The First 100 Fully Porous-Coated Femoral Components in Hip Resurfacing

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Abstract

Uncemented fixation of implants to bone is a proven technology in traditional hip arthroplasty surgery. However, cement fixation is currently the standard method for the femoral component in hip resurfacing. The purpose of this study was to evaluate the performance of uncemented fixation of the femoral component in the first 100 fully porous-coated metal-on-metal hip resurfacing arthroplasties at a minimum follow-up of 2 years.

Materials and Methods: From March to October 2007, 100 consecutive uncemented metal-on-metal hip resurfacing arthroplasties in 95 patients (74 males and 21 females) were implanted by the same surgeon, using bone ingrowth technology for both femoral and acetabular components. The posterior minimally invasive approach was utilized in all cases. The primary diagnosis was osteoarthritis in 72% of cases, but other diagnoses were not excluded for the purposes of this study. The mean femoral component size was 51 ± 4 millimeters, and patients were not excluded for small component size.

Results: The mean follow-up was 2.9 ± 0.2 years. The mean pre-operative Harris hip score was 57 ± 13 and improved to 96 ± 6 at the final follow-up visit. The mean UCLA activity score was 8 ± 2. There were two failures (2%): one femoral neck fracture at 2 months and one femoral component loosening at 12 months postoperatively.

Conclusion: The study demonstrated that fully porous-coated femoral resurfacing components have equivalent results to those reported for cemented femoral components at short-term follow-up. This suggests that the femoral head can reliably achieve bone ingrowth into a fully porous-coated femoral component. This encourages us to continue utilizing this bone ingrowth technique as an alternative to cement in this young and active patient group. Long-term follow-up will be needed.

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The current accepted standard fixation method for modern metal-on-metal hip resurfacing arthroplasty is a hybrid technique using a cemented femoral component in combination with an uncemented acetabular component. Prior investigators had tested various fixation methods before settling on hybrid fixation for metal-on-metal hip resurfacing.[1] They evaluated bone ongrowth, but not porous bone ingrowth methods for femoral components. McMinn pioneered metal-on-metal resurfacing with hybrid fixation, uncemented fixation on the socket side, and cemented fixation on the femoral side, first with the McMinn Corin system (Corin, Cirencester, Gloucestershire, UK),[2] and then with the Birmingham Midlands Medical Technology system (Smith & Nephew, Memphis, Tennessee).[3] Amstutz took the same path using hybrid fixation with the Conserve® Plus Wright Medical system(Wright Medical Technology, Arlington, Tennessee).[4] Therefore, hybrid fixation has now been adopted as the standard for metal-on-metal resurfacing worldwide. McMinn, Amstutz, and numerous other investigators have shown 95% survivorship after contemporary hip resurfacing in young and active patients at 7 years, and even 99% survivorship in ideal candidates at 8 to 10 years with use of this hybrid fixation method.[5-6]

Our approach has been different. At the time that the senior investigator (TPG.) began resurfacing in 1999,[7] it appeared likely that uncemented fixation would prove superior for young active patients in conventional total hip arthroplasty (THA).[8-11] It is estimated that 95% of all sockets and 80% of all stems implanted in THAs in the US today are porous in-growth types. In 1999, metal-on-metal resurfacing

Gross TP, Liu F. The first 100 fully porous-coated femoral components in hip resurfacing. Bull NYU Hosp Jt Dis. 2011;69(Suppl 1):S30-5.

had just re-emerged as a promising alternative to stemmed THA in young patients. Our initial small series of resurfacings were uncemented, showing 100% femoral survivorship at 8 years, despite the fact that the femoral component featured an ongrowth, rather than ingrowth component.[7] After a 7-year development process with hip resurfacing, we were able to begin implantation of the first fully porous-coated bone ingrowth femoral component in March 2007, to begin testing our hypothesis that uncemented fixation of both components in resurfacing would provide superior long-term fixation in this young active patient cohort. The purpose of this study was to report our preliminary experience with the first 100 contemporary fully porous-coated (uncemented) metal-on-metal hip resurfacing arthroplasties with a minimum 2-year follow-up.

Materials and Methods

In March of 2007, the senior investigator (TPG) implanted the first contemporary fully porous-coated metal-on-metal hip resurfacing implant by combining the Biomet® femoral uncemented ReCap® and acetabular Magnum™ hip resurfacing components (Biomet®, Warsaw, Indiana). All patients under 65 years of age, who were candidates for hip arthroplasty and had adequate bone stock for resurfacing, were offered hip resurfacing. We did not select for gender, diagnosis, bone density, presence of cysts, or component size. As of June 2010, 995 hip resurfacing cases have been performed with the use of these components. All of the first 100 consecutive fully porous-coated hip resurfacing arthroplasties in 95 patients reached their minimum 2-year follow-up in June of 2010, which formed the present study group. Detailed pre-operative, intra-operative and postoperative clinical and radiographic data were collected and maintained in our database. This database was retrospectively analyzed for the current study. Institutional Review Board (IRB) approval was obtained for this analysis. The preoperative demographic and diagnostic data are summarized in Table 1.

Table 1 Demographic and Diagnosis Data

	Average	Range
Age at surgery (years)	49 ± 8	28 to 66
Weight (lbs)	187 ± 32	115 to 267
Body Mass Index (BMI)	27 ± 4	20 to 43
T-Score	0 ± 2	-2.2 to 5.2
Gender (N = 95 patients)	Number	Percent
Males	74	78%
Females	21	22%
Diagnosis (N = 100 hips)	Number	Percent
OA	72	72%
Dysplasia	13	13%
AVN	6	6%
Post-trauma	3	3%
LCP	2	2%
RA	2	2%
Others	2	2%

AVN, avascular necrosis; LCP, Legg-Calve-Perthes; OA, osteoarthritis; RA, rheumatoid arthritis.

Postoperative follow-up visits were requested at 6 weeks, 1 year, 2 years, and thereafter every other year postoperatively. The follow-up evaluation was completed by using one of the following two methods: 1. office visit; and 2. completed online or phone questionnaire, radiographs, and physical examination results completed by a physical therapist. Clinical and radiographic outcomes were entered into our database and analyzed. The Harris hip score (HHS) was used to evaluate the clinical outcome. The University of California, Los Angeles (UCLA) activity score was used to estimate the activity level after the surgery; it is based on a grade of 1 to 10, where 10 represents the most active level.[12] A visual analogue scale pain score[13] was utilized to evaluate the pain level and graded from 0 to 10; zero represents no pain and 10 represents the worst pain.

Anteroposterior and lateral radiographs of the pelvis and hip were analyzed for component position, migration, and radiolucencies.[4] Implant femoral shaft angle was assessed by measuring the angle between the axis of the stem of the femoral component and the center axis of the femoral shaft. The acetabular inclination angle was assessed by measuring the angle formed between a line across the inferior pubic rami and a line across the opening face of the acetabular component. Radiographic measurements and data calculations were performed with use of custom developed software: OrthoTrack (Midlands Orthopaedics, P.A., Columbia, South Carolina).

Implant System

The femoral component has an internal shape of a hemisphere on top of a cylinder and a layer of titanium plasma spray identical to that which is applied on other Biomet® products such as the Magnum™ acetabular component (Fig. 1). The femoral instrumentation is the same for the uncemented versions as the cemented version.[14] A complete plasma spray coating on the undersurface of the uncemented version creates a tight initial press-fit. The stem is uncoated. Femoral sizes are from 40 to 66 millimeters, in 2 millimeter increments, with one matching Magnum™ acetabular component available for each femoral component size.

Surgical Technique

A minimally invasive posterior surgical technique previously described was utilized.[14] The surgical technique used in preparing the femoral head for the fully porous-coated femoral component is similar to that used for the cemented femoral component from the same manufacturer. After the femoral cuts were made, a trial was performed to check the position of the femoral component and protect the femoral head. Prior to implantation of the final component, all soft tissue and loose necrotic bone was removed. Defects were grafted using acetabular reamings. Platelet-rich concentrate (Magellan, Medtronic, Minneapolis, Minnesota) was sprayed on the femoral head. The component was placed

Figure 1 Fully porous coated components (Magnum™, ReCap®, Biomet®; Warsaw, Indiana).

onto the femoral head. Initial seating of the implant was approximately 1 to 2 centimeters proximal to the final position. Several moderate mallet blows helped seat the implant completely. These blows were naturally more forceful when strong bone was encountered and lighter when softer bone was present. The implant was seated to the same position marked from the trial and had a tight initial press-fit. No implants could be rotated by hand. In no instance was the technique abandoned due to failure of initial fixation. The surgical data is summarized in Table 2.

The same rehabilitation program was used with fully porous-coated implants as was previously used for the hybrid fixation resurfacing patients. Patients were advised to proceed with a program of increasing ambulation, using crutches for 1 to 2 weeks, a cane for 1 to 2 weeks, and walking without devices for 1 mile by 6 weeks postoperatively. There was no formal therapy after hospital discharge. Between 6 weeks and 6 months, increasing walking, isometric exercises and light aerobic exercises were encouraged. Impact sports were begun 6 months after surgery. There were no restrictions after 6 months, including unlimited running.

Statistical Analysis

The paired t-test was used to compare the preoperative and postoperative HHS scores. The significance level α was chosen as 0.05. The Kaplan-Meier method was used to calculate the survivorship rate of the fully porous-coated hip resurfacing system. All of the statistical analyses were performed with use of either OrthoTrack or JMP® (SAS, Cary, North Carolina).

Table 2 Surgical Summary for the Biomet® ReCap® Fully Porous-Coated HRA

	Average	Range
Length of incision (inch)	4 ± 0.4	4 to 6
Operation time (min)	116 ± 21	80 to 220
Estimated blood loss (EBL) (cc)	274 ± 111	100 to 550
Transfusions	0	0
Hospital stay (days)	3 ± 1	2 to 7
Size of femoral component (mm)	51 ± 4	40 to 64

Results

The mean follow-up duration was 2.9 ± 0.2 years (range, 2.7 to 3.3 years). The clinical and radiographic results are summarized in Table 3. Many patients returned to a high activity lifestyle; 80% of patients reported a UCLA score of 7 points or greater, and 60% of patients reported a UCLA score of 8 points or above. Range of motion was significantly imporoved after surgery (Table 4).

The mean acetabular inclination angle was 47° ± 5° (range: 36° to 59°). Only two acetabular components had a partial radiolucency in one zone[4] at the time of the latest follow-up. With the exception of the two failed cases, no radiolucency or migration was seen for any femoral components (Fig. 2).

Kaplan-Meier survivorship rate was 99% at 1 year and 98% at 2 and 3 years using revision of any component for any reason as the end point (Fig. 3). Two cases (2%) failed in this series. The first failure was in a 63-year-old male who had posttraumatic arthritis, a T-score (bone density) of 1.4, and a body mass index of 28. Two months after the primary hip resurfacing procedure, he required femoral revision to the THA due to femoral neck fracture. At his latest 2-year follow-up after the revision, he was doing well, with a HHS score of 94 points. The second failure was in a 60-year-old male with osteoarthritis, a T-score of -1.7, and a body mass index of 25. Twelve months after the primary hip resurfacing procedure, the femoral component required revision because of femoral head collapse (possibly from osteonecrosis). Two years after the revision, his hip is functioning well, with a HHS score of 98 points. There were no acetabular revisions. One 55-year-old male with osteoarthritis experienced an isolated hip dislocation at 4-months postoperative that was treated with closed reduction.

Table 3 Follow-up Summary of the Modern Biomet® Recap® Fully Porous-Coated HRA

Clinical Results	Average	Range
Pre-operative HHS	57 ± 13	27 to 83
Postoperative HHS	96 ± 6	73 to 100
UCLA score	8 ± 2	2 to 10
VAS regular day	1 ± 1	0 to 7
VAS worse Day	2 ± 2	0 to 10
	Number	Percentage
Complications	1	1%
Failures	2	2%
Deceased	0	0%
Radiological Results	Average	Range
Implant femoral shaft angle	141° ± 6°	125° to 151°
Acetabular angle of inclination	47° ± 5°	36° to 59°
	Number	Percentage
Radiolucency	2	2%
Osteolysis	0	0%

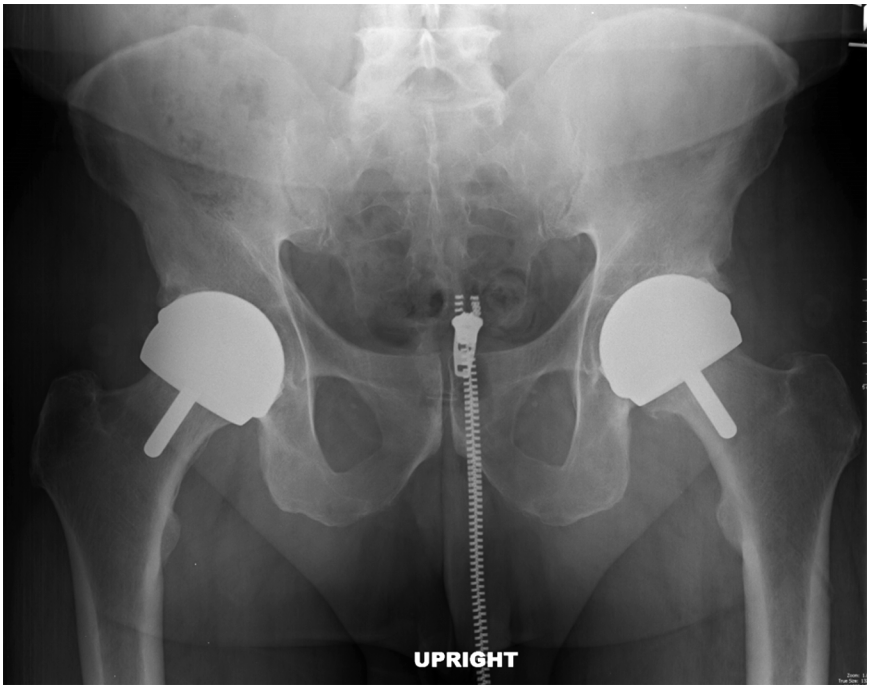

Figure 2 Radiographs of a patient with bilateral well functioning fully porous coated hip resurfacings at 3-year follow-up visit.

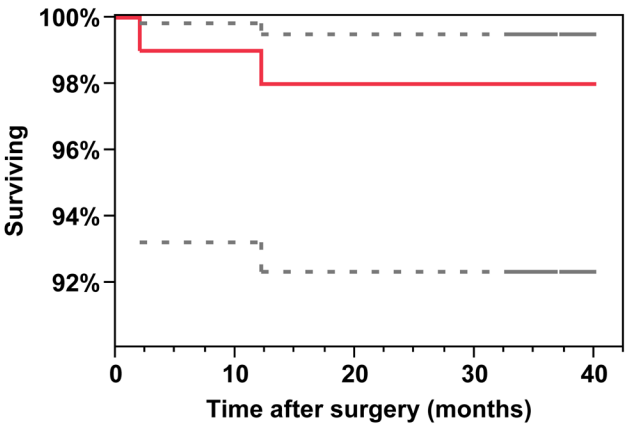

Figure 3 Kaplan Meier Survivorship of the first 100 fully porous coated metal-on-metal HRA, with 95% confidence interval.

Discussion

Currently, uncemented fixation on the acetabular side and cemented fixation on the femoral side are the standard for modern metal-on-metal hip resurfacing. We believe that there were two reasons why fully porous-coated femoral implants were not adopted when metal-on-metal hip resurfacing re-emerged in the early 1990s. First, it is technically difficult from a manufacturing standpoint to apply a layer of porous coating with a reproducible thickness to the inner surface of the femoral component. A precise set of bone measuring and cutting tools had to be developed to reliably and reproducibly prepare femoral heads so that the femoral component could be tightly wedged-on with a predictable amount of press-fit.[14] There should also be no gaps between the bone and the porous surface. Secondly, we believe that a delay in developing these components was due to a concern about the vascularity of the femoral head[15-17]; a femoral head without adequate blood flow may not be healthy enough to achieve bone ingrowth into a porous surface. In this study, we demonstrated a similar early failure rate compared to previous reports of cemented femoral components (Table 5). After excluding the one case of femoral neck fracture and the one case of femoral head osteonecrosis, we could find no evidence of radiolucent lines and no cases where the femoral component showed signs of migration.

There are several limitations to this study. The outcomes are promising, but preliminary. They only prove the high survival rate and low complication rate at early-term follow-up. It is not clear if uncemented technology on the femur will be better or worse than cemented femoral components at this point. Long-term follow-up studies with a large population of patients are necessary. Secondly, 100 cases performed by only a single surgeon, who had more than 10 years of experience with hip resurfacing, were retrospectively reviewed and reported in this study. If performed by less experienced surgeons, the outcome may vary, since many studies have demonstrated that there is a significant learning curve for hip resurfacing.[5,18-19] However, it is our opinion that the surgical technique of uncemented fixation is somewhat less demanding than that required for cemented femoral fixation.

At the early stages of developing modern metal-on-metal hip resurfacing systems, some surgeons tested different designs of uncemented fixation both on the femoral side and the acetabular side. Wagner's resurfacing prosthesis, which had a metal-on-metal cobalt-chrome bearing and achieved bone attachment by a roughened titanium surface pressed

Table 4 Pre-operative and Postoperative Range of Motions for This Series (Unit: Degrees)

Variables	Pre-operative		Postoperative		P Values
	Average	Range	Average	Range	
ROM	86 ± 18	10 to 120	108 ± 10	72 to 12	< 0.001
Abduction	29 ± 16	0 to 60	49 ± 12	25 to 70	< 0.001
Adduction	9 ± 9	-20 to 40	29 ± 8	10 to 45	< 0.001
External rotation	21 ± 13	0 to 50	41 ± 11	20 to 70	< 0.001
Internal rotation	3 ± 14	-45 to 60	28 ± 11	0 to 60	< 0.001

Table 5 Comparison of Survivor Rates After Contemporary Metal-on-Metal HRA in Different Studies

Study	Type of Implant	Years Operations Performed	Mean Duration of Follow-up (Yrs)	No. of Hips	Age of Patients	Survival Rate		
						Total	Femoral	Acetabular
Back et al.[26]	Birmingham Hip* Resurfacing	1999-2001	3 (range, 2 to 4)	230	52 (range, 18 to 82)	99%	100%	99%
Amstutz et al.[4]	Conserve® Plus	1996-2000	3.5 (range, 2 to 6)	400	48 (range, 15 to 77)	94.4%	97%	NA
Mont et al.[27]	Conserve® Plus	2002-2005	3.3 (range, 2 to 5)	54	55 (range, 35 to 79)	98%	98%	100%
Jaffe et al.[28]	Hybrid Corin Cormet 2000	2001-2003	2.6 (range, 2 to 3)	337	50.1	92.9%	94.3%	98.8%
Lilikakis et al.[25]	Uncemented Corin Cormet 2000	2001-2002	2.4 (range, 24 to 38)	70	52 (range, 23 to 73)	97%	98.6%	NA
Current study	Uncemented Biomet® Recap®	2007-2008	2.9 (range, 2.7 to 3.3)	100	50 (range, 28 to 73)	98%	98%	100%

into bone without cement and without a true porous ingrowth surface,[20] was abandoned because of failure of fixation. McMinn reported preliminary results of cemented, uncemented, and hybrid fixation in an early publication on hip resurfacing in 1991.[1] In his comparison study, there was one small group that had a roughened grit-blast cobalt chrome surface and that showed good short-term results. In none of these designs was a porous ingrowth surface employed on the femoral component. However, by the early 1990s, many studies had shown that bone ingrowth-type uncemented fixation was similar or superior to cement for standard total hip arthroplasty sockets and for femoral components as well, particularly in the young and active patient.[21-24] Therefore, it is logical to apply this uncemented fixation to contemporary metal-on-metal hip resurfacing implants. Few surgeons in the world have reported experience with bone-ongrowth fixation technique for resurfacing femoral components.[7,25] Lilikakis and colleagues[25] reported a 97.1% success rate for the femoral component at a mean 3-year follow-up using the Corin Cormet uncemented 2000 prosthesis (Corin Group, Cirencester, Gloucestershire, UK), which had a grit ballast cobalt chrome surface and plasma spray hydroxyapatite coating on the entire undersurface on the femoral side. Also, their study directly compared this uncemented device with the hybrid Birmingham Hip* Resurfacing, and no significant difference was found at 2-years postoperatively between these two implant systems. In the present study, our first 100 cases also reached a survivorship rate of 98% at approximately 3-years follow-up. We previously reported on the Corin uncemented implant, showing that 15 of 15 femoral components were well-fixed at a mean 7-year follow-up. Even though this was a small group, it shows that the femoral component in metal-on-metal HRA is able to achieve successful medium-term fixation without cement.

Conclusion

This fully porous-coated hip resurfacing system demonstrated promising early results at a mean 2.9-year follow-up. All but one porous femoral component appear to have achieved bone ingrowth without any adverse radiographic signs. We suggest that bone ingrowth into the femoral resurfacing implant may be an alternative method of fixation for young patients. However, this hypothesis needs to be proven in larger and longer-term prospective studies.

Disclosure Statement

Thomas P. Gross, M.D., has earned royalty income from Biomet. Fei Liu, Ph.D., has no financial disclosure.

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