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The Hemispherical Porous Acetabular Component Fixed by Press-Fit Technique and Additional Screws

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Abstract

Seventy consecutive primary total hip arthroplasties in which a Harris-Galante porous-coated acetabular component had been used from October, 1986 to December, 1989 were reviewed for 5 to 9 years follow-up. We performed the retrospective, clinical and radiological analysis of the hemispheric, porous-coated, cementless acetabular component using press-fit and screw fixation. No component had detectable migration or any other position change. No acetabular fractures and no screw problems were noted. Initial peripheral gaps were observed in 11 cases (16%). Twelve cases had a postoperative polar gap less than 0.5 mm which were stabilized at 2 years postoperatively. Radiolucent line was present in at least one zone in 53% of cases and occurred most frequently in zones 1 and 3. No continuous radiolucent line greater than 2 mm was seen in any zone and radiolucent lines were stabilized 2–3 years postoperatively. Twelve hips (17.1%) had osteolysis of the acetabulum. No acetabular component was revised because of aseptic loosening. Revision arthroplasties were performed in 9 hips during follow-up. We concluded that the hemispheric porous-coated, acetabular components using press-fit and screw fixation had good results with a 5 to 9-year follow-up.

Key Words: Acetabulum, Harris-Galante acetabular component, press-fit, screw fixation, total hip arthroplasty

INTRODUCTION

The Harris-Galante porous (HGP, Zimmer, Warsaw, Indiana, USA) acetabular component was designed and intended for use with multiple screw fixation, and excellent bony ingrowth has been demonstrated with this component when transfixed with screws.[1] In primary cementless total hip arthroplasty (THA) using HGP acetabular components inserted with line-to-line fit (acetabulum was reamed to the size of the cup) and fixated with 3–4 screws, a radiographic analysis revealed that gaps between the porous mesh and bone on the immediate postoperative radiograph were present at the periphery of the acetabulum in nearly half of the cases.[2] The presence of initial peripheral gaps may have prognostic significance for the subsequent development of a progressive radiolucent line. The degree of intimacy of the bone-implant interface at the periphery of the acetabular component resisting particle invasion may be critical to the long-term stability of the acetabular component.[3] In order to reduce the development of these initial peripheral gaps, the press-fitting method where the acetabular component is inserted 2–4 mm larger than the nominal diameter of the last reamer used in preparation of the acetabular bed has been used. In results from the press-fitting method, the peripheral gaps were decreased, but the polar gaps were increased in comparison to the previously published results of a line-to-line fit.[4] In order to overcome these disadvantages, we performed acetabular fixation with minimal press-fit where the cups used were 1–2 mm larger than the diameter of the last reamer and 3 or 4 screws fixation. We now report the clinical and radiographic results of 70 primary cases of avascular necrosis of the femoral head with this technique.

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MATERIALS AND METHODS

From October 1986 to December 1989, 81 consecutive primary total hip arthroplasties using the HGP acetabular component were performed by one of the authors (C.D.H.). Among them, 7 hips were not included in this study because of follow-up loss or patient death and 4 hips were not included because of missing or incomplete radiographic records. Only 70 hips in 59 patients were studied for the results of HGP acetabular components. The initial diagnosis of all patients was avascular necrosis of the femoral head. Patient age ranged from 22 to 71 years at the time of index operation (average, 42 years). There were 36 males and 23 females. The mean height of patients was 163 cm (145 – 185 cm) and the mean weight was 59 kg (42 – 92 kg). The average duration of follow-up was 98 months (range, 60 to 109 months).

The HGP acetabular component is a titanium-alloy hemispherical prosthesis with sintered titanium fiber-mesh at the bone-implant interface. Multiple ports within the hemisphere allow for fixation with titanium-alloy screws. A modular polyethylene liner is held in place with titanium-alloy tines located around the mouth of the hemispherical shell. The HGP femoral component has a collar and the fiber mesh is sintered on the proximal one-third of the component, but on the lateral surface. The size of the femoral head was 22 mm in 5 cases, 28 mm in 53 cases, and 32 mm in 12 cases.

All procedures were performed through a standard posterolateral approach. The acetabular component was inserted in press-fit and dome contact; the diameter of the implant was 1 – 2 mm larger than the normal diameter of the last reamer used in preparation of the acetabular bed, and additionally 3 or 4 screws were inserted in superolateral and superoposterior directions through screw holes. We tried to keep 45 degrees of abduction and 20 degrees of anteversion during insertion of the acetabular component. The femoral component was inserted without cement. The range of motion was checked in the operation field and the wound was closed with suction drains. Patients received prophylactic antibiotics until the suction drains were removed (usually 48 hours after the operation). The treated extremity was kept in balanced suspension for 24 hours, after which gait training was begun. The patients were allowed weight bearing on the affected limb as tolerated, and they generally used 2 crutches for the first 6 weeks after the operation. Patients were followed in the office at 6 weeks, 3 months, 6 months postoperatively and yearly thereafter, according to a predetermined protocol. Clinical and radiographic assessments were made at each office visit. At each yearly visit, a Harris hip score was determined by an individual other than the operating surgeon. Standardized radiographs, including anteroposterior radiographs of the hips and pelvis, a frog-leg lateral radiograph, and a true lateral radiograph of the treated hip, were obtained at each follow-up visit. The radiograph was taken as the beam was aimed at the symphysis pubis of the patient. This image well visualized the position of the acetabular cup, screws, and femoral stem. Magnification of the film was made at 110% through the tube which was located 90 – 100 cm from the plate.

Each acetabular component was evaluated for the presence and progression of radiolucent lines at the bone-implant interface within the 3 zones of DeLee and Charnley.[5] A continuous radiolucent line at the bone-implant interface at 2 mm wide at every zone was accepted as radiographic evidence of impending failure according to the criteria of Dorr et al.[6] Evidence of acetabular migration, both vertical and horizontal, was measured on serial radiographs according to Massin's criteria.[7] Vertical migration was evaluated by measuring the vertical distance from the center of the acetabular component to a horizontal line through the bottom edge of the teardrops. Horizontal migration was evaluated by measuring the horizontal distance between the center of the acetabular component, and a vertical line was drawn through the medial edge of the ipsilateral teardrop. When the teardrop was not visible, vertical migration was measured between the bottom edge of the cup while the abductor line and horizontal migration was measured as the horizontal distance between the center of the acetabular component and Köhler's line (a line drawn on the anteroposterior radiograph of the pelvis along the medial aspect of the ilium and ischium). Acetabular migration was defined as a change of more than 2 mm in the horizontal or vertical dimensions and more than 5° in inclination angle.[8] A component was considered to be definitely loose if migration could be demonstrated. Abduction angle of the acetabular component was measured as the angle of intersection between the horizontal line through the teardrops and the plane of the cup opening. Acetabular cup coverage was calculated as a percentage of the total 180 degrees of the hemispheric shell with superolateral coverage. Medialization of the acetabular component was measured as the horizontal distance from the center of the acetabular component to the vertical line of the medial border of the ipsilateral teardrop. The number of acetabular fixation screws was recorded and assessed for breakage, penetration, loosening, and/or surrounding radiolucency. The difference of magnification in serial radiographs was corrected on the basis of the size of the inserted femoral head.

RESULTS

The mean preoperative Harris hip score was 57.2 (range, 26.3−80.1), and at the final follow-up examination it was 95.1 (range, 62.2−100). By radiographic analysis, the average cup position was 36° of abduction (range, 28−50°) and 22° of anteversion (range, 0−37°). No component had detectable migration or any other position change. No component displayed any disruption of the fiber mesh. No acetabular fractures were noted. None of the screws had bent, broken, or loosened as seen radiographically.

The immediate postoperative radiographs demonstrated gaps at the acetabular implant-bone interface in 33 hips (47%). Gaps were identified at zone II (12 cases, 17%) and zone I (11 cases, 16%). Most of these gaps measured 0.5 mm and none were more than 1 mm wide. The fate of the gap was determined by comparing the appearance immediately after surgery with the corresponding region on the 2-year follow-up radiograph. Gaps at zone II (polar gap) decreased during 6 or 12-month follow-up, and were not visible at 2 years in all cases. The wedge-shaped peripheral gaps that developed at zone I due to undercoverage of the cup in cases of acetabular dysplasia were observed in 11 cases (16%). In 7 of these cases, the gaps were not visible due to bone ingrowth and were unchanged in 4 cases.

New radiolucencies, in contrast to gaps, were identified on the 2-year follow-up radiograph around 38 components (54%) (Table 1). These radiolucent lines occurred most frequently in zones I and III (Fig. 1). Radiolucent lines of less than 1 mm were seen in 22 cases (31%): 8 cases at zone I, 2 cases in zone II, and 12 cases in zone III. Radiolucent lines of 1−2 mm were seen in 6 cases (9%): 2 cases in zone I, 1 case in zone II, and 3 cases in zone III. Radiolucent lines greater than 2 mm were seen in 3 cases (4%): 1 case at zone I and 2 cases at zone III. Radiolucent lines developed at all three zones in 7 cases: less than 1 mm in 5 cases and 1−2 mm in 2 cases. But there was no clinical finding of component loosening. Most progressive radiolucent lines were stabilized at 2 years after operation. Twelve hips (17.1%) had osteolysis of the acetabulum. For the location of osteolytic lesions, 7 hips had a lesion in zone 1, 5 hips had a lesion in zone 2, and 2 hips had a lesion in zone 3. The osteolytic lesions were first detected at an average 42 months (range, 24 to 84). There were no vascular or neural complications associated with the screws used for fixation. Two hips had a dislocation, but additional treatments were not performed. Revision arthroplasties were performed in 9 hips during follow-up: progressive osteolysis in 5 hips, severe polyethylene liner wearing in 2 hips, and excessive wear of metal

Table 1. Acetabular Radiolucent Lines According to Gruen Zone

Radiolucent line (mm)	Zone			
			3	Continuous (1,2,3)
≤1	8	2	12	5
to ≤2	2		3	2
>2	1	0	2	0

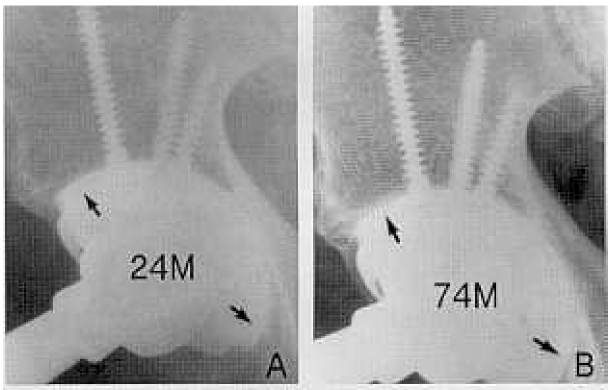

Fig. 1. (A) Anteroposterior radiograph, 24 months postoperatively, shows a radiolucent line (arrow), 1 mm wide in zones I and III. (B) The radiolucent line (arrow) was unchanged at 74 months follow-up evaluation.

shell and metallosis in 2 hips. A dissociation of the liner secondary to fractures of the tines was found in 5 hips at the time of revision of the acetabulum. No acetabular component was revised because of aseptic loosening.

DISCUSSION

An important and controversial aspect of cementless acetabular component design is the use of supplementary fixation. Lachiewicz et al. demonstrated superior fixation of porous-coated acetabular components with three screws, as compared with pegs.[9] Cook et al. studied histologically the cementless porous-coated acetabular components retrieved from 42 patients.[1] Bone ingrowth was found more frequently, in greater amounts, and more evenly distributed anatomically in cups using screws rather than pegs for adjunct fixation. The potential risk of injury to intrapelvic vasculature when using transacetabular fixation screws has been well delineated in anatomic studies.[10,11] When using screw fixation in a cementless cup, the operator should avoid screw placement within the anterior quadrants of the acetabulum to prevent injury to the pelvic vasculature. To date, there has been only 1 reported case of a vascular complication associated with a noncemented acetabular component transfixed with screws.[12] In a minimum 5-year follow-up of primary noncemented THA using HGP acetabular components inserted with line-to-line fit (acetabulum was reamed to the size of the cup) and fixated with 3−4 screws, Schmalzried and Harris reported that the initial gaps were found in 49% of hips and the size of gaps was mostly less than 0.5 mm.[2] Geographically, gaps were predominantly located in zone I and zone III. Also, radiolucent lines developed in 59% of hips and were predominantly located in zones I and III. Progressive radiolucent lines occurred in 27% of hips. Progressive radiolucent lines developed in 39% of cases with an initial gap and 14% of cases without an initial gap. According to their results, the disadvantages of a line-to-line fit is the development of an initial peripheral gap, and the possibility of developing progressive radiolucent lines is high because of an influx of polyethylene debris through this initial gap. In order to overcome these disadvantages, several authors tried the rim fit (press-fit) where the acetabulum was underreamed by 2−4 mm and inserted without screws. McKenzie et al. noted no difference between cups implanted with screw fixation and those implanted without screws.[13] Dorr et al. said that acetabular components could be press-fitted without screw fixation in 90% of patients undergoing THA.[6] Schmalzried et al. reported the clinical and radiographic results of 122 cases of press-fit HGP acetabular components with the same criteria for assessing radiographs that were used in their minimum 5-year follow-up study of HGP acetabular components fixed without screws.[4] According to their results, the initial gap occurred in 44 cases (36%). There were 33 zone I gaps, 24 zone II gaps, and 7 zone III gaps. The gaps were not visible in 15 cases, decreased in 3, and unchanged in 26 at 2-year follow-up. Analysis by zone revealed 22 zone I gaps, 9 zone II gaps, and 6 zone III gaps that remained. Progressive radiolucencies were observed in 31 cases around 30 acetabular components (24.6%) and they occurred predominantly in zone II (20 cases). So with regard to the results, the peripheral gaps decreased, but the polar gaps increased in comparison of the previously published results of a line-to-line fit.

We inserted the acetabular component with press-fit (underream the acetabulum 1−2 mm) and 3−4 screws fixation simultaneously. The initial polar gaps occurred in 12 cases (17%) and the width of these gaps was less than 0.5 mm. These polar gaps decreased during follow-up and were not visible at final follow-up. But we could not determine whether or not the gaps disappeared through migration or bone ingrowth. The initial peripheral wedged-shaped gaps were found in 11 cases (16%). Seven gaps were filled with bone ingrowth and 4 gaps were unchanged at final follow-up. These results were noted where the initial polar and peripheral gaps were markedly decreased in comparison to press-fit only or a line-to-line fit only. New radiolucencies were identified on 2-year follow-up radiographs in 38 cases (54%): 11 in zone I radiolucency, 3 in zone II, and 17 in zone III. Seven cases developed discontinuous radiolucencies in all 3 zones. We can confirm that the progressive radiolucent lines were stabilized at 2−3 year follow-up.

Rorabeck et al. reported 9% of acetabular osteolysis at a 5 to 7 year follow-up after cementless total hip arthroplasties.[14] Kennedy et al. reported 13−24% of pelvic osteolysis at 4 years after index surgery.[15] In the results associated with Harris-Galante acetabular prosthesis, 0−4% of acetabular osteolysis has been documented in the literature.[16-21] This study showed 17.1% of acetabular osteolysis at a minimum 5 years follow-up. This incidence was higher than in other reports.[15-21] Because mechanical and biological factors have appeared to be important in the aetiology of periprosthetic osteolysis, the differences in variables for patients and operative procedure may be related to the incidence of osteolysis. As well, the possibility can't be excluded that radiolucency by stress shielding has been misinterpreted as osteolysis. Long-term follow-up is necessary in order to evaluate acetabular osteolysis and its progression.

In summary, fixation of the acetabular component with press-fit and screw augmentation had good results with a 5 to 9-year follow-up.

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