Hip Resurfacing With the Biomet Hybrid ReCap-Magnum System

7-Year Results

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Abstract: The purpose of this study was to report our clinical outcome of a large series of metal-on-metal hip resurfacing arthroplasty (HRA) using the hybrid Biomet ReCap-Magnum system. This is a single-designer surgeon series with an average of 5 ± 1 years. Seven hundred forty consecutive hybrid HRAs were performed in 653 patients. Kaplan-Meier survivorship with any revision as an end point was 96.4% at 7 years. Twenty-five (3.4%) cases were revised: 8 due to acetabular component loosening, 6 due to femoral neck facture, 4 due to failure of femoral component fixation, 2 due to deep infection, 2 due to adverse wear, 1 due to psoas tendonitis, 1 due to recurrent dislocation, and 1 due to unexplained pain. Biomet ReCap and Magnum HRA components with hybrid fixation methods showed excellent survivorship for a minimally selected young patient cohort at 7 years. **Keywords:** hip resurfacing, hip arthroplasty, hybrid fixation, metal on metal, adverse wear.

The theoretical advantages of hip resurfacing arthroplasty (HRA) are a reduced dislocation rate, avoidance of thigh pain, more normal gait, ability of patients to tolerate higher activity levels, and preservation of the femoral neck, sometimes allowing easier revision compared with traditional stemmed total hip arthroplasty (THA) [1,2]. When compared with first-generation metal-on-polyethylene HRA designs, the introduction of contemporary metal-on-metal bearings has significantly reduced implant wear debris and has produced excellent survivorship rates in young, active patients [3-5]. In England, 46% of patients younger than 55 years received HRA in 2004 [4]; 29% of patients in Australia from the same age group chose this new surgical procedure in 2005 [6]. In the United States, a rapid growth in the demand for hip arthroplasty is expected because the aging population and the number of potential patients could become as large as 572 000 by 2030 [7]. Furthermore, patients 65 years and younger will account for more than 50% of the population requiring hip arthroplasty in the next 20 years [8]. Although HRA has been developed to address this younger population, it is not yet clear what the best arthroplasty approach will be to best serve both their short- and long-term goals.

Several studies have reported successful midterm survival rates for 3 hip resurfacing systems: the Birmingham hip resurfacing (BHR) (Smith and Nephew, Memphis, Tennessee) [4,9,10], Cormet 2000 (Corin, Cirencester, UK) [11,12], and the Conserve Plus (Wright Medical Technologies, Arlington, Tennessee) [2,13,14]. The most common failure mechanisms have been femoral neck fractures, femoral head collapse, femoral loosening, and failure of acetabular ingrowth. Recently, failure due to adverse wear reaction has been reported as an important new failure mechanism with all metal-bearing devices. Although one center has had a high rate of failure due to adverse wear with Conserve Plus and BHR implants [15], others have reported low rates of adverse wear failure with these same implants [16]. Problems with implant design have led to the recall of 2 hip resurfacing systems: the Durom (Zimmer, Warsaw, Indiana) [17,18] and the articular surface replacement (ASR) hip resurfacing system (DePuy International Ltd, Leeds, UK) [19-21]. The mechanisms of failure for these metal-on-metal hybrid systems include unsuccessful acetabular bone ingrowth in the former due to a suboptimal acetabular interface and problems with both acetabular ingrowth as well as adverse wear due to problems with the bearing design in the latter.

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After discounting the 2 recalled devices, it remains unclear if differences in other modern metal-on-metal hip resurfacing implant designs influence failure rate. National joint registries provide valuable general information for various implant systems. However, it is also helpful to compare the more detailed information contained in separate series using various implant systems. The Biomet implants became available in November 2004. To our knowledge, only small series with short-term survivorship rates have been reported for both hybrid and completely uncemented methods of fixation using the Biomet ReCap and Biomet Magnum components [22-24]. The purposes of this study, therefore, were to present our clinical and radiologic results of a large series of consecutive HRAs performed by a single surgeon using the Biomet Hybrid ReCap-Magnum large-diameter articulation system and to evaluate the factors affecting the midterm survivorship of the device. Our hypothesis was that HRA with the Biomet system showed results similar to reports with other well-designed systems and were not subject to the same high failure rates as the 2 recalled devices mentioned.

Materials and Methods

Patients

Between November 2004 and August 2008, a total of 740 hips in 653 patients underwent metal-on-metal HRA through a minimally invasive posterior approach [24] by the senior author with the use of the Biomet Hybrid ReCap-Magnum hip resurfacing implants (Fig. 1) at a single hospital. Institutional review board approval was obtained for this study. Six patients died with causes unrelated to their hip arthroplasties. Our clinical follow-up rate was 92% in this study. The demographic data and diagnoses of the study group were listed in Table 1 (available at www.arthroplastyjournal.org).

Implant System

The Biomet ReCap Femoral and Magnum Acetabular system as well as the Magnum (Biomet Inc, Warsaw, Indiana) large bearing femoral head for stemmed THA were sold outside the United States beginning June 2003. Also, it was cleared by the Food and Drug Administration and released for sale in the United States in November 2004. The Biomet Magnum uncemented acetabular component and the cemented ReCap femoral component have been approved for use in most countries. Using them together for the indication of hybrid hip resurfacing is currently under clinical trial and is considered an off-label use in the United States but is approved in most other countries. The components were designed, in part, by the senior author (T.P.G.), and he began implanting the prostheses for HRA in November 2004.

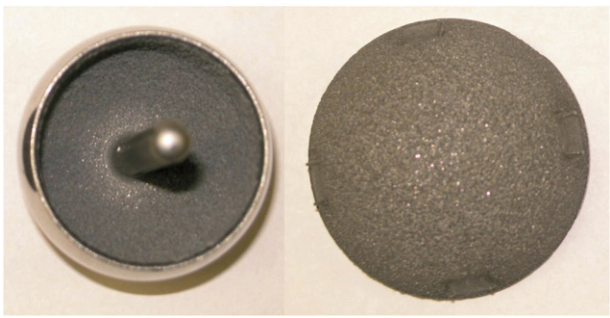

Fig. 1. Biomet ReCap-Magnum Hybrid HRA prosthesis.

Metallurgy of this system is high-carbon (>0.2%) cast cobalt-chrome without heat treatments. Each individual component sold is quality tested, with surface roughness less than 0.5 μm and a radial clearance of 75 μm. The ReCap femoral component has an undersurface of a hemisphere on the top of a cylinder with a grit blast cobalt-chrome surface. The apex of each component is 6 mm thick, and this tapers to zero at the head-neck junction. The machined radial gap for cement is 0.5 mm. The stem is cylindrical. The implants are slightly thinner than most others on the market. This was the first system to offer 2-mm increment sizing to allow more accurate matching of the implants to the patient's actual size. The range of femoral component sizes is 38 to 60 mm. One matching Magnum acetabular component was originally available for each femoral size. Now, an additional Trispike Magnum component is also available for each size. The acetabular component is 3 mm thick at the equator and 6 mm at the pole inclusive of the porous coating. The added thickness at the apex increases stiffness of the components, preventing deformation during impaction. The porous coating is titanium plasma spray for bone ingrowth. Four pairs of small fins are present to add rotational control. The acetabular bearing profile arc ranges from 154.6° in the smallest component to 163.6° in the largest component. The femoral instrumentation was the first that was designed using a measured resection philosophy. This allows the surgeon to choose a reproducing femoral length or, alternatively, to choose increasing or decreasing it by up to 6 mm to correct deformity.

Procedure

The minimally invasive posterior approach used in these cases was previously described [24]. Briefly, this involves a 4- to 5-inch skin incision, partial gluteus maximus release, complete release of the quadratus femoris, and all 3 short rotators off of the bone with subsequent repair, as well as a neck-sparing complete capsular division and repair. A multimodal pain management protocol and a comprehensive blood management protocol [23] were used. Femoral components were cemented using small amounts of high-viscosity cement on both the bone and implant surfaces with an escape trough machined into the femoral head. The stems were never cemented. The acetabulum was

Table 2. Surgical Data for the Study Groups

N = 740 Cases	Total	Male	Female	*P*	Unilateral	Bilateral	*P*
ASA score	2 ± 1	2 ± 1	2 ± 1	.04	2 ± 1	2 ± 1	.3
Length of incision (in)	4 ± 1	4 ± 1	4 ± 1	.21	4 ± 1	4 ± 1	.42
Operation time (min)	119 ± 22	121 ± 22	114 ± 23	**<.001**	118 ± 20	120 ± 25	.28
Estimated blood loss (mL)	229 ± 114	240 ± 122	200 ± 87	**<.001**	222 ± 104	240 ± 129	.06
Hospital stay (d)	1.4 ± 0.8	1.3 ± 0.8	1.6 ± 0.7	**<.001**	1.4 ± 0.7	1.5 ± 0.8	**.05**

ASA indicates American Society of Anesthesiologists.

typically under reamed by 1 mm before impaction of the acetabular component. Detailed data were recorded into the database in the operating room. A summary of the surgical information was listed in Table 2.

Postoperative Protocol

Full weight bearing as tolerated was allowed immediately after surgery. Crutches were recommended for 1 to 2 weeks and a cane for 1 to 2 weeks thereafter. Physical therapy was limited to 1 to 2 days of in-hospital instruction. Extreme bending, leg crossing, heavy lifting, and high-impact activities such as jumping and jogging were discouraged until 6 months postsurgery. Deep vein thrombosis precautions included sequential compression devices started intraoperatively and discontinued at the time of hospital discharge (mean, 1.4 days postoperatively). Low-molecular-weight heparin was used, in addition, at different times in this study.

Clinical and Radiographic Analysis

Office follow-up was requested at 6 weeks, 1 and 2 years, and every other year thereafter. If the patient was unable to comply, remote follow-up was arranged. A clinical questionnaire, radiographs and a physical examination testing range of motion (ROM), and strength were performed at each visit. Remote follow-ups included these same data at 6 weeks and 1 year. Thereafter, physical examinations were no longer required. OrthoTrack (Midlands Orthopaedics, Columbia, South Carolina) was used in this study to collect and analyze the demographic, clinical, and radiographic data for all patients.

The following scores were calculated from patient questionnaires for clinical evaluation: Harris hip score (HHS); University of California, Los Angeles (UCLA) activity score; and visual analog scale (VAS) pain score for normal and worst days. The HHS was used to determine clinical outcome; UCLA activity scores measured activity level after surgery on a scale from 1 to 10, for which 10 represented the highest level of activity; and VAS pain scores rated the level of pain from 0 to 10, with zero representing no pain and 10 representing maximum levels of debilitating pain.

Anterior-posterior pelvis and lateral radiographs were taken and analyzed for component position, shifting, and radiolucencies by the senior author [25]. The acetabular inclination angle was determined by measuring the angle formed between 2 straight lines: one running across the face of the acetabular component and the other across the inferior pubic rami [25]. The femoral shaft angle was determined by measuring the angle formed between the center axis of the femoral shaft and the axis of the femoral component stem. All measurements were performed using OrthoTrack (Midlands Orthopaedics).

Statistical Analysis

The significant level α is defined as .05 in this study. The paired t test was used to calculate the significant difference between preoperative and postoperative numerical outcomes for the same group; the Student t test was used to compare the difference of numeric variances between groups. All categorical variables were compared with use of χ^2 tests. Kaplan-Meier survivorship curves were plotted to evaluate the survival rates among different groups. Log-rank tests were performed to calculate significant differences between the survivorship curves of comparison groups.

Results

At the time of this study, 57 cases (57/740; 7.7%) reached 7 years of follow-up. The Kaplan-Meier survivorship rate using failure of any component as the end point was 96.4% for the entire group at 7 years: 96.4% for the unilateral group vs 96.2% for the bilateral group, 97.4% for the male group vs 93.7% for the female group, and 97.4% for the group with the primary diagnosis of osteoarthritis vs 91.8% with other primary diagnoses. Twenty-five cases (3.4%) were revised at the time of the study (Table 3; available at www.arthroplastyjournal.org). The most common failure mechanisms were acetabular component fixation failure (1.1%), femoral neck fracture (0.8%), and femoral fixation failure (0.5%). The Kaplan-Meier survival curves are plotted using the revision for different causes in Fig. 2. All femoral neck fractures occurred before 6 months postoperatively. Dislocations occurred in 5 (0.7%) cases. After the first 6 months postoperatively, we removed all ROM restrictions; despite this, only 1 patient (0.1%) required revision for recurrent instability. Complications not requiring revision occurred in an additional 19 cases (2.4%). Among these, femoral component loosing was observed in 2 cases both at their 5 years postoperatively. Revision THA was recommended. However, the patients decided to wait because the symptoms were mild. There were 2

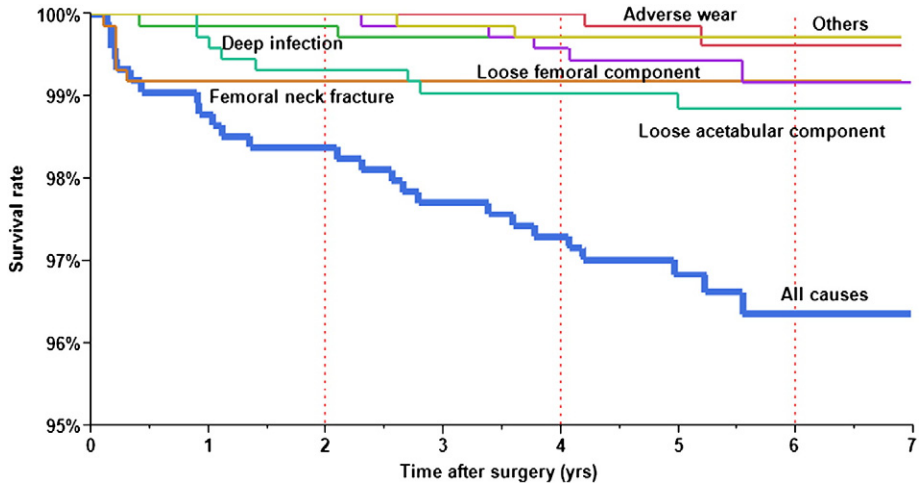

Fig. 2. The Kaplan-Meier survivorship curves of different causes of failures. Others: 1 case failed due to psoas tendonitis, 1 case failed due to recurrent dislocation, and 1 case failed due to unexplained pain but had no metal wear and no component loosening.

sciatic nerve palsies (0.3%). Clinical and radiographic data for the study groups were summarized in Table 4 (available at www.arthroplastyjournal.org). No deep vein thrombosis or pulmonary embolus was observed in the present study.

We did find numerous statistically significant differences between men and women (P = .04) but not between patients with unilateral and bilateral resurfacing (P = .99). Women were more likely to have dysplasia (24% vs 2.1%), whereas men were more likely to have osteoarthritis (88% vs 67%). For women, preoperatively, the mean total ROM was greater and the mean weight and body mass index was less. This may have been the reason that operating room time and estimated blood loss were less for women. Hospital stay was greater, and HHS and UCLA scores were lower for women. Mirroring preoperative ROM, postoperative ROM was significantly greater for women ($P < .001$). Failures were twice as common for women (5.6% vs 2.5%) primarily due to a higher rate of acetabular component fixation failures in women (3.2% vs 0.2%), most of which occurred in patients with dysplasia (4/63; 6.3%). Dislocation was also more common in women (1.4% vs 0.4%; 3 vs 2) possibly due to their increased ROM and higher incidence of dysplasia.

Discussion

This study shows that metal-on-metal HRA with the Biomet ReCap-Magnum large-diameter articulation system in a young patient cohort has a midterm Kaplan-Meier survivorship rate of 96.4% at 7 years using revision for any reason as the end point. The low number of failures in this study confirms our hypothesis that the Biomet ReCap and Magnum components are not susceptible to the same design problems resulting in implant recall specific to the Durom and ASR prostheses.

Successful midterm clinical outcomes for 3 modern metal-on-metal hip resurfacing implants have been reported: Birmingham hip resurfacing arthroplasties were reported to have 95% to 98% survivorship rate at 6 years [4,7,9,26-28]; Corin Cormet 2000 hip resurfacing systems were reported to have the survivorship rate of 96% at 6 years [11,29,30]; and Conserve Plus devices were reported to have a survivorship rate of 95.2% at 5 years [13]. We compared our results only with other consecutive series and excluded series that evaluated only certain subsets of patients [27]. A literature comparison for various metal-on-metal hybrid hip resurfacing prostheses is shown in Table 5 (available at www.arthroplastyjournal.org).

Femoral neck fracture was the most common mechanism of early failure after hip resurfacing and accounted for most revisions within the first 6 months postoperatively; no failure due to femoral neck fracture occurred after 6 months, and component fixation failure became the primary cause of revision thereafter. The present study reports acetabular fixation failure (1.1%), femoral neck fracture (0.8%), and femoral fixation failure (0.5%) as the 3 most common modes of failure, respectively, for the hybrid Biomet ReCap-Magnum prosthesis. Studies for the BHR, Cormet 2000, and Conserve Plus prostheses report similar modes of failure [11,27,31]. Femoral neck fractures and acetabular loosening represent 0.6% and 0.4% of overall failure rates, respectively, for the BHR [27], and component loosening and femoral neck fracture accounted for 3.2% and 1.3% of failures for the Cormet 2000 device [11] and 2.3% and 0.8% for the Conserve Plus device [31], respectively. The failure rates and low incidences of revision due to component loosening and femoral neck fracture for 3 other successful HRA devices are also comparable with the results in the present study.

When comparing our results with the recently recalled Zimmer Durom (2008) and DePuy ASR (2010) hip

resurfacing implants, the Biomet prosthesis demonstrates a significantly higher midterm survivorship rate [17-19,21]. The cause of excess failures in the Durom acetabular component was the failure of acetabular bone ingrowth [17,32]. The plasma spray titanium coating was relatively smooth, and a pair of sharp peripheral rings may have prevented full seating and led to inadequate stress transfer to the porous coating. This resulted in fixation failures of the acetabular component. The ASR system has had 2 mechanisms of excess failure, both of which are probably related to bearing design [19]. The ASR system did have a cobalt-chrome–sintered bead ingrowth surface that was previously proven successful in other implants. The problems with the ASR have been a high rate of failure both due to adverse wear and due to failure of bone ingrowth of the acetabular component. Three problems with the acetabular bearing design have been identified. A low radial clearance (50 μm) coupled with the thinnest acetabular wall size on the market (3 mm inclusive of coating). It has been shown that thin acetabular components can slightly deform when impacted into a hard bone [33,34]. If the radial clearance is very low, a deformed cup may begin exhibiting equatorial bearing instead of polar bearing. This could result in high shear forces on the implant-bone interface and explain the failure of bone ingrowth. Also, the bearing profile arc of this implant was lower than others on the market. The attachment mechanism for the inserter was inside the bearing (other competitors have inserter attachment mechanisms that do not affect the bearing), further decreasing the component bearing profile arc. These design variations from those of other successful implants have likely led to the high rate of failure of this component due to both fixation failure and adverse wear failure modes.

De Smet et al [35] have shown that the arc of coverage of the implanted acetabular component is the most important factor that affects the development of adverse wear failure. Three factors determine this arc of coverage of the implanted acetabular component: bearing profile arc of a specific implant design, implant size, and implanted inclination angle [16,36]. The inherent inaccuracy of x-ray, however, is still a limitation in most studies [25]. In the present series, we experienced 2 (0.3%) adverse wear failures, 1 in a woman and 1 in a man. Both had small component sizes and high acetabular inclination angles in the standing x-rays (59° and 65°). Revision was uncomplicated, and metallic wear debris was removed without significant muscle damage. Although these adverse wear failures were discovered in patients who presented with symptoms, we have now begun recommending routine screening with metal ion tests in all patients who are at least 2 years postoperatively. It is likely that more adverse wear failures will be discovered at an earlier stage using this protocol. Similar to our study, none of the comparison studies in Table 5 (available at www.arthroplastyjournal.org) used routine ion testing.

We experienced 8 acetabular fixation failures. Four (50%) of 8 were in patients with dysplasia. We have previously described a higher risk of socket fixation problems with this diagnosis [37].

The strength of this study was that this was a consecutive unselected series with a high rate of follow-up of an experienced resurfacing surgeon not practicing at a university center. In this study, we were able to achieve 92% follow-up. This follow-up rate compares favorably with the percentage of follow-up reached in other studies listed in Table 5 (available at www.arthroplastyjournal.org), which reports clinical outcomes for successful hybrid HRA prostheses with comparable follow-up duration. Table 5 (available at www.arthroplastyjournal.org) shows that most midterm reports indicate a follow-up rate of 90% or greater; however, with larger patient cohorts, lower follow-up rates may be expected.

All operations in this series were performed by a single experienced hip resurfacing surgeon at a small nonacademic hospital. The surgeon already had performed nearly 400 hip resurfacings before this series was started [11]. Therefore, well-documented complications associated with the learning curve are avoided [1,11,13].

Several limitations are acknowledged in this study. First, the present study is reporting only midterm survivorship rates for the Biomet ReCap-Magnum hip resurfacing system. Although we agree that long-term follow-up is needed to fully understand design and clinical factors influencing implant survivorship rates, no other studies have reported the survivorship or failure rates for this prosthesis, which was introduced in 2004 in the United States. Second, this is a single-surgeon designer series. Similarly, McMinn is the BHR designer, and Amstutz is the Wright medical designer. Our financial bias is mitigated by that the senior surgeon's royalty contract with Biomet ended in December of 2010. No further financial benefits from the company have been received since that time. Finally, there is no control group. Comparison with other similar series is required to judge effectiveness of this implant. The patient population and follow-up methods are not identical between different series.

We conclude the following:

(1) Midterm results with the Biomet system are comparable with other well-designed HRA implant systems (96.4% survivorship at 7 years).
(2) Adverse wear is an uncommon failure mode (0.3%) when an experienced HRA surgeon uses a well-designed implant system.
(3) No difference in complication risks is seen when comparing patients with unilateral or bilateral hip resurfacing.
(4) Women have twice the failure rate of men (5.6% vs 2.5%) primarily due to acetabular fixation failures in dysplasia patients.

(5) Failure of acetabular fixation is the most common failure mechanism (1.1%).
(6) All femoral neck fractures (0.8%) occurred before 6 months of follow-up. There was no difference between women and men.
(7) Failure due to hip instability is rare (0.1%).
(8) The complication of venous thromboembolism is rare after HRA (0/740).

Although HRA has been demonstrated to be a safe and effective, stable, bone-preserving option for younger patients, it is likely that results can be further improved by focusing on strategies to improve acetabular fixation, femoral neck fractures, femoral fixation, and adverse wear.

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Table 1. Demographics and Diagnoses of the Study Group

Variables	Total	Male	Female	*P*	Unilateral	Bilateral	*P*
No. of cases	740	526 (71.1%)	214 (28.9%)	–	473 (63.9%)	267 (36.1%)	–
Age at surgery (y)	51 ± 8	51 ± 7	51 ± 8	.62	51 ± 8	51 ± 7	.5
Weight (kg)	190 ± 40	202 ± 35	160 ± 33	**<.001**	190 ± 39	190 ± 41	.94
Body mass index (kg/m^2)	27 ± 4	28 ± 4	26 ± 5	**<.001**	28 ± 4	27 ± 4	.16
t Score *	0 ± 1	0 ± 1	0 ± 1	.48	0 ± 1	0 ± 1	.19
Diagnosis				<.001 †			.11 †
Osteoarthritis	606 (81.9%)	463 (88%)	143 (66.8%)	**<.001**	384 (81.2%)	222 (83.1%)	.50
Dysplasia	63 (8.5%)	11 (2.1%)	52 (24.3%)	**<.001**	36 (7.6%)	27 (10.1%)	.25
Avascular necrosis	31 (4.2%)	24 (4.6%)	7 (3.3%)	.42	20 (4.2%)	11 (4.1%)	.94
Posttrauma	16 (2.2%)	13 (2.5%)	3 (1.4%)	.34	14 (3.0%)	2 (0.7%)	**.03**
Legg-Calvé-Perthes	12 (1.6%)	9 (1.7%)	3 (1.4%)	.76	10 (2.1%)	2 (0.7%)	.13
Others	12 (1.6%)	6 (1.1%)	6 (2.8%)	.12	9 (1.9%)	3 (1.1%)	.41

* *t* Scores have been recorded since July 2006, but not routinely, and are available in 109 cases (15%).
† *P* value calculated considering all the diagnoses between 2 groups.

Table 3. Summary of Failures and Complications

Variables	Total	Male	Female	*P**	Unilateral	Bilateral	*P**
No. of cases	740	526 (71.1%)	214 (28.9%)	–	473 (63.9%)	267 (36.1%)	–
Modes of failure	25 (3.4%)	13 (2.5%)	12 (5.6%)	.04	16 (3.4%)	9 (3.4%)	.99
Acetabular fixation failure	8 (1.1%)	1 (0.2%)	7 (3.2%)	**<.001**	7 (1.5%)	1 (0.4%)	.13
Femoral neck fracture	6 (0.8%)	4 (0.8%)	2 (0.9%)	.81	3 (0.6%)	3 (1.1%)	.48
Femoral fixation failure	4 (0.5%)	3 (0.6%)	1 (0.5%)	.86	1 (0.2%)	3 (1.1%)	.11
Deep infection	2 (0.3%)	2 (0.4%)	0 (0%)	.24	2 (0.4%)	0 (0%)	.18
Adverse wear	2 (0.3%)	1 (0.2%)	1 (0.5%)	.53	1 (0.2%)	1 (0.4%)	.69
Psoas tendonitis	1 (0.1%)	1 (0.2%)	0 (0%)	.41	0 (0%)	1 (0.4%)	.15
Recurrent dislocation	1 (0.1%)	1 (0.2%)	0 (0%)	.41	1 (0.2%)	0 (0%)	.34
Unexplained pain	1 (0.1%)	0 (0%)	1 (0.5%)	.12	1 (0.2%)	0 (0%)	.34
Complications	19 (2.7%)	5 (1.1%)	14 (6.5%)	<.001	13 (3.0%)	6 (2.2%)	.68
Femoral component loosening	2 (0.3%)	0 (0%)	2 (0.9%)	**.03**	1 (0.2%)	1 (0.4%)	.69
Femoral neck fracture healed	1 (0.1%)	0 (0%)	1 (0.5%)	.12	1 (0.2%)	0 (0%)	.34
Dislocation	4 (0.5%)	1 (0.2%)	3 (1.4%)	.06	2 (0.4%)	2 (0.7%)	.57
Deep infection (cured)	2 (0.3%)	1 (0.2%)	1 (0.5%)	.53	1 (0.2%)	1 (0.4%)	.69
Sciatic nerve palsy	2 (0.3%)	1 (0.2%)	1 (0.5%)	.53	2 (0.4%)	0 (0%)	.18
Psoas tendonitis	1 (0.1%)	0 (0%)	1 (0.5%)	.12	1 (0.2%)	0 (0%)	.34
Abductor tear	3 (0.4%)	0 (0%)	3 (1.4%)	**.006**	2 (0.4%)	1 (0.4%)	.92
Others	4 (0.5%)	2 (0.4%)	2 (0.9%)	.37	3 (0.6%)	1(0.4%)	.63

* Revision is recommended, but the patient is not yet symptomatic enough.

Table 4. Clinical and Radiographic Data for the Biomet ReCap-Magnum HRA Group

Variables	Total	Male	Female	*P*	Unilateral	Bilateral	*P*
No. of cases	740	526 (71.1%)	214 (28.9%)	–	473 (63.9%)	267 (36.1%)	–
Deceased *	6 (0.9%)	4 (0.9%)	2 (1.0%)	.81	6 (1.3%)	0	**.02**
Preoperative							
HHS	54 ± 13	55 ± 13	50 ± 12	**<.001**	54 ± 12	53 ± 13	.15
Postoperative							
Clinical data							
Latest follow-up available	682 (92.2%)	490 (93.2%)	192 (89.7%)	–	429 (90.7%)	253 (94.8%)	–
HHS	98 ± 6	98 ± 5	96 ± 9	**<.001**	97 ± 7	98 ± 6	.33
UCLA activity score	7 ± 2	7 ± 2	6 ± 2	**<.001**	7 ± 2	7 ± 2	.47
VAS pain: regular days	0 ± 1	0.2 ± 0.7	0.3 ± 1	**.05**	0.2 ± 0.9	0.2 ± 0.7	.17
VAS pain: worst days	1 ± 2	1.1 ± 1.9	1.4 ± 2.1	.1	1.2 ± 2	1.2 ± 1.9	.82
Radiographic data							
FSA (deg)	142 ± 7	141 ± 7	144 ± 8	.04	141 ± 7	143 ± 9	.15
AIA (deg)	46 ± 8	46 ± 8	46 ± 6	.83	46 ± 7	46 ± 8	.82
Radiolucency	2	0	2	**.03**	1	1	.69
Osteolysis	0	0	0	–	0	0	–

FSA, femoral shaft angle; AIA, acetabular inclination angle.
* Number and percentage of 461 men and 192 women.

Table 5. Literature Comparison of Midterm Follow-Up Using Hybrid HRA Prostheses

Study	Prosthesis	Dates of Procedure	Primary Diagnosis	Patient Cohort			Femoral Component Size *(mm)	Percent FU Achieved	Average Series FU Duration	Survivorship †	
				Hips	Female	Bilateral				FU (y)	Rate
Amstutz et al [31]	Conserve Plus	1996-2007	Varied	1107	26.2%	19.9%	49.2	96.9% ‡	6.8	5	93.2%-96.5%
Hulst et al [38]	Conserve Plus	1996-2003	Varied	643	25.0%	10.9%	NA	75.0	10.4	5	99.6% §
Gross et al [11]	Corin Cormet 2000	2000-2005	Varied	373	30.1%	11.8%	50 ± 4	NA	8	6	96.0%
McBryde et al. [27]	Birmingham	1997-2008	OA	2123	38.0%	NA	(38-58) ‖	90.0	3.46	6	96.5%
Heilpern et al [28]	Birmingham	1999-2002	Varied	110	41.8%	12.2%	NA	97.0 ¶	5.9	5	96.3%
McMinn et al [39]	Birmingham	1997-2009	Varied	3095	38.1%	NA	NA	NA	8	10	97.0%
Current study	Biomet ReCap-Magnum	2004-2007	Varied	740	29.0%	36.1%	51 ± 4	92.0	4.5	7	96.4.0%

FU, follow-up; OA, osteoarthritis; NA, not available.
* Values given as the average.
† Values represent percentage at number of years of follow-up.
‡ Calculated percentage based on 29 of 923 patients not reaching a minimum 2-year follow-up.
§ Percentage represents survival of only the acetabular component.
‖ Range specified in absence of average.
¶ Calculated percentage based on 3 of 101 patients lost to follow-up.