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Birmingham Hip Resurfacing: A Single Surgeon Series Reported at a Minimum of 10 Years Follow-Up

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ABSTRACT

We report outcomes on 120 Birmingham Hip Resurfacings (BHRs) (mean age 50 years) at a minimum of ten-years follow-up. Cases were performed by one surgeon and included his learning curve. Six hips were revised, with no revisions for infection, dislocation, or adverse reaction to metal debris. Ten-year survival was 94.2% (95% confidence interval (CI) 88.8%–98.7%) for all revisions and 96.1% (95% CI 91.5%–99.8%) for revisions for aseptic loosening. Gender ($P = 0.463$) and head size ($P = 0.114$) did not affect revision risk. Mean post-operative Harris hip score was 84.0. Contrary to previous independent reports, good outcomes into the second decade were achieved with the BHR in both men and women. Longer term follow-up will confirm whether these promising outcomes in women continue.

In young and active patients, total hip arthroplasty (THR) using metal-on-polyethylene bearings has been associated with unsatisfactory outcomes and high failure rates due to wear debris resulting in osteolysis and component loosening [1,2]. Hard-on-hard bearings, such as metal-on-metal and ceramic-on-ceramic, were subsequently introduced as a low wearing alternative arthroplasty option for these high demand patients [3]. Hip resurfacing had also been an attractive concept as a bone conserving and more functional arthroplasty option to THR. Although hip resurfacing was originally described in the 1950s [4], over the decades attempts by numerous surgeons using a metal-on-polyethylene articulation were unsuccessful due to early fixation failures and high polyethylene wear rates [5–7]. Metal-on-metal hip resurfacing was subsequently developed to address these major wear and fixation issues. Metal-on-metal hip resurfacing provides an alternative to THR, and appears best suited to younger patients given that it preserves femoral bone stock, therefore theoretically allowing more straightforward revision surgery [8,9].

Over recent years concerns have mounted regarding adverse reactions to metal debris (ARMD) associated with metal-on-metal hip arthroplasties. This condition is the sequelae of large amounts of metal debris released from metal-on-metal articulations due to wear and corrosion, with ARMD resulting in high short-term failure of certain metal-on-metal hip arthroplasties [10–12]. It has become apparent that the outcomes of metal-on-metal hip resurfacing are dependent on various patient, surgeon, and implant factors [13]. Women, small femoral component size, malposition of the acetabular component, patients with hip dysplasia, and certain implant designs are reported risk factors for hip resurfacing failure [11,12,14–16]. Hip resurfacing usage has significantly declined from 10.8% of all primary hip arthroplasties in England and Wales in 2006 to 1.3% in 2012 [17]. Whilst some designs have performed poorly and subsequently been withdrawn [17–19], the Birmingham Hip Resurfacing (BHR) remains the most commonly implanted resurfacing device worldwide [20]. Good to excellent outcomes are reported for the BHR by the designing surgeons [21,22] at up to 15-years follow-up, and by independent centres at 10-years [23–26]. However, despite achieving good outcomes in men some of these independent centres have observed significantly inferior results in women leading them to recommend against performing hip resurfacing in women [23,25].

The study aims were to determine the survival, radiological, and functional outcomes of the first 120 BHRs performed by a single surgeon at a minimum of 10 years follow-up.

Patients and Methods

Study Design, Patient Selection Criteria and Demographics

A retrospective review of prospectively collected data was performed on all consecutive BHRs (Smith & Nephew, Warwick, United Kingdom) implanted at one district general hospital between

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1997 and 2001. All operations were performed by a single surgeon (ESI). The operating surgeon had trained with the designing surgeon during the early 1990s, and to date has implanted over 1000 BHRs independently. This cohort includes the surgeon's first BHRs, and therefore his learning curve with this procedure.

Patients were considered eligible for BHR if they were young (men 65 years and under, and women 60 years and under) and maintained an active lifestyle (including sports participation and/or manual employment), with relatively normal hip morphology and likely to require revision surgery during their lifetime. At the time these operations were performed, diagnoses other than primary osteoarthritis (such as avascular necrosis and inflammatory arthritis) were not considered absolute contraindications for BHR provided patients met all of the other selection criteria. Other surgeons have similarly performed hip resurfacing in patients with these alternative diagnoses early in their respective cohorts [21,22,25,26]. However, the indications at this centre have subsequently been modified over recent years to be more selective and exclude patients with inflammatory arthritis. Contraindications for BHR included patients with impaired renal function, or hip morphology requiring significant correction of offset, leg length and/or where there was a large femoro-acetabular size mismatch [27]. Patient demographics are summarised in Table 1 with the study cohort comprising 120 consecutive BHRs implanted in 103 patients. All data presented were collected from the hospital database, patient case notes, and pelvic radiographs.

Surgical Technique and Postoperative Regimen

All surgeries were performed using a posterior approach to the hip joint [28]. Care was taken to achieve good exposure to allow satisfactory component alignment. The intention was to achieve 45° of acetabular component inclination, an anteversion aligned with the native acetabulum, and slight femoral valgus. All patients with acetabular dysplasia underwent bone grafting using autograft (acetabular reamings). Femoral neck notching and excessive loading of the femoral neck during preparation was avoided to minimise the risk of fracture. Cysts and areas of avascular necrosis were curetted to healthy bone in all cases. Defects of up to 30% were accepted though in the area of the superior head/neck junction only smaller defects were accepted. Additional cement rather than bone graft was used to fill any defects. Low viscosity cement was used on the femoral side filling the component to just above the chamfer line.

Postoperatively all patients were allowed to mobilise full weight bearing with crutches except those requiring bone grafting for acetabular dysplasia or where there was concern over acetabular press-fit or proximal femoral bone stock. This latter group was kept partial weight bearing for 6 to 12 weeks. Patients received both mechanical (TED anti-embolism stocking, Kendall Health Care Group, Miami, Florida) and chemical (Warfarin) thromboprophylaxis for 6 weeks postoperatively, with the latter commenced the day before BHR surgery. All patients underwent clinical review in the outpatient clinic at 6 weeks, 3 months, and 1 year postoperatively, and then every subsequent 2 years postoperatively. These consultations included clinical examination and anteroposterior pelvic radiographs, however blood and urine analyses to determine metal ion concentrations were not performed. In addition, the Oswestry Outcome Centre independently posted functional outcome scores to all patients at annual intervals postoperatively as previously described [29].

Table 1
Summary of the Study Cohort.

		Study Group (n = 120 hips)
Gender	Male	63 (52.5%)
	Female	57 (47.5%)
Age	Mean (range) in years	50 (28 to 63)
Diagnosis	Primary osteoarthritis	68 (56.6%)
	Avascular necrosis	17 (14.1%)
	Developmental dysplasia	14 (11.6%)
	Other causes	9 (7.5%)
	Not documented	8 (6.6%)
	Rheumatoid arthritis	4 (3.3%)
Follow-up time	Mean (range) in years	10.8 (10.0 to 14.0)
Femoral component size	42 mm	28 (23.3%)
	46 mm	28 (23.3%)
	50 mm	30 (25.0%)
	54 mm	26 (21.6%)
	58 mm	3 (2.5%)
	Not documented	5 (4.1%)

Outcomes of Interest

Outcomes of interest at a minimum of 10-years follow-up were implant survival, radiological outcome, and functional outcome.

Radiographs were assessed for acetabular component inclination and anteversion angles using the open source software, ImageJ [30]. Inclination was measured directly on the radiographs using the angle between the tear drop line and the long axis of an ellipse projected on the circular opening of the cup; the length of the short and long axes of the fitted ellipse was also measured automatically for the calculation of the version angle (Fig. 1). Radiographic anteversion was computed using the Lewinnek method [31] (Fig. 1). This method has been shown to have good inter-observer and intra-observer reliability with the measurements obtained similar to those from computerised tomography scanning [32].

All radiographs were also analysed for signs suggestive of implant failure. The femoral component was considered to have evidence of loosening if there was a radiolucent line >2 mm in any of the three zones described by Amstutz et al [33]. Acetabular loosening was defined as a radiolucent line >2 mm in two or more zones as described by DeLee and Charnley [34]. Femoral neck narrowing of greater than 10% was considered significant as previously described [35]. Any osteolysis around the femoral or acetabular component was recorded.

Functional outcomes were assessed using the Harris hip score (HHS; 0–100) [36] and a patient satisfaction score (0–4). The scoring for patient satisfaction after BHR surgery was as follows: 4 = extremely pleased, 3 = pleased, 2 = no different, 1 = worse than before, 0 = much worse than before [29].

Statistical Analysis

All statistical analysis was performed using the programme R (R Foundation for Statistical Computing, Vienna, Austria) [37]. Cumulative BHR survival was determined using the Kaplan–Meier method, with the Peto method used to calculate the lower 95% confidence interval (CI). The endpoint for survival analysis was revision surgery, defined as removal or exchange of either the femoral or the acetabular component, or both. Patients not undergoing revision surgery were censored after their last contact with the hospital or after death. A Cox's proportional hazards model was used to compare the differences in BHR survival distributions for each of the covariates recorded. A multivariate model was constructed, and then covariates that were not significantly influential were systematically removed from the model to identify those having the greatest influence on survival. Depending on data distribution either the median and interquartile range (IQR) or the mean and range were used. The level of significance was set at $P < 0.05$ with CIs set at the 95% level.

Results

Survival Analysis and Factors Affecting Survival

Of the 120 BHRs implanted in 103 patients, 13 hips (12 patients) were lost to follow-up and 9 hips (8 patients) died during the study