

# Outcomes of Birmingham Hip Resurfacing: A Systematic Review

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## Abstract

**Purpose:** We performed a systematic review to assess the functional outcomes of Birmingham Hip Resurfacing as reported in peer-reviewed literature.

**Methods:** We performed a computerized search on the data sources up to February 2011. The following text and key words were searched: "Birmingham hip", "Birmingham hip resurfacing" and "Hip resurfacing". Each of these key words was again searched with "outcomes" following them. We also hand searched the bibliographies of the retrieved articles and our own files to identify specifically relevant articles.

**Results:** Fourteen retrospective studies and three prospective studies were included for review. Each of these studies was evaluated by the criteria given by Sackett and AACPD. The design, patient criteria, intervention, outcomes, duration of follow up and results of the research were reported.

**Conclusions:** Although the technique of BHR does allow the femur to be spared, claims that it may allow patients to be more active need to be further investigated.

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## INTRODUCTION

Hip pathology is a common diagnosis that can cause pain and limit activity. In a younger population hip pain commonly occurs from pathology to the labrum<sup>[1]</sup>. Progressive degeneration in these patients may eventually lead to osteoarthritis (OA)<sup>[2,3]</sup>. It is estimated that 0.4% to 27% of adults have some form of hip osteoarthritis<sup>[4]</sup>. The traditional surgical treatment for those with OA who have failed conservative treatment is total hip arthroplasty (THA). However, THA has been reported to fail in younger patients with more active lifestyles<sup>[5-7]</sup>. Recently, hip resurfacing (HR) has emerged as a relatively new surgery that has potential advantage to eliminate these failure issues encountered with THA in select individuals. There are a variety of devices that are options for HR and they include; Durom Hybrid System by Zimmer, Conserve Plus by Wright, Cormet MoM by Corin, and the Birmingham

HR (BHR, Smith & Nephew Inc., Memphis, TN, USA) system by Smith and Nephew.

Specifically, Birmingham Hip Resurfacing is said to "allow you to return to most activities, including impact activities," according to the Smith and Nephew website. This direct to patient advertising has had an effect on patient education. In a study considering a group of patients presenting to one clinic for consultation for hip pain, 41% were aware of HR<sup>[8]</sup>. Of these patients 46% learned of the procedure from the internet, 42% through family or friends, and only 19% from an orthopedic surgeon. A majority of these patients preferred to have HR and 82% felt that it was safer than THA.

Despite its technical challenge BHR has grown in popularity around the world<sup>[9]</sup>. This new procedure was approved by the FDA in 2006, and is now in use in the United States<sup>[10]</sup>. The primary aim of BHR may not be return to a higher level of function; it simply may be

to decrease pain from hip osteoarthritis for a period of time before a revision is needed. BHR may decrease this pain to the equivalent level of a THA, while still preserving the femur. However, more active patients considering this surgical option will need to be educated on its long-term outcomes and their potential to return to sporting activities. The purpose of this paper is to provide a systematic review of the current literature available for the functional outcomes of BHR.

## METHODS AND SUBJECTS

We performed a computerized search of publications listed in the electronic data bases CINAHL Plus with Full Text, Medline (Ovid), and SPORT Discuss up to February 2011. The following text and key words were searched: “Birmingham hip”, “Birmingham hip resurfacing” and “Hip resurfacing”. Each of these key words was again searched with “outcomes” following them. We also searched the bibliographies of the retrieved articles and our own files to identify specifically relevant articles.

### *Study Selection:*

Studies were included for review if: 1) patients received Birmingham Hip resurfacing, 2) an outcome measure of any type was completed and 3) a portion of the group whose outcome was assessed had received Birmingham Hip resurfacing.

### *Data Extraction and quality assessment:*

The investigator independently extracted data using a standardized form. Data were extracted for study design, patient inclusion, patient exclusion, outcomes assessed, duration of follow up and results. Not every study had all of this data. No attempt was made to ascertain quality of the research since the intent of the paper was to report on specific outcomes of a specific surgery. The brevity of the literature required us to consider most of the research we identified.

### *Study Identification and selection:*

Using the predefined search strategy, 315 titles were returned. Many of these titles were repeated in each search. Of these, 18 titles were identified as eligible for the review.

### *Study characteristics:*

Detailed characteristics of the author and year of publication, Sackett level of evidence <sup>[11]</sup>, and quality score based on AACPDm (www.aacpdm.org), study design, patient inclusion, patient exclusion, intervention, outcomes assessed, and duration of follow up and results are available in Table 1.

Three prospective studies were identified. Two had outcomes pre and post-operatively and one issued a post-operative employment survey. Fifteen retrospective studies were identified. Six with post operative outcomes, three with post operative surveys, five with pre and post-op outcomes, and one with a pre and post-op questionnaire. No randomized control trials were identified. No studies with control groups were identified. The maximum follow up for any research was 10 years using a survey or outcome tools.

### *Operative method:*

Eleven of the papers identified did not provide descriptions of the operative method, other than to identify it as a BHR. Four identified the BHR approach as posterior <sup>[12-16]</sup> one as extended posterior <sup>[17]</sup> and one as modified extended posterior <sup>[18]</sup>. No research was identified that examined a specific operative method of BHR and its effects on postoperative outcomes.

### *Rehabilitation:*

Four of the articles discussed post-operative rehabilitation. One study stated that the post-operative protocols varied <sup>[12]</sup>. Another study stated that the early rehabilitation was “slow”, but eventually was “normal” <sup>[15]</sup>. Two studies included specific post-operative criteria. One encouraged immediate full weight bearing, but allowed the use of one or two canes. <sup>[13]</sup> Another implemented traditional THA precautions for six weeks, dictated partial weight bearing for the first week, followed by the use of a cane(s) for one to two weeks as needed <sup>[19]</sup>. No research was identified that

Author, year, Sackett Level, Quality score	Study Design	Patient Inclusion	Patient Exclusion	Intervention	Outcomes assessed	Duration of follow-up	Results	Comments
Back, 2005 4 4/7	Prospective, n=230, mean age=52.1	BHR patients in one center operated on by three surgeons.	Osteopenia or osteoporosis, renal impairment, metal sensitivity, long term steroid use, previous pelvic and femoral surgery, poor bone stock. Leg length discrepancy > 3cm	BHR posterior approach. Post operative rehabilitation varied between surgeons	Pre-op: HHS, short form-12, Charley grades Post-op: HHS, short form-12, Charley grades, OHS, flexion ROM	Mean follow-up=3 years (2.0-4.4)	Poorer outcomes of OHS, HHS with lesser Charley grade. Mean flexion increased by 18.9 degrees.	.86% failure rate. No radiographic component loosening.
Kim, 2007 4 NA	Retrospective, n=20, mean age=35.9 (22-65)	BHR patients in one center	NA	BHR	Pre-op: HHS Post-op: HHS	Mean follow-up=5 years	Mean HHS improved 56 points.	Lack of English translation limited review.
Valle, 2009. 4 2/7	Retrospective, n=537, mean age=52 (16-82)	BHR patients of 89 surgeons in the US with varying experience levels	NA	BHR	Pre-op: none Post-op: Physician completed "Adverse Event Report"	Mean follow-up=10.4 months	32 major adverse events reported (10 femoral neck fractures, 8 dislocations, 9 nerve injuries, 5 other)	No outcomes assessed. Study was designed to focus on early post operative risk.
Steffen, 2007 4 3/7	Retrospective, independent series, n=610 mean age=51.8 in entire group. n=110, mean age=50.5 in 5 year follow up group.	BHR patients at one center	NA	BHR extended posterior approach	Pre-op: none Post-op: OHS and UCLA AS	Entire group: mean follow-up=4.2 years. Five year group mean follow-up: 5.3 years.	Entire Group: mean OHS=16.1, mean UCLA AS=6-6 5 year follow-up group: mean OHS: 16.4, mean UCLA AS: 6.7, mean HHS=93.1, mean hip flexion=105 degrees	20 revisions, 92% of patients had a primary diagnosis of OA.
Treacy, 2005 4 3/7	Retrospective, n=130, mean age=52.1	Patients with BHR performed by single surgeon based on age, subjective quality of bone, and patient's expectations of postoperative activity level.	NA	BHR posterior approach. Initially full weight bearing, but encouraged to use two, then one cane.	Pre-op: none Post-op: HHS	5 year	HHS not clearly reported, but conclusions advocate consideration of BHR for young, active patients.	6 revisions, 87% had a preoperative diagnosis of hip OA.
Heilpern, 2008. 4 3/7	Retrospective, n=117, mean age=54.5	BHR performed by a single surgeon.	NA	BHR	Pre-op: HHS, OHS, UCLA AS Post-op: HHS, OHS, UCLA AS	Mean follow-up=6 years, Minimum follow-up of 5 years	Mean HHS=96.4, Mean OHS improved 26.3 points. UCLA AS improved 3.61 points.	3.7% failure rate.
Mathu, 2009. 4 4/7	Retrospective Cohort, n=117, mean age=54 (0-74)	BHR performed by a single surgeon.	NA	BHR	Pre-op: none Post-op: OHS, HHS, flexion ROM	Mean follow up 7 years, minimum of 5 years	mean OHS=21.4 (12-52), Mean Harris Hip Score=84.8 (25-100), mean flexion AROM=100 degrees	6.8% failure rate. 63% had OA as primary diagnosis.
Reito, 2010. 4 3/7	Retrospective cohort, n=144	BHR performed at a single center.	NA	BHR	Pre-op: none Post-op: HHS, patient satisfaction (0-1 scale where 0=poor, 3=excellent)	Follow-up=5 to 8 years	Mean HHS=95.3 Mean satisfaction=2.53	3.3% failure rate.
Narrani, 2006. 4 3/7	Retrospective Cohort, N=51	BHR patients.	NA	BHR	Pre-op: Sports Activity Questionnaire Post-op: Sports Activity Questionnaire	Minimum of 6 months	Pre-op 65% were active in sports, post-op 92%. Of those active in sports 92% felt their sporting function improved post op. Overall there was a significant difference in reported intensity and frequency of sports participation.	Questionnaire not published.

Author, year, Sackett Level, Quality score	Study Design	Patient Inclusion	Patient Exclusion	Intervention	Outcomes assessed	Duration of follow-up	Results	Comments
<b>Pollard, 2006</b> 4 5/7	Retrospective, n=63 for BHR.	BHR performed by a single surgeon.	Operative decision to exclude.	BHR posterior approach.	Pre-op: none Post-op: OHS, UCLA AS	Mean follow up 61 months (52-71)	Post-op OHS mean=15.9 (12-42), Post-op UCLA activity level was higher than THA group, mean=8.4 (4-10).	78% of preoperative diagnosis was OA.
<b>Banerjee, 2010</b> 4 4/7	Retrospective case series, n=159, Mean ages: <55,n=88, >55; n=64	BHR performed at a single center. Men > 60 yo, women > 55 yo, a preoperative high activity level via subjective report.	Known osteoporosis, femoral head cyst >1cm, varus deformity at the femoral head	BHR. PWB for one week. Cane(s) for two weeks. Initial 6 weeks post op: no flexion >90, no internal rotation, adduction or active external rotation BHR	Post-op: Questionnaire regarding their activity level before and after surgery. Sports were assigned ranks of 1 for low impact, 2 for intermediate impact, and 3 for high impact Employment surveys	Mean follow-up of 2 years post op	Number of sports patients participated in declined post op. Intermediate and high impact sports decreased post op. Low impact sports increased. One third of patients gave up sports they wanted to participate in. 90% had the same employment.	3 revisions. 86% of the hip resurfacings were BHR. 91% had a preoperative diagnosis of OA.
<b>Malek, 2010</b> 4 1/7	n=100, prospective cohort, mean age=51	BHR performed by a single surgeon.	NA	BHR	Employment surveys	10 year follow up	90% had the same employment.	
<b>Rose, 2010</b> 4 5/7	N=96, retrospective cohort	BHR performed in a single center on patients with a diagnosis of femoral head avascular necrosis.	Patients with bilateral AVN prior to 4 year follow up	BHR: modification of the extended posterior approach	Pre-op: UCLA AS Post-op: UCLA AS	Mean follow up=5.4 years (4-8.1)	UCLA scores improvement were statistically significant postoperatively	4.6% failure
<b>Smet, 2002</b> 4 3/7	n=200, retrospective, mean age=49.5 (16-75)	BHR performed in single center	NA	BHR posterior approach. "...the early post operative rehabilitation sometimes progresses only slowly, but with time it becomes almost normal"	Pre-op: none Post-op: HHS, Hip flexion ROM, pain	Follow-up range: 6 months to 3.5 years	HHS mean=97.24, hip flexion mean=120.36 (90-240), 97.5% reported no pain	80% had a diagnosis of OA
<b>Khan, 2009</b> 4 3/7	n=652, prospective multicenter study, median age=51 (15.8-87.9)	BHR multicenter study performed by 58 surgeons in 8 countries.	NA	BHR	Pre-op: HHS, score Post-op: HHS, general satisfaction questionnaire, D'Aubigne score	Follow-up: median=6 years (5-8 years)	HHS improved significantly postoperatively, 95% extremely pleased or pleased	2% failure rate, half occurring in first year
<b>Larppaihoonpong, 2009</b> 4 3/7	n=40, retrospective	BHR of single surgeon, single center.	Patient with secondary osteonecrosis	BHR	Pre-op: HHS, OHS, UCLA AS, Short form 12 score Post-op: HHS, OHS, UCLA AS, Short form 12 score	Follow-up mean=16.2 months(3-33)	All measures improved postoperatively	2.5% failure rate.
<b>Treacy, 2011</b> 4 4/7	N=144	BHR of a single surgeon that were included in same surgeon's five year follow up	NA	BHR posterior approach. Initially full weight bearing, but encouraged to use two, then one cane. BHR	Pre-op: none Post-op: Modified OHS, UCLA AS	Follow up mean=10.9 years	Modified OHS median=4.2%, Median UCLA AS=7.0	6.5% revision rate, patient selection noted as "crucial" to success
<b>Hing, 2007</b> 4 3/7	N=230, retrospective	BHR	NA	BHR	Pre-op: HHS, Flexion ROM Post-op: HHS, Flexion ROM	Follow-up means: 3 years (2.1-4.3) and 5 years.	3 years: HHS improved significantly, mean flexion improved significantly. 5 years: HHS deteriorated slightly, mean flexion remained same as 3 years	2.2% failure

N=number of hips, HHS=Harris Hip Score, OHS=Oxford Hip Score, UCLA AS: University of California Los Angeles Activity Score, ROM=range of motion, NA=not assessed  
 1A=Systematic Review of Randomized Controlled Trials (RCTs) / 1B=RCTs with Narrow Confidence Interval / 1C=All or None Case Series / 2A=Systematic Review Cohort Studies / 2B=Cohort Study/Low Quality RCT / 2C=Outcomes Research / 3A = Systematic Review of Case-Controlled Studies / 3B = Case-Controlled Studies / 4 = Case Series, Poor

evaluated a specific postoperative rehabilitative course.

#### ***Duration of follow-up:***

The duration of follow-up varied significantly among the research from six months to ten years. Seven studies had group results for less than five years [12,15,17,19-22], two for exactly five years [13,23] and eight for longer than five years [14,16,17,24-28].

## **RESULTS**

Of the seven studies that included pre and post-operative outcomes three documented increases in hip flexion active range of motion (AROM), one by a mean of 18.9 degrees, one noted a significant improvement, and another showed a mean hip flexion of 120.36 degrees [12,29,15]. Six assessed the Harris Hip Score (HHS) and noted the following: an increase of 56, means of 96.4 and 84.8, poorer outcomes with lesser Charnley grades, one simply noted improvement, and two noted significant improvement [12,21,23-25,28,29]. The four studies which noted the Oxford Hip Score (OHS) found means of 16.1 and 16.4, a mean 26.3 improvement, a mean of 21.4, and poorer outcomes with lower Charnley grades [12,24,25]. One study reported the median modified OHS as 4.2% using the Pynsent method [16]. The five that documented the University of California Los Angeles Activity Score (UCLA AS) noted means of 6.6 and 6.7, a 3.61 improvement, a mean of 8.4, statistical improvement, and a median of 7.0 [14,16-18,24].

One study included a pre and post-operative questionnaire and had participants' complete information on sports participation before and after BHR. 65% were active in sports preoperatively, and this increased to 92% postoperatively. 92% reported that their sporting function had improved. There was a significant difference in the intensity and frequency of sports participation [21].

Of the six studies which detailed only post-operative outcomes, those that used the HHS reported means of 95.3, 97.24 and 84.8 [15,25,26]. One author reported that

the HHS had him conclude that BHR was effective for a younger, active population. The scores were not reported [13]. On those that used the UCLA AS provided means of 8.4 [14] and 6.7 [17]. Studies reporting the OHS listed means of 15.9 [14] and 16.4 [17]. One study reported satisfaction means of 2.53 out of a 0 (poor) to 3 (excellent) scale [26]. Finally, where AROM hip flexion was considered, the mean was 100 degrees [24].

The three studies which contained only post operative questionnaires included reports of adverse events, sports participation, and employment status [19,20,27]. Adverse events were less than one percent. Sports participation was reported to have declined in high and intermediate impact activities and increased in low impact activities. One third of the subjects reported they had to give up sports that they intended on continuing. Employment surveys showed 90% of patients' employment was not affected.

#### ***Limitations:***

The research identified using outcomes to report on BHR falls into the Level of Evidence: 4 of the Sackett scale. Level 4 is defined as a "Case series and poor quality cohort and case-control studies" [11]. This limitation in research design does not allow for a complete appreciation of the outcomes of BHR, either on its own or in comparison with THA, arthroscopic procedures, other hip resurfacing systems, or absence of surgical intervention.

The quality assessment scale as defined by AACPD in the included research had a mean of 3.25 on the 7 point scale. Only three of the studies presented clear inclusion and exclusion criteria. Six of the studies clearly noted the surgical approach utilized, while four contained comments concerning the post-operative care and/or rehabilitation. While some of the outcome tools used, such as the HHS, OHS, and UCLA AS have been shown to be valid, their reliability when applied to BHR has not yet been established. None of the studies utilized any type of blinding when assessing the patients. Use of statistical evaluation and power analysis varied in the research. Finally, the dropout/loss rate was typically below the established 20% and reported failure rates were acceptable.

## CONCLUSION

BHR is currently being used worldwide as a means to delay THA in the younger patient with OA of the hip or as an option for the more active individual. BHR is chosen in active individuals because a higher level of activity post THA is typically not advised and can be damaging to the implant. In addition, the patient's own femur is spared due to the surgical method.

While the sparing of the femur does occur, whether a patient can maintain a high level of function post BHR is not known. The current literature on BHR, a specific type of hip resurfacing, is lacking and has not shown the results that the theoretical concepts suggest or the manufacturer of the device has advocated. Our review

of the literature suggests that more complete research is needed. We would suggest utilization of outcome tools such as the Western Ontario and McMaster Universities' Osteoarthritis Index (WOMAC) and the HHS. These outcome tools have been validated<sup>[30]</sup>. These measures should be assessed pre-operatively and post-operatively as part of the evaluation and follow up process. In addition they could be used for comparisons of various surgical approaches and post-operative rehabilitation protocols. Clearer inclusion and exclusion criteria as well as longer follow-up would also add to the body of research. Once these questions have been addressed, we may better educate our patients who are considering this relatively new procedure.

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