# Clinical and Functional Outcomes of the Birmingham Hip Resurfacing System

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## abstract

This study reported the outcomes of patients treated with the Birmingham Hip Resurfacing System (Smith & Nephew, Memphis, Tennessee) to identify the prevalence of complications and failures. A retrospective review of 202 patients (206 hips) was performed. Outcomes were assessed clinically with Harris Hip Score at 6 and 12 months and then yearly. Subanalysis was performed, with the hips divided according to patient sex and size of the femoral component. Mean patient age was 51±8 years, and mean follow-up was 4±1.6 years. Of the patients, 163 were men (83%) and 35 were women (17%). Postoperative improvement was significant, with preoperative Harris Hip Score of 62.9±10.6 and postoperative Harris Hip Score of 98.6±6.7 ($P<.001$). There were 9 patients (4%) who had complications. A total of 5 hips (2.4%) underwent revision. At 3 years, mean survival was better for men than for women (99% vs 92%, respectively). Survival was lowest in patients with femoral component diameter of less than 46 mm. According to the authors' results, the Birmingham Hip Resurfacing System resulted in good clinical outcomes at 4 years. Survival and outcomes in women, particularly those with modest bone size, are inferior. [*Orthopedics*.]


Hip resurfacing arthroplasty is an established surgical option, particularly for active patients with end-stage degenerative hip disease. Early and midterm reports of hip resurfacing from surgeon-designers and independent centers showed 5-year survival rates of 95% to 100% and 10-year survival rates of 88% to 97%.[1-5]

Hip resurfacing has a number of potential advantages compared with total hip arthroplasty (THA), including return to higher activity levels, less activity-related thigh pain, and fewer complications with postoperative limb length discrepancy.[6-9] However, concerns about complications, such as aseptic lymphocytic vascular and associated lesions, adverse local tissue reaction, osteonecrosis, and femoral neck fracture, raised questions about the indications for hip resurfacing. Data suggest that sex may be a factor to consider when performing this procedure; most series reported less favorable results in women than in men, as reflected by a higher incidence of femoral neck fractures and formation of aseptic lymphocytic vascular and associated lesions.[5,10]

Compared with THA, fewer patients with hip arthritis qualify as reasonable candidates for hip resurfacing.[11] Previous authors suggested that women are not good candidates for hip resurfacing because they have a higher incidence of complications.[3]

This study reports the outcomes of patients treated with a Birmingham Hip Resurfacing System (BHR; Smith & Nephew, Memphis, Tennessee) and identifies the prevalence of complications and failures.

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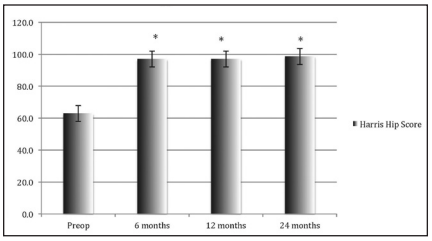


**Figure 1:** Harris Hip Score vs time for all patients. *$P$<.05.

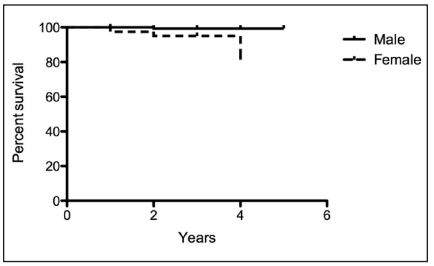


**Figure 2:** Kaplan-Meier survival vs patient sex.

## Materials and Methods

Between 2006 and 2011, 214 patients treated with BHR implants were identified. A single surgeon (M.R.D.) treated all patients. The indication for BHR treatment was symptomatic end-stage osteoarthritis of the hip. Contraindications to BHR included insufficient bone stock, such as severe osteopenia, femoral head osteonecrosis with greater than 30% involvement of the femoral head, or multiple cysts of the femoral head. Also excluded were women of childbearing age, patients with renal insufficiency or compromise, those receiving high doses of steroids, and patients who were severely overweight (body mass index>30 kg/m$^2$ or obesity class I, II, or III). All patients were prospectively followed with Harris Hip Score. Only patients with a minimum of 24 months of follow-up were included.

### Patient Data

Of the 214 patients, 12 patients could not be reached for follow-up. This resulted in a final cohort of 202 patients (206 hips). Average patient age was 51 years (range, 31-75 years). The study group included 167 (83%) men and 35 (17%) women. Of these patients, 36 (17%) had previous surgery, including hip arthroscopy, periacetabular osteotomy, open osteochondroplasty, and open reduction and internal fixation for acetabular fracture. Primary osteoarthritis was the most common diagnosis (202 hips, 98%), followed by osteoarthritis as a result of dysplasia (2 hips, 1%) and osteonecrosis (2 hips, 1%). All procedures were performed by a surgeon who was trained in the BHR procedure (M.R.D.), and all patients received the same components (BHR; Smith & Nephew). In all cases, a posterior surgical approach was used, as described by McMinn et al.[12] Harris Hip Score (range, 0-100, with 100 denoting the best outcome) was obtained prospectively for all patients during follow-up.[13]

Implant survival for the entire cohort was established at 4 years, with failure defined as revision surgery.[13] Implant survival and patient-reported outcomes were established for different subgroups. Subanalysis was performed, with the hips divided according to sex and component size range. Patients were grouped on the basis of femoral component diameter, from small to large, with the following categories: less than 46 mm, 46 to 48 mm, 50 mm, and greater than 50 mm.

### Statistical Analysis

Descriptive statistics were calculated according to standard methods, including frequency, mean, standard deviation, and range when appropriate. Clinical outcome scores were analyzed at 2 time points: preoperatively and at the most recent follow-up. Improvement in score was calculated with paired Student's $t$ test. Subgroup analysis was performed with 1-way analysis of variance with the Tukey post hoc test to determine differences among subgroups. Survival analysis that considered time to revision was performed with Kaplan-Meier survival. Statistical significance was set at $P$<.05. Statistical analysis was performed with GraphPad software (GraphPad Software, Inc, La Jolla, California).

## Results

### Clinical Assessment

Mean follow-up was 4 years (SD, ±1.6). Overall statistically significant improvement (pre- to postoperative) was seen in Harris Hip Score (62.9±9.6 to 98.6±8; $P$<.001). Statistical improvement was seen as early as 6 months (**Figure 1**).

### Subgroup Analysis

No statistical difference in the change in Harris Hip Score was noted between men and women. Both men and women showed statistically significant clinical improvement at the time of the last follow-up. In contrast, the survival rate was statistically different between men and women, with 99% survival for men and 81% for women at 4 years (**Figure 2**). The most conspicuous differences in complications and survival rate were found between groups of different component sizes (**Table 1** and **Figure 3**). Iliopsoas tendinitis was diagnosed clinically by a positive bicycle test result and pain with resisted flexion of the hip. Ultrasound-guided lidocaine injection was used for confirmation. One patient had limited flexion and pain on impingement test and radiographic signs of heterotopic ossification. Persistent pain was defined as persistent hip pain without any sign of metal-on-metal reaction or another major complication. The number of patients in each femoral head size group was as follows: 46 mm (n=9, all women); 46 to 48 mm (n=19, 1 man and 18 women); 50 mm (n=58, 55 men and 3 women); and greater than 50 mm (n=120, 113 men and 7 women). The distribution is shown in **Table 2**.

### Conversion to Total Hip Arthroplasty

Complications were inversely related to femoral head size. A total of 5 failures (2.46%) occurred, and all cases were fully converted to THA (removing the metal-on-metal surface). Two failures were converted to THA as a result of femoral neck fracture. One was converted as a result of avascular necrosis. The fourth case was converted to

THA because of persistent pain after the index procedure. The fifth case was converted because of aseptic lymphocytic vascular and associated lesions (**Table 2**).

## Discussion

This study showed that midterm survival of BHR implants can be achieved in active patients with hip osteoarthritis. Based on short-term data, in the current study, with mean follow-up of 4 years, survival rates were 99% in men and 81% in women. The results showed that indications in women should be selective, given the lower survival rates (81%) in women, particularly those with a smaller femoral component diameter (<46 mm). The data suggest that the BHR procedure is not an optimal choice in women with a femoral component diameter of less than 46 mm.

The current study had limitations. It was a retrospective investigation and reported short-term outcomes. However, an experienced single surgeon using a standardized indication and surgical technique in an established population performed all procedures, thus allowing consistency that is not found in a cross-sectional registry database.

When different national registries are analyzed, revision rates and complications may differ. The Nordic Arthroplasty Register Association, including Danish, Swedish, and Norwegian cases, reported a revision rate of 2.4% at 2 years vs 1.1% for THA.[14] The current study reported a similar revision rate (2.3%). The Nordic report included multiple implants (Durom, Zimmer, Warsaw, Indiana; ASR, DePuy, West Chester, Pennsylvania; BHR, Smith & Nephew; 2000 HAP, Stryker, Kalamazoo, Michigan; Recap, Biomet, Warsaw, Indiana; and Cormet, Corin, Tampa, Florida). Contrary to this report, the current study included only the BHR procedure, which has the lowest reported fracture and revision rates.[4] Prosser et al[15] examined 12,903 hip resurfacing procedures performed in Australia between 1998 and 2009. As in the current study, women had a higher revision rate than men. However, after adjustment for femoral component size, revision rates were similar. Femoral implants with a head size of less than 50 mm had a higher revision rate than those with a diameter of 50 mm or greater. In the current study, femoral component diameter of less than 46 mm was associated with a higher rate of complications and revision.

Analysis of the British National Joint Registry by McMinn et al[16] included 283,365 procedures, with a mean follow-up of 3.6 years (range, 0.01-9.7 years). The objective of this analysis was unlike those of other registries. It not only studied revision rates after adjustment for sex, age, implant size, and American Society of Anesthesiologists grade but also evaluated the mortality rate. After adjustment for all known risk factors associated with revision surgery, mortality in men was statistically lower for the BHR implant compared with a group of patients treated with uncemented THA. The authors concluded that for every 23 men treated, 1 less death

Table 1

**Data by Diameter of the Femoral Component**

| Femoral Component Diameter, mm | No. of Hips, M/F (Total No.) | No. of Complications | Type | Failure |
|---|---|---|---|---|
| <46 | 0/9 (9) | 5 (55%) | 1 femoral neck fracture, 1 persistent pain, 3 iliopsoas tendontis | 1 revised to THA |
| 46-48 | 1/18 (19) | 1 (5%) | 1 femoral neck fracture | 1 revised to THA |
| 50 | 55/3 (58) | 2 (3%) | 1 persistent pain, 1 iliopsoas tendonits | 1 revised to THA |
| >50 | 113/7 (120) | 3 (2%) | 1 aseptic lymphocytic vascular and associated lesions, 1 heterotopic ossification, 1 persistent hip pain | 2 revised to THA |

*Abbreviations: F, female; M, male; THA, total hip arthroplasty.*

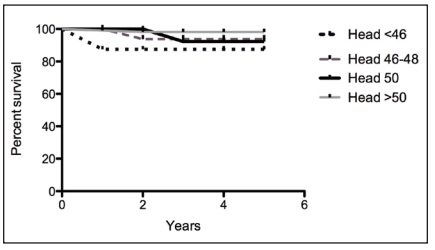


**Figure 3:** Kaplan-Meier survival rate by femoral head diameter size.

Table 2

**Cases of Treatment Failure Converted to Total Hip Arthroplasty**

| Failure | Sex | Cause of Failure |
|---|---|---|
| 1 | M | Traumatic femoral neck fracture |
| 2 | M | Technical femoral neck fracture |
| 3 | F | Avascular necrosis |
| 4 | F | Persistent pain |
| 5 | F | Aseptic lymphocytic vascular and associated lesions |

*Abbreviations: F, female; M, male.*

will occur in the BHR group compared with the cemented THA group at 6 years of follow-up.[16]

In the current study, all patients received BHR implants. Murray et al[3] published a multicenter study of 5000 hips and reported survival rates of 96.3% at 7 years and 95.3% at 10 years, with a 3.6% revision rate. Revision rates were significantly higher in women.[3] Femoral neck fracture and persistent pain were the most common types of failure among women. As noted in the current study, women with a small femoral component diameter (<46 mm) had the worst outcomes of any subgroup. Nawabi et al[17] retrospectively performed magnetic resonance imaging evaluation of asymptomatic vs symptomatic patients after metal-on-metal hip resurfacing arthroplasty. Of the 69 patients included (74 hips), 84% received a BHR implant. As in the current study, unexplained pain was more prevalent in women. Magnetic resonance imaging confirmed that the proportion of women was higher among patients with adverse local tissue reaction. However, these authors did not report the size of the femoral component in this female population. Amstutz et al[4] reported clinical and radiographic results of metal-on-metal hip resurfacing, with 10-year survival of 88%. As in the current study, survival rates were statistically poorer for patients with a femoral component diameter of less than 46 mm, body mass index of 25 or less, and femoral defect size of greater than 1 cm compared with less than 1 cm.[4]

Smaller implants and female sex were associated with significantly lower survival and inferior functional outcomes. A variety of variables may contribute to this finding, including gait pattern, greater flexibility, and susceptibility to a metal reaction. Smaller implants are more sensitive to component malorientation and are more likely to have a greater reduction in femoral head size during the procedure.[17] Both factors are associated with increased wear and failure.[16,18,19] In the United States, when the BHR implant was initially approved, implants were available only in 4-mm increments, and preferred practice in cases where 2 sizes were possible was to downsize the femoral head to preserve acetabular bone. Currently, with additional size increments allowing more accurate sizing, the risk associated with the use of excessively small implants may decrease. However, further work is needed to improve results with smaller implants.

## Conclusion

This single-surgeon retrospective study showed good results with BHR implants at 4 years in active patients with hip osteoarthritis. This finding suggests that this treatment is a good option for active patients. Conversely, survival and outcomes in women, particularly those with modest bone size, are inferior. Therefore, the authors do not recommend resurfacing in women with femoral head diameter of less than 46 mm.

## References


1. Heilpern GN, Shah NN, Fordyce MJ. Birmingham hip resurfacing arthroplasty: a series of 110 consecutive hips with a minimum five-year clinical and radiological follow-up. *J Bone Joint Surg Br.* 2008; 90(9):1137-1142.
2. Steffen RT, Pandit HP, Palan J, et al. The five-year results of the Birmingham Hip Resurfacing arthroplasty: an independent series. *J Bone Joint Surg Br.* 2008; 90(4):436-441.
3. Murray DW, Grammatopoulos G, Pandit H, Gundle R, Gill HS, McLardy-Smith P. The ten-year survival of the Birmingham hip resurfacing: an independent series. *J Bone Joint Surg Br.* 2012; 94(9):1180-1186.
4. Amstutz HC, Le Duff MJ, Campbell PA, Gruen TA, Wisk LE. Clinical and radiographic results of metal-on-metal hip resurfacing with a minimum ten-year follow-up. *J Bone Joint Surg Am.* 2010; 92(16):2663-2671.
5. Treacy RB, McBryde CW, Shears E, Pynsent PB. Birmingham hip resurfacing: a minimum follow-up of ten years. *J Bone Joint Surg Br.* 2011; 93(1):27-33.
6. Jiang Y, Zhang K, Die J, Shi Z, Zhao H, Wang K. A systematic review of modern metal-on-metal total hip resurfacing vs standard total hip arthroplasty in active young patients. *J Arthroplasty.* 2011; 26(3):419-426.
7. Mont MA, Marker DR, Smith JM, Ulrich SD, McGrath MS. Resurfacing is comparable to total hip arthroplasty at short-term follow-up. *Clin Orthop Relat Res.* 2009; 467(1):66-71.
8. Vail TP, Mina CA, Yergler JD, Pietrobon R. Metal-on-metal hip resurfacing compares favorably with THA at 2 years followup. *Clin Orthop Relat Res.* 2006; 453:123-131.
9. Vendittoli PA, Lavigne M, Roy AG, Lusignan D. A prospective randomized clinical trial comparing metal-on-metal total hip arthroplasty and metal-on-metal total hip resurfacing in patients less than 65 years old. *Hip Int.* 2006; 16(suppl 4):73-81.
10. Malviya A, Holland JP. Pseudotumours associated with metal-on-metal hip resurfacing: 10-year Newcastle experience. *Acta Orthop Belg.* 2009; 75(4):477-483.
11. Della Valle CJ, Nunley RM, Barrack RL. When is the right time to resurface? *Orthopedics.* 2008; 31(12 suppl 2):119-123.
12. McMinn DJ, Daniel J, Pynsent PB, Pradhan C. Mini-incision resurfacing arthroplasty of hip through the posterior approach. *Clin Orthop Relat Res.* 2005; 441:91-98.
13. Murray DW, Carr AJ, Bulstrode C. Survival analysis of joint replacements. *J Bone Joint Surg Br.* 1993; 75(5):697-704.
14. Johanson PE, Fenstad AM, Furnes O, et al. Inferior outcome after hip resurfacing arthroplasty than after conventional arthroplasty: evidence from the Nordic Arthroplasty Register Association (NARA) database, 1995 to 2007. *Acta Orthop.* 2010; 81(5):535-541.
15. Prosser GH, Yates PJ, Wood DJ, Graves SE, de Steiger RN, Miller LN. Outcome of primary resurfacing hip replacement: evaluation of risk factors for early revision. *Acta Orthop.* 2010; 81(1):66-71.
16. McMinn DJ, Snell KI, Daniel J, Treacy RB, Pynsent PB, Riley RD. Mortality and implant revision rates of hip arthroplasty in patients with osteoarthritis: registry based cohort study. *BMJ.* 2012; 344:e3319.
17. Nawabi DH, Hayter CL, Su EP, et al. Magnetic resonance imaging findings in symptomatic versus asymptomatic subjects following metal-on-metal hip resurfacing arthroplasty. *J Bone Joint Surg Am.* 2013; 95(10):895-902.
18. Langton DJ, Jameson SS, Joyce TJ, Webb J, Nargol AV. The effect of component size and orientation on the concentrations of metal ions after resurfacing arthroplasty of the hip. *J Bone Joint Surg Br.* 2008; 90(9):1143-1151.
19. Grammatopoulos G, Pandit H, Oxford Hip and Knee Group, Murray DW, Gill HS. The relationship between head-neck ratio and pseudotumour formation in metal-on-metal resurfacing arthroplasty of the hip. *J Bone Joint Surg Br.* 2010; 92(11):1527-1534.