispherical component to be used, a standard or small-diameter component is often positioned on viable bone at a high location [8,9]. Limb-length discrepancy, abductor muscle strength, and osseous impingement are concerns for this procedure. We used a long-neck femoral component to adjust limb-length discrepancy for hips with the acetabular component at a high location. Twenty-eight (78%) of 36 shorter limbs were found to be equal in length to the contralateral limb postoperatively in this study, suggesting that use of a long-neck femoral component might be an appropriate procedure for limb-lengthening.

There is no standardized definition which is generally accepted for the size of “jumbo”, “extra-large”, “large”, or “small” acetabular component. The average outer diameter was 59 mm in 48 hips with an anatomic hip center in this study, which was smaller than those of previous reports that described the results of “jumbo” or “extra-large” components [3,5-7]. The population of this study consists of relatively short stature and lightweight patients compared to those of previous studies. These terms may depend on the individual relative ratio of the component size to the pelvis and hip joint [5].

Periacetabular osteolysis was identified in 4% of the hips in this study. Intermediate to long-term follow-up studies reported the incidence of osteolysis ranging from 1%–23% using Harris-Galante-I, II Porous component, or Trilogy component [7,9,15-18]. The present low rate of osteolysis might attribute to the relative low head penetration rate (average

0.10 mm/year). Lightweight of our patients (average 56 kg) might contribute to the present low head penetration rate.

Dislodgement of the polyethylene liner from the metal shell has been reported as a complication of the HGP-I or II component [16,26]. The locking mechanism for the modular polyethylene liner has been improved in the same ingrowth surface of the titanium fiber-coated Trilogy component, which now we use routinely for acetabular revision. As the most frequent postoperative complication was dislocation, which occurred in 12 (16%) hips in this series, larger diameter femoral heads with wear-resistant materials such as highly cross-linked polyethylene are recommended to decrease the risks of dislocation.

One relative disadvantage of using a large acetabular component is that augmentation of the host bone is decreased because the component occupies space that could otherwise have been filled with some type of grafted bone [3-7]. Postoperative dislocation, infection, and dislodgement of the polyethylene liner remain concerns. On the basis of our results, however, we recommend and continue to use a cementless acetabular component that is placed without structural bulk bone graft for most acetabular revisions.

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