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Current Status of Modern Fully Porous Coated Metal-On-Metal Hip Resurfacing Arthroplasty

Thomas P. Gross, MD, Fei Liu, PhD

Midlands Orthopedics, P.A., Columbia, South Carolina

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ABSTRACT

Between March 2007 and July 2010, 1000 consecutive fully porous coated hip resurfacing arthroplasties (HRA) were performed by a single surgeon in 871 patients. The average length of follow-up was 3 ± 1 years. Three cases (0.3%) in three patients showed adverse wear related failures. Another 17 (1.7%) failures were identified at the time of this study. Using any failure of any component as the endpoint, the survivorship rate was 98.8% at two years and 97.4% at five years. Excluding the failed cases, all components were radiographically stable; there was only one partial femoral radiolucency seen. The clinical and radiological outcomes of this fully porous coated hip resurfacing were comparable to, if not better than, those reported by others using hybrid fixation methods at five years post-operatively.

Although the majority of metal-on-metal hip resurfacing implants currently being used worldwide utilize bone ingrowth fixation on the acetabular side, cement fixation remains the standard method of fixation on the femoral side [1,2]. The literature supporting uncemented fixation in stemmed total hip arthroplasty (THA) led us to develop an uncemented femoral resurfacing component and to test our hypothesis that bone ingrowth may also be a superior method of fixation in the femoral resurfacing component. To study the value of bone ingrowth fixation of the femoral resurfacing component, we must analyze not only clinical femoral failures but also signs of radiographic fixation. Because we suspect that different types of failures may have different causative factors, we divide femoral failures into early (less than 2 years postoperative) and late types. The most common early femoral failure mode is femoral neck fracture [3,4]. The second early mode of failure is a slow collapse of the femoral head, where the component subsides and migrates into a varus position. It is suspected that this is usually caused by osteonecrosis (ON) of the femoral head due to surgical devascularization. In retrieval studies, dead bone is typically seen [5,6]. The cause of late femoral failures is more controversial. We believe that they are chiefly due to mechanical failure of cement fixation, but others have often listed late failures as ON as well [7].

Our hypothesis is that bone ingrowth fixation of a fully porous-coated component can provide the initial fixation of the femoral hip resurfacing component. We hypothesize that use of a fully porous-coated femoral hip resurfacing component will result in a high rate of bone ingrowth and therefore clinical and radiographically stable fixation on the femoral head. Bone ingrowth will reliably occur even when a posterior hip approach is used. There will be a low rate of early femoral failures: femoral neck fractures and osteonecrosis. Bone ingrowth will be demonstrated by a lack of migration of the component and absence of radiolucencies by two years postoperatively. Normally, femoral components that have achieved bone-ingrowth fixation by the above criteria will not subsequently loosen [8]. We wanted to know if this was true for uncemented femoral resurfacing components as well.

Material and Methods

At the time of this study, the senior author had performed 2801 HRA cases. Of these, 1668 cases employed a combination of a fully porous coated Biomet Recap™ femoral component and a fully porous coated acetabular component Magnum™ (Biomet, Warsaw, IN, USA). We analyzed data prospectively collected on a consecutive series of the first 1000 metal-on-metal fully porous coated total hip resurfacing arthroplasties in 871 patients from March 2007 and July 2010 (Table 1).

The Biomet hybrid resurfacing system employing the Recap and Magnum implants has been previously described in detail [9,10]. In this report, only the undersurface of the femoral component was modified. A layer of plasma sprayed titanium was added to the grit blasted cobalt-chrome undersurface of the femoral component. In the Biomet Recap system, the same instruments are used for femoral preparation whether cement or bone ingrowth fixation is used. The instrumentation allows a 0.5 mm gap for the cemented device. The added titanium layer on the undersurface of the Recap component was designed to provide a 1 mm interference fit across the diameter

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Reprint requests: Fei Liu, PhD, Midlands Orthopaedics, P.A., 1910 Blanding St., Columbia, SC 29201.

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Table 1
Demographic Information of the Study Group.

Variables	Number	Percentage
# of Cases	1000	—
In women	250	25.0%
In men	750	75.0%
Deceased[a]	4	0.4%
Diagnosis		
Osteoarthritis	761	76.1%
Dysplasia	125	12.5%
Osteonecrosis	54	5.4%
Post-trauma	24	2.4%
Legg-Calvé-Perthes	13	1.3%
Others	23	2.3%
	Average	Range
Follow-up (yr)	3 ± 1	2–5
Age at surgery (yr)	52 ± 8	12–76
Weight (kg)	190 ± 38	105–318
BMI (kg/m^2)	27 ± 4	18–44
T-score	0 ± 1	−3.4 to 6.7

[a] 4 patients (4 cases) died with the causes unrelated to their hip arthroplasties.

for the uncemented device. The femoral peg is uncoated. The operations were performed through a posterior minimally invasive vascular sparing surgical approach (Table 2). Details of the surgical technique were previously reported [9]. The only significant change was that femoral fixation was uncemented in this study. Spinal anesthesia was used in 992 cases, and general anesthesia was used in eight cases.

Four patients died from causes unrelated to their hip surgery. Because their two-year follow-up information was available in our database, two of these four deceased patients were still included in this study. Three other cases (0.3%) were missing their minimal two-year follow-ups in this study. The three most common primary diagnoses were osteoarthritis in 761 (76.1%) hips, dysplasia in 125 (12.5%) hips, and osteonecrosis in 54 (5.4%) hips. The average size of the femoral component was 50 ± 4 cm (range: 40 to 60 mm), and the average size of the acetabular component was 56 ± 4 cm (range: 46 to 66 mm). All pre-operative, intra-operative, and post-operative data were prospectively collected and entered into our database for later review.

Postoperatively, all patients with good bone quality (DEXA scan bone density of $T > -1.5$) were allowed to proceed with a rapid mobilization program. Weight bearing as tolerated was allowed as soon as the effects of the spinal anesthesia wore off, either on the day of surgery or post-operative day one. Patients used crutches for one to two weeks and afterwards used a cane for one to two weeks. In the hospital, physical therapists taught patients a home program of simple hip exercises and precautions to avoid extreme hip positions. No formal therapy was employed after discharge from the hospital. At 6 weeks post-operatively, a home program of light strengthening and aerobic exercise was started. Impact activities were not allowed until six months after the surgery. In patients with weaker bone density ($T \leq -1.5$), slower progression to full weight bearing over a period of 10 weeks was recommended.

Regular follow-ups were requested at six weeks, one year, two years, and every other year thereafter post-operatively. In-office follow-ups were recommended at the six week and one year postoperative. However, because 80% of the patients came from out of the state where the senior author practices, remote follow-up was sometimes obtained through the online database, or by a telephone interview. Their x-rays and physical exam results were obtained either during the office visit or performed by their local therapists and radiology centers and mailed to us. HHS, UCLA activity score, and Visual Analog Scale (VAS) pain score were utilized to evaluate the clinical outcomes after the hip resurfacing procedure. Anteroposterior and lateral radiographs from the time of the latest follow-up evaluation were evaluated. Since 2010, metal ion tests were routinely requested for all patients who had reached at least two-years post-operatively. Institutional review board approval was obtained for this study.

Statistical differences between pre-operative and post-operative Harris hip score (HHS) and the ranges of motion were performed using two-tailed student *t*-tests. The level of significance (α) was set as 0.5. Kaplan-Meier curves were plotted to report the survivorship rate using two different end points. Uni-variable and multi-variable proportional hazard regression models were used to identify the potential risk factors for the failures in metal-on-metal fully porous coated hip resurfacing.

Table 2
Surgical Summary of the Study Group.

Variables	Average	Range
ASA score[a]	2 ± 1	1–3
Length of Incision (in)	4 ± 1	3–6
Operation Time (min)	105 ± 17	35–220
Estimated Blood Loss (mL)	196 ± 102	50–600
Size of femoral components (mm)	50 ± 4	40–60
Hospital Stay (days)	2 ± 1	1–5

[a] American Society of Anesthesiologists Scores.

Results

The average length of follow-up was 3 ± 1 year (range: 2 to 5 years). There were a total of 20 revisions (2%) (Table 3). There were eight (0.8%) early femoral failures: six (0.6%) femoral neck fractures occurred between one month and two months post-operatively and two (0.2%) cases of femoral head collapse (osteonecrosis [ON]) at ten months and twelve months post-operatively. In both ON cases, radiographs revealed subsidence and varus tilt of the femoral component with development of a radiolucent line in zone 3 and a sclerotic line in zone 1. There were no femoral failures after one year post-operatively. In all eight femoral failures, the femoral components were revised with the use of stemmed large bearing metal-on-metal prostheses that mated with the remaining acetabular components. There were nine (0.9%) acetabular failures: six (0.6%) failures of acetabular component ingrowth recognized at 2 months to 32 months postoperatively and three (0.3%) cases due to acetabular malposition resulting in adverse wear related failures, which occurred between 24 months and 44 months postoperatively. There was one patient revised to a THA elsewhere for recurrent subluxation; two cases were revised to THA — one due to intertrochanteric fracture and one due to periprosthetic femur fracture.

The *Kaplan-Meier* survivorship rate was 98.8% at the two-year follow-up, and 97.4% at the five-year follow-up when failure of any component was used as the endpoint (Fig. 1). The *Kaplan-Meier* survivorship rate was 100% at the two-year follow-up, and 99.4% at the five-year follow-up when adverse wear related failure was taken as the endpoint. When any femoral failure was taken as the endpoint, the *Kaplan-Meier* survivorship rate was 99.8% at both the two-year and five-year intervals.

Excluding the failed cases, there was only one case in which a partial radiolucency was identified around the femoral component. There were no cases of osteolysis. Therefore, there were no impending radiographic failures in addition to the known clinical failures. The average acetabular inclination angle was 39° ± 7° (range: 15° to 57°) (Table 4). In 18 cases, the acetabular inclination angle (AIA) was ≥55° (range: 56 to 59). In 46 cases, the AIA was ≥50°.

The average blood loss was 195 ± 102 cc (range: 50 to 600 cc). Cell saver was used in 117 patients with an average amount returned of 104 ± 58 cc (range: 20 to 300 cc). No blood transfusion was required for any patient. After all failures are excluded, the average post-operative HHS score was 98 ± 7 at the latest follow-up showing significant improvement compared with the average pre-operative HHS score of 57 ± 15 ($P < 0.001$) (Table 4). At the latest follow-up,