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Clinical, functional and radiographic long-term follow-up (7-12 years) of Birmingham Hip Resurfacing, including metal ions evaluation: a single surgeon series

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Hip resurfacing arthroplasty (HRA) has been advocated as an attractive therapy for a younger, more demanding patient population with debilitating hip osteoarthritis. Controversies surrounding metal-on-metal (MoM) hip resurfacing have, however, led to a significant decline in the popularity of the HRA. Despite this, substantial evidence supports the use of specific implants in a selected group of patients. This is a continued retrospective analysis of a single surgeon series of the Birmingham Hip Resurfacing (BHR). Initial medium-term analysis was done in 2011 and published by Van der Bracht et al.[13]. This analysis includes a long-term follow-up of 7 to 12 years, including functional scoring (HHS, HOOS and UCLA activity score), metal ion evaluation and survival analysis. Failure was defined as revision for any cause. A total of 267 resurfacing procedures with the BHR were included in 247 patients. We had a mean follow-up of 8.3 years. Overall survival at ten years was 94.8%(97.2% for males and 90.1% for females). There was a statistically significant increase in mean HHS score at follow-up (56.03 - IQR 47-65 to 96.07 - IQR 96-100). Elevated metal ions were correlated with a statistically significant increase in the probability of complications. This cohort study further proved that hip resurfacing arthroplasty with the Birmingham Hip Resurfacing implant provides a good alternative to conventional total hip arthroplasty in young patients. There was a significant increase in functional scores at follow-up. There is further evidence of less favorable outcomes in female patients.

Keywords: arthroplasty, Birmingham Hip Resurfacing, hip, hip resurfacing, metal-on-metal.

INTRODUCTION

Hip resurfacing arthroplasty (HRA) has been advocated as an attractive therapy for a younger, more demanding patient population with debilitating hip osteoarthritis. Persisting poor outcomes after conventional total hip arthroplasty (THA) in this specific patient population guided further research for an alternative option[1].

The first and second-generation resurfacing implants were correlated with poor outcomes mainly based on early failure[2,3] and metal related complications such as soft-tissue reaction to wear debris (ARMD: adverse reaction to metal debris) and concerns about elevated blood levels of cobalt and chromium ions and their clinical significance, led to a significant decline in HRA's popularity[4-7]. The resurfacing concept saw its latest rebirth during the 1990s with the 'third generation' implants, consisting of a large-head cemented femoral component and a press-fitted acetabular cup coated with hydroxyapatite to allow osseointegration. Even though there were excellent survival rates reported by designer surgeons, ranging from 94,0 to 99,7% at 10-year follow-up, national registry-based analyses showed significantly less impressive short-to-midterm outcomes of MoM arthroplasties[3]. Previous research could partly attribute these inconsistent findings to the clustering of MoM devices with different designs, and suggests viewing the MoM HRA and stemmed MoM THA as two different entities based on the distinct wear characteristics related to the taper/trunnion connection in MoM THA. Both designer and independent researchers advocate for the reporting of implant-specific outcomes and emphasize the need for surgical precision, since metal bearing surfaces cannot overcome complications due to design or component malpositioning[8].

The BIRMINGHAM HIP™ Resurfacing (BHR™) System (Midland Medical Technologies Ltd., Birmingham, UK and Smith & Nephew Orthopaedics, Warwick, UK) is currently one of the resurfacing devices

with the longest follow-up available. The UK Orthopaedic Data Evaluation Panel (ODEP) ranks the BHR as 10A, showing good evidence that this implant has >90% survival at ten years. Several designer and independent surgeon series support this benchmark in young male patients with primary osteoarthritis of the hip, but in patients with femoral implants <48mm or atypical anatomy, survival is generally inferior and may not reach the ODEP 10A scoring[9]. Advantages of the BHR system include conserving femoral bone stock compared to conventional THR[10,11], allowing more function due to the bigger, more anatomical components[12], increased stability and the low rate of wear of this MoM bearing[12].

As implant survival of conventional THA is increasing in a younger patient population with the development of highly cross-linked polyethylene and ceramic surfaces, better knowledge of the long-term results after MoM hip resurfacing arthroplasty remains essential.

Fig. 1. — Postoperatieve radiograph of the Birmingham hip resurfacing.

METHODS

This retrospective cohort study aims to evaluate the results at a 7-to-12-year follow-up of 267 BHR™ implants in terms of overall implant survival, functional outcome and complication rate, and the relation to systemic metal-ion exposure. This study is a single surgeon non-designer series where all procedures were performed by the senior author (EJ) in an independent centre from 2001 to 2006. This is an additional follow-up study to the original research article by Van Der Bracht et al.[13]. Twenty-five patients from the original study population described in the article by Van Der Bracht et al. were excluded (18 male and 7 female). Four patients died due to non-arthroplasty related causes and two patients were satisfied but did not give informed consent. Nineteen patients could not be contacted for longer follow-up, at the last moment of contact, no revision had been performed or was planned to be performed.

A standardized extensile posterior approach as described by McMinn was used to obtain an excellent view for optimal implant positioning, aiming for an acetabular inclination of 45° abduction and 20° anteversion and a neutral to slight valgus positioning of the femoral component (Figure 1). All patients received a high-carbon as-cast chromium-cobalt BHR prosthesis with a cemented femoral stem and an uncemented hydroxyapatite coated porous acetabular cup. The press-fit fixation is achieved by underreaming the acetabulum by 1-2mm. Femoral component sizes were determined intraoperatively by measuring the femoral neck diameter and vary from 38mm to 58mm, with 4mm increments (the option for intermediate sizing with 2mm increments was not available at the time of inclusion). In order to preserve acetabular bone stock, the matching acetabular component of the smallest size was implanted. Two patients received a cup with additional locking screw fixation because of dysplasia. The post-operative regimen was identical for each patient and has been described previously in the article by Van Der Bracht et al.[13].

A Harris Hip Score (HHS) questionnaire[14] was obtained for all patients pre- and post-operatively. All patients underwent functional scoring with the validated Hip Disability and Osteoarthritis Outcome Score (HOOS)[15] and University of California Los Angeles (UCLA) activity score[16] at 6 weeks, 3 months, 12 months and on a yearly basis post-surgery. Approval was obtained through the Ethics Committee. Metal ion levels were measured in post-operative blood samples and radiographs were obtained annually during follow-up.

Statistical analysis of survival rate, functional scores, elevated metal ion levels and complication rates was performed using SPSS. A Kaplan-Meier plot survival analysis at 12 years follow-up was performed.

RESULTS

A total of 267 resurfacing procedures with the BHR were included in 247 patients. The indication for the procedure was osteoarthritis in 94% of the cases. Other

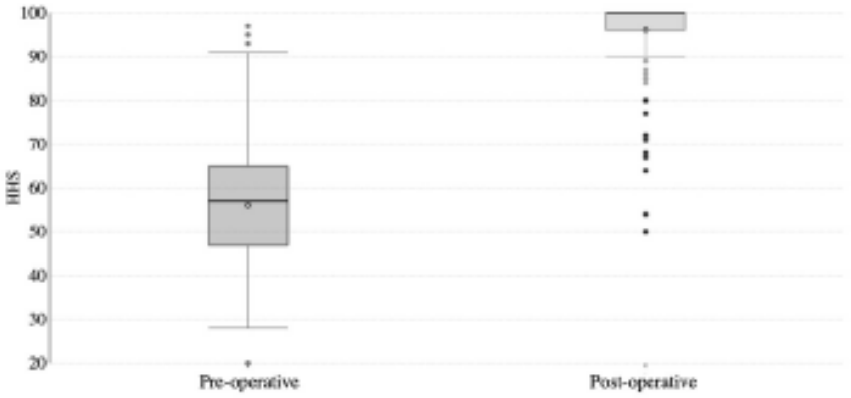

Fig. 2. — Preoperative and postoperative Harris Hip Scores. The mean preoperative HHS was 56 and the mean postoperative HHS was 96.

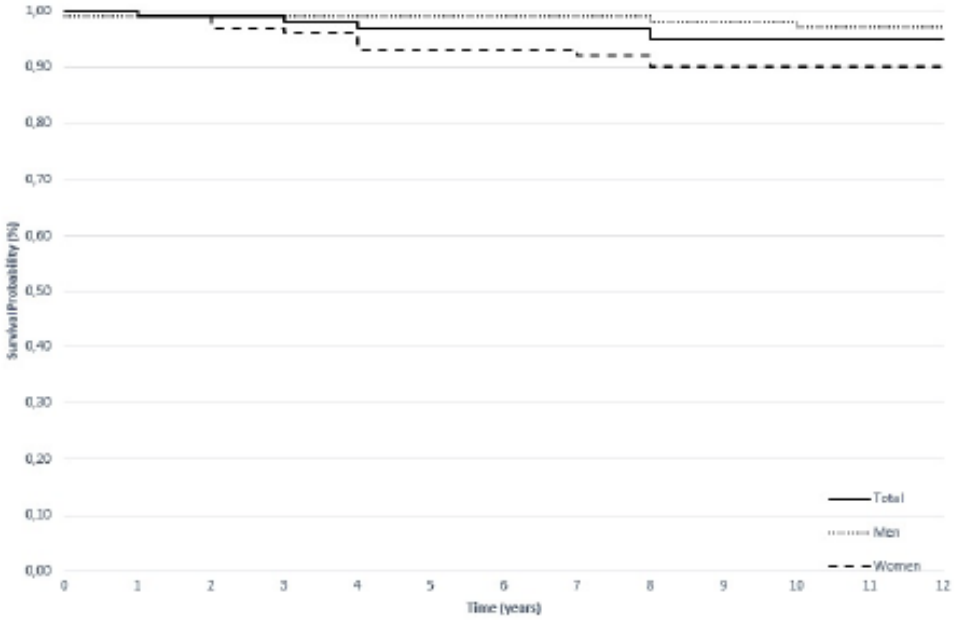

Fig. 3. — A Kaplan-Meier survival rate of 94.8% (95% CI [0.9208-0.9743]) at 10 years follow-up. A male survival rate of 97.1% (95% CI [0.9467-0.9961]) and a female survival rate of 90.2% (95% CI [0.8415-0.9629]).

less prevalent indications were avascular necrosis (13%) or rheumatoid arthritis (3%). Sixty-six percent of the patient pool were males. The mean age was 55 years, ranging from 14 to 74 years. After a mean follow-up of 8.3 years (Inter-quartile range 7.4-9.2yr), 5 patients (2%) died of non-arthroplasty related causes and 6 patients (2%) were lost to follow-up.

The mean HHS score at baseline was 56.03 (IQR 47-65) and 96.07 (IQR 96-100) after surgery. During follow-up, there was a significant increase in mean HHS score following surgery for non-elevated (mean increase 40.1, $p<0.0001$, paired sample t-test) as well as elevated metal blood concentration group (mean increase 39.8, $p<0.0001$, paired sample t-test) (Figure 2). Mean post-operative HOOS and UCLA score was 591.18 (IQR: 463-500) and 7 (IQR: 7-9), respectively.

There were fourteen patients (5.2%) with major complications necessitating a revision procedure resulting in a survival rate of 94.8%. The implant survival rate in male patients was 97.2% and 90.1% in female patients (Figure 3). Five patients had major complications not requiring revision surgery (1.9%). The indications for revision and their prevalence are summarized in Table 1. Ten patients (3.7%) experienced minor complications such as myalgia, trochanteritis or scar pain.

Table I. — Complications after BHR procedure

	Study group (n=267)
Major complications requiring revision (%)	14 (5.3%)
Deep infection	2
ALVAL	3
Aseptic loosening	2
Osteonecrosis	2
Elevated metal ion concentrations in blood	2
Subcapital fracture	2
PAO	1
Acetabular malposition	1
Major complications not requiring revision (%)	5 (1.9%)
Deep infection	2
Pulmonary embolism	2
Hip dislocation	1
Minor complications (%)	10 (3.7%)

Blood cobalt and chromium concentration were available for analysis in 195 patients (73%) due to some patients refusing regular blood samples. Blood tests were taken annually post-surgery. Elevated levels of cobalt or chromium (≥ 7.0 ug/L) were observed in 7 (2.8%) and 16 (6.5%) patients, respectively.

No significant difference in baseline HHS score (p=0.295, independent sample t-test) or post-operative HHS score (p=0.070, independent sample t-test) was observed between patients with normal metal ion levels versus elevated metal ion levels. Moreover, there was also no significant difference between the two groups in the mean post-operative HOOS score (p=0.872, Mann Whitney U test) or UCLA scores (p=0.606, Mann Whitney U test).

There was no correlation between the mean acetabular or femoral inclination and the blood metal ion concentration (p=0.424 and p=0.738, independent sample T-test). Mean acetabular and femoral inclination angles were 45 degrees (IQR 41-50) and 135 degrees (IQR 131-135), respectively.

Elevated blood metal ion concentration and acetabular inclination were significantly associated with the occurrence of complications (combined both major and minor) with an odds ratio of 10.035 (95% CI 2.628-38.321, p=0.001) and 0.884 (95% CI 0.783-0.999, p=0.048), respectively.

Males had lower odds for revision surgery when compared to females OR 0.269, 95% CI 0.087-0.830, p=0.022). However, when taking all complications into account this correlation is not significant.

There was no significant correlation with age, femoral inclination or HHS score.

DISCUSSION

Hip resurfacing arthroplasty has been reintroduced with marked advantages over conventional total hip arthroplasty in an active young population. Benefits include conserving femoral bone stock, allowing more function due to the bigger more anatomical components, increased stability and the low rate of wear of the MoM bearing. However, concerns about metal debris with subsequent ALVAL reaction, osteolysis and pseudotumor formation have been raised.

Multiple studies have proven that MoM HRA suffers from higher failure and worse outcomes in females. The main reason seems to be the average smaller size of the acetabulum being less forgiving for suboptimal positioning of the components resulting in more increased wear. The importance of size has been described in detail in a larger series of BHR patients[17]. Reports from the designing surgeons also suggest inferior results in females[18,19], however they underline the fact that the results are still well within recommendations for continued implant usage[20]. Our study has replicated a similar outcome with a higher failure rate in the female population within acceptable parameters.

Previous studies have shown that smaller sizes and acetabular inclination outside the recommended interval correlate to elevated blood metal ion concentrations. Our study did not show a significant relation between the acetabular inclination and elevated blood metal ion concentrations. However, we found that the elevated presence of cobalt and chromium in the patient's blood post-operatively had a significant correlation with a higher complication rate. Previous studies also advocate for the follow-up of cobalt and chromium levels post-operatively as an early diagnosis of possible failure[21].

A retrospective cohort study is subject to the limitations of any study of this type. Some patients were lost to follow-up from the initial study population. The unknown outcome of these patients could possibly influence the survival scenario. Contact was made with all other patients in the follow-up. Some patients were lost during follow-up or were unable to complete a

full radiographic, functional and biochemical analysis. Even though not all patients completed their post-operative assessments and blood tests, we were able to establish that at the moment of contact, no revision had been performed or was planned to be performed. This way, the patients lost in follow-up did not influence the survival outcome.

CONCLUSION

This cohort study further proved that hip resurfacing arthroplasty with the Birmingham Hip Resurfacing implant provides a good alternative to conventional total hip arthroplasty in young patients demanding good function while reserving femoral bone stock. Our study has demonstrated a survival rate of 94.8% at 12 years follow-up with a mean improvement in Harris Hip Score of 40. There is further evidence of less favourable outcomes in female patients with a survival rate of 90.1% compared to a male survival rate of 97.2% at 12 years follow-up. The importance of blood metal ion concentrations has been demonstrated with a correlation with a higher complication rate.

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