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HIP ARTHROPLASTY

Return to sports after hip resurfacing versus total hip arthroplasty: a mid-term case control study

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Abstract

Background Hip resurfacing (HR) is an alternative to conventional total hip arthroplasty (THA) for the treatment of osteoarthritis (OA) in very active, young male patients. However, there is no study in the literature that has proven its benefits for high-impact sport over standard primary THA. The aim of the current study was to investigate the return to sport and function level of male patients after THA vs. HR.

Materials and methods This prospective study is based on a telephone questionnaire for general health and sports activities. 40 HRs were matched with 40 THAs based on preoperative University of California Arthroplasty Score (UCLA), BMI, age at time of surgery and age at follow-up. The mean follow-up period was 56 months (range 24–87 months).

Results HR patients showed a significantly higher High-activity arthroplasty score (HAAS) (14.9 vs. 12.9, $p<0.001$) and Lower extremity activity scale (LEAS) (15.9 vs. 14.1, $p<0.001$) and reached significantly higher values in the Hip cycle score (HCS) (44.7 vs. 35.7 $p=0.037$) and Impact score (IS) (40.9 vs. 29.6, $p<0.002$) than THA patients. No significant differences were found in the HOOS function section (91.4 vs. 90.3, $p=0.803$) and the Pain numeric rating scale (NRS)-11 (0.6 vs. 0.9 $p=0.169$). Patients with HR had a slightly higher Harris hip score (HHS) (97.8 vs. 95.6, $p=0.015$)

Conclusion The current study suggests that young male patients are able to engage in higher activity levels after HR compared to standard THA.

Keywords Hip resurfacing · Hip replacement · Outcome · Osteoarthritis of the hip · Total hip arthroplasty

Introduction

Hip resurfacing (HR) is an alternative to conventional Total hip arthroplasty (THA) for the treatment of osteoarthritis (OA) of the hip. HR is a bone preserving technique that restores femoral offset more precisely than THA and avoids overlengthening of the limb [1]. The hard on hard metal on metal (MoM) bearing surface has lower wear rates and accommodates the use of larger diameter ball in socket components [2]. The later increases implant stability [3]. Low wear rates and increased stability have made HR an appealing treatment option for very active patients [4]. While THA shows outstanding long-term results in OA patients older than 60 years [5, 6], survival rates in the past were significantly lower in patients younger than 50 years [7] and in patients that perform high impact activities [8]. It is usually recommended that patients after surgery switch to lower impact activities [9]. For active young patients, HR implants might offer better longevity in the face of increased activity levels [10]. However, concerns remain about increased chromium and cobalt ion levels and adverse local soft tissue reactions [11, 12]. Small head size and mal-positioning seem to be the most important risk factors for failure [13]. However, with current indications limited to male sex, age less than 60 years, and larger implant size, excellent short- to mid-term outcomes are reported [13, 14]. Recent studies suggest overall implant survival rates of the Birmingham Hip Resurfacing (BHR) of 98.4% at 10 years follow-up according to data from the Swedish hip arthroplasty register [15], respectively, 99.4% in patients under 50 years at 15 years; follow-up [16]. With increased need for joint

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replacement procedures in young and active patients [17, 18] there is a need to proof that HR facilitates higher activity levels in order to justify possible risks of a MoM bearing. The current study was designed to answer the following research questions: (1) Are HR patients more active and perform higher impact sports more frequently than patients after standard primary THA? (2) Since standard outcome scores show a ceiling effect in very active patients, does the Hip Activity Arthroplasty Score (HAAS) show a difference in postoperative activity level?

Materials and methods

This is a prospective study on patients that underwent HR or conventional THA surgery by the senior author between January 2010 and July 2015. Inclusion criteria were male gender, a desired UCLA score of ≥ 8, less than 56 years of age at time of surgery, a minimum follow-up of 2 years and a maximum of 7 years. Reasons for exclusion were patients with a BMI > 35 at time of surgery, patients that were older than 60 years at time of follow-up evaluation, patients who underwent revision surgery or other lower extremity arthroplasty as well as other lower extremity involvement (3 patients had a severe OA of the knee or contralateral hip, 1 had a recent hip resurfacing of the contralateral hip and 1 patient passed away). In total 106 HR hips in 96 male patients and 99 THA hips in 82 male patients were enrolled in this study. Out of these follow-up data were available for 79 HR (74.5%) and 67 matched pair THA. All HR patients had received a Birmingham Hip Resurfacing® (BHR) (Smith & Nephew Inc, Memphis TN).

The following data were collected preoperative: demographic data, UCLA und desired UCLA, Lower Extremity Activity Scale (LEAS) [19], and Pain Numeric Rating Scale (NRS-11) [20]. Postoperative data included the HAAS [21] as primary outcome score as well as Impact Score (IS) [22], Hip-Cycle Score (HCS) [22], Hip Disability and Osteoarthritis Outcome Score (HOOS) Sections Quality of life and Function [23], Harris Hip Score (HHS) [24], LEAS, UCLA and NRS-11 as secondary outcome scores. Additionally, patients were asked to assign their workplace. Work load was measured by a simple score: office work (1 pts), work in sales (2 pts), light manual labor (3 pts) and heavy manual labor (4 pts). The LEAS could be converted into the UCLA using the crosswalk created by Ghomravi, Lee et al. [25]. The quotient IS/HCS was calculated to visualize if patients perform more high-impact activities when IS/HCS > 1 or activities that involve a high number of hip cycles (IS/HCS < 1).

For matched pair analysis, we created a THA control group to the HR group based on preoperative UCLA, range ± 1 pts; age at time of surgery, range ± 5 years; age at time of follow up, range ± 5 years; and BMI, range ± 5 kg/m^2. The final study cohort consisted of 40 matching pairs. The mean follow-up period at the time of data collection was 54 months (range 24–87 months) for HR and 57 months (range 26–82 months) for THA patients. Table 1 summarizes the matching variables and patient demographics as well as preoperative data. There were no statistically significant differences between the HR and THA group (Table 1). The study was approved by the author's institutional review board.

Statistical analysis

Each variable was tested for normal distribution using the Kolmogorov–Smirnov test. Standard student *t* tests were performed, if the data were normally distributed and a non-parametric Mann–Whitney *U* test, if the data were not normally distributed. Results with values $p < 0.05$ were considered as statistically significant, and $p < 0.001$ as highly significant. To detect a significant difference in IS or HCS of 20% (i.e. 6 pts) with a SD of 15 in independent groups, power calculation for an alpha failure of $\alpha = 0.05$, an effect size of 0.5, and an aimed power (1-β) of 80% yield a required sample size of 51 patients per group. The post hoc calculation for the primary outcome IS showed an actual power of 98%. All analyses were conducted using SPSS® 24.0 software for Windows® (SPSS Inc, Chicago, IL, USA).

Table 1 Comparison of demographic and preoperative data between HR and THA group

Characteristics	HR group	THA group	*p* value
Number of cases	40	40	
Bilateral hips	1 (2 hips)	6 (12 hips)	
Number of patients	39	34	
Age at surgery, mean (SD)	47.6 (5.2)	48.3 (6.1)	0.267
Age at follow-up, mean (SD)	52.1 (5.4)	53.0 (5.7)	0.242
Follow-up time, mean (SD)	54.4 (21.3)	56.7 (13.9)	0.627
BMI, mean (SD)	27.6 (3.3)	27.5 (3.7)	0.939
Distribution of diagnosis, *n* (%)			
Primary osteoarthritis	40 (100%)	36 (90%)	
Avascular necrosis	0	3 (7.5%)	
Slipped capital femoral epiphysis	0	1 (2.5%)	
PROMs preoperatively, *n*			
UCLA, mean (SD)	6.0 (2.3)	5.8 (2.4)	0.687
Desired UCLA, mean (SD)	9.6 (0.7)	9.4 (0.7)	0.343
NRS-11 hip pain, mean (SD)	6.7 (1.8)	7.1 (2.3)	0.155

BMI Body mass index, *PROM* Patient reported outcome measurement, *UCLA* University of California Arthroplasty Score, *NRS-11* Numeric rating scale

Results

Patients that underwent HR procedure had a significantly higher HAAS (14.9 vs. 12.9, $p<0.001$) and LEAS (15.9 vs. 14.1, $p=0.001$) and reached significantly higher values in the HCS (44.7 vs. 35.7 $p=0.037$) and IS (40.9 vs. 29.6, $p=0.002$) than THA patients.

The HR group had a significantly higher postoperative UCLA-Score compared to the THA group (9.4 pts vs. 7.7 pts, $p<0.001$). Based on the UCLA Score, 70% of HR patients reached or exceeded their preoperative desired activity level compared to 43% of THA patients. In the HR group there was no significant difference between the desired and postoperative UCLA Score (9.6 vs. 9.2, $p=0.688$), whereas THA patients missed the desired UCLA by 1.7 points in average (9.4 vs. 7.7, $p<0.001$) (Table 2). HR patients showed a higher score in the HOOS Quality of Life section than THA patients (86.6% vs. 80.0%, $p=0.021$). No significant differences were found in the HOOS Function section (91.4 vs. 90.3, $p=0.848$) and the pain level (NRS-11 0.6 pts vs. 0.9 pts $p=0.169$). The HHS showed a minimal but significant tendency in favor of HR patients (97.8 vs. 95.6, $p=0.015$) (Fig. 1). 37% of the HR group had an IS/HCS > 1 compared to 16% in the THA group. Average IS/HCS was significantly higher after HR than after THA (1.0 vs. 0.8, $p<0.028$). The IS showed a normally distributed curve (Fig. 1) with patients reaching 18% of the maximum possible IS score. In contrast the HSS was 97% of the maximum score in average and was not normally distributed (Fig. 1). 18% of the HR group participated in heavy manual labor jobs compared to 18% in the THA group. However, there was no difference in work load average between the two groups (HR 2.0 pts vs. THA 2.0 pts, $p=0.858$).

Table 2 Comparison of postoperative outcomes between HR and THA group

Variables, mean (SD)	HR group	THA group	*p* value
NRS-11 hip pain	0.6 (1.0)	0.9 (1.3)	0.169
HOOS Quality of life	86.6 (12.6)	80.0 (13.3)	0.021*
HOOS Function	91.4 (13.0)	90.3 (13.0)	0.848
HHS	97.8 (3.4)	95.6 (4.8)	0.015*
HAAS	14.9 (2.5)	12.9 (2.4)	0.000**
LEAS	15.9 (1.5)	14.1 (2.5)	0.001**
UCLA	9.4 (2.1)	7.7 (2.0)	0.000**
IS	40.9 (15.5)	29.6 (19.2)	0.002**
HCS	44.7 (17.4)	35.7 (20.3)	0.037*

NRS-11 Numeric rating scale, *HOOS* Hip disability and osteoarthritis outcome score, *HHS* Harris hip score, *HAAS* High-activity arthroplasty score, *LEAS* Lower extremity activity scale, *IS* Impact score, *HCS* Hip CYCLE Score.

*Significant, **Highly significant

Discussion

To the author's knowledge, this is the first study to compare postoperative activity levels after HR and THA procedure using a matching pairs design, comparing only patients with a high preoperative desired UCLA score and applying function scores without ceiling effect. The current results confirmed that HR and THA provide similar pain relief and everyday activities. However, utilizing scores without ceiling effect the HR group showed higher postoperative activity levels and participation in high-impact sport. Similar to the findings of previous studies, these higher activity levels correlated with higher quality of life scores after HR [26].

The current study has the following limitations: (1) Both, HR and THA patients, were informed that the risk of implant

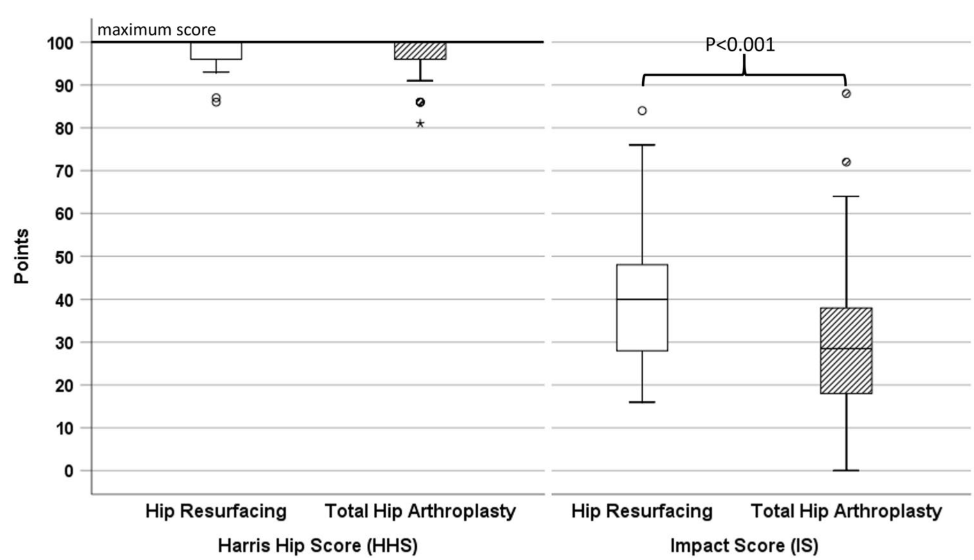

Fig. 1 Postoperative outcome [Harris Hip Score (HHS) and Impact Score (IS)] for Hip Resurfacing (HR) and Total Hip Arthroplasty (THA). Both, the THA and the HR group, reached almost maximum HHS. Due to the ceiling effect, HSS showed only minor differences between both procedures, whereas the Impact Score was normally distributed for both groups and demonstrated a highly significant better outcome for HR hips

failure, wear or aseptic loosening might be elevated when performing high-impact activities postoperatively. Subsequently some patients might have reduced their sporting activity. Patients after THA do precautions for a period of 4 weeks after surgery [27, 28]. While general activity recommendations are the same for both groups, patients after THA are advised not to engage in long-distance (> 5 mile) running and high-impact competitive sports. Figure and younger age were chosen as an inclusion and matching criteria to ensure comparable intention to return to sport in both groups. (2) Patients with a HR procedure often have higher expectations and this might impact postoperative outcomes. (3) Although the phone calls were carried out by the same examiner, there is a possibility of communication errors. (4) All procedures were performed by the senior author, a high-volume surgeon. This single-surgeon design benefits this study as results after HR are widely affected by the surgeons surgical experience [29]; however, a selection bias for more active patient to select a HR cannot be ruled out. Considering that most HR failures happen within the first 3 years [30], this study reports a relatively long follow-up period with an average of 54 months' (range 24–87 months) follow-up interval.

The current study focused on young and active male patients. This patient group typically outperformed a standard hip replacement cohort. Consequently, both study groups scored nearly 100% in the established HSS or HOOS (Fig. 1). This ceiling effect commonly limits the validity of these scores in this specific patients group [31]. In line with previous studies that used the HHS [32] or HOOS [23], these scores were not able to show any difference in postoperative outcomes between HR and THA procedures. To ensure sensitive assessment of individual activity levels, mean outcome values should ideally be located in midrange of a scores [33]. The current postoperative results for HOOS (77%) and LEAS (82%) already showed less ceiling effect. IS and HCS score values showed a normal distribution in the current study (Fig. 1). In average, our patients reached only 17% and 19%, respectively, of the maximum score, allowing a valid analysis of high activity levels. In summary, the use of specially designed high-activity scores like IS, HCS, HAAS, and LEAS allows better differentiation of activity levels and should be favored to analyse this young patient cohort [19, 21].

There is currently no report on IS or HCS results following THA in literature. LEAS were reported to be 11.6 with a minimum 2-year follow-up (66% women; mean age, 66 years) [25]. The current THA group was younger (mean age of 47.7) and had a LEAS of 14.1.

Duff et al. reported for young (mean age of 48.7 years), predominantly male (74.4%) HR patients a mean IS of 28.1 and a mean HCS of 33.0 at a mean follow-up of 1.9 years (1–5 years). In the current HR group, mean age was comparable (47.6 years) but all patients were males. The IS of 40.9, HCS of 44.7 and LEAS of 15.9 were superior.

Regardless of the type of implant type high-activity levels may reduce implant durability. According to Le Duff et al., HR patients with an IS of < 50 had a significantly higher implant survival rate (96.4% at eight years) compared to patients with an IS of ≥ 50 (88.8%) [34]. In the current study group only 20% of HR and 10% of THA patients had an IS ≥ 50. Long-term follow-up results are needed to predict the impact of high-level activities on aseptic failure rates of HR and THA patients.

Conclusion

In the current study, the HR group showed higher activity and impact scores than THA patients at mid-term follow-up supporting the utilization of HR in young male patients with high-activity level expectations prior to surgery. Traditional hip outcome scores including the HHS or HOOS were designed for an elderly patient population. Alternative outcome measurement scores such as IS, HCS or HAAS might be more suitable to investigate younger and more active patients after hip replacement. In the hands of a skilled surgeon, HR seems to have benefits for young and active male patients.

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Compliance with ethical standards

Conflict of interest One author (FB) has received royalties by Ortho development Inc. He has also received compensation by Smith and Nephew, and DePuy. All other authors certify that they have no conflict of interest in connection with the submitted article.

Ethical approval For this type of study formal consent is not required. This article does not contain any studies with animals performed by any of the authors. The study has been performed in accordance with the ethical standards in the 1964 Declaration of Helsinki. It has also been carried out in accordance with relevant regulations of the US Health Insurance Portability and Accountability Act (HIPAA).

Informed consent Informed consent was obtained from all individual participants included in the study.

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