ORIGINAL ARTICLE

HIP REPLACEMENT OR HIP RESURFACING WITH A HIGHLY CROSS-LINKED POLYETHYLENE ACETABULAR BEARING: A QUALITATIVE AND QUANTITATIVE PREFERENCE STUDY

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Abstract

Background

Most surgeons strongly prefer total hip replacement (THR) over resurfacing (HRA). However, it is unknown whether patients prefer one procedure over the other. This study asked: (1) Do patients with an HRA on 1 side and a THR on the other notice a difference? (2) Do patients have a preference? (3) What are the reasons for their preference?

Methods

Between 1998 and 2012, 332 patients underwent staged bilateral hip arthroplasties with cementless THR on 1 hip and HRA on the other using a highly cross-linked polyethylene acetabular component. Patient preferences, Harris Hip, and WOMAC scores were recorded by blinded examiners. Patients' provided reasons for their preference in semi-structured interviews using both quantitative and qualitative measures.

Results

Mean follow-up was 11 years (range, 7 - 21). Of 324 patients with complete data, 278 (86%) preferred their HRA, 19 (6%) preferred their THR, and 26 (8%) had no preference. The most common reasons for preference were better balance (n=143), felt more normal (n=141), better activity participation/most reliable hip during sports (n=139), and stronger on stairs (n=129). A fair or poor outcome was reported by 4 HRA patients and 7 THR patients. The remainder reported that both hips provided improved function, satisfactory pain relief and range of motion.

Conclusions

A paired bilateral study eliminates most confounding variables and may be the optimal way to determine patient postoperative preference. Patient preference studies go beyond patient-reported outcomes in determining how a patient values one choice over another. This study found a strong patient preference for HRA.

Level of Evidence: III

Introduction

Surgeons and some patients have preferences with respect to their choices about hip implant arthroplasty[1]. Despite the success of total hip replacement (THR), some younger and active patients have concerns about THR meeting all their functional and implant survivorship needs. The literature has described the hip resurfacing

arthroplasty procedure (HRA) as having better functional outcomes, better durability, and better revision options compared to THR[2-9]. It also has been described as unproven and unnecessarily risky, with results no better than THR[10-14].

There are reasons beyond femoral bone conservation for surgeons to consider HRA. There is less stress shielding of the proximal femur with HRA, since the endosteal medullary surface of the femur is loaded more physiologically[15,16]. Complications, such as infection and instability, can be more difficult to treat after THR[16]. There are also disadvantages; HRA is a demanding surgical exercise for exposure, it is difficult to size correctly, and there can be impingement from the large retained femoral neck. The femoral neck can fracture and the femoral head under the resurfacing cap can degrade, necessitating revision [17-19].

It is not well known if patients can consistently recognize any functional or other differences between a THR and an HRA. Research questions focused on asking "why" are better answered using qualitative methods[20,21].This study asked: (1) Do patients with an HRA on 1 side and a THR on the other notice a difference? (2) Do patients have a preference? (3) What are the reasons for their preference?

Materials and Methods

This prospective, non-randomized, single-center study was granted blanket approval by the Institutional Review Board to study all patients who received polyethylene HRA. The patients were enrolled at the time the care was provided. Patients provided written consent for either HRA or THR but not both procedures, since patients were not blinded to which procedure they would receive. Study participants were a subset of 5511 patients who underwent HRA performed by the author between 1998 and 2012; 1296 patients had staged bilateral HRA procedures. An additional 332 patients who received THR on 1 side and HRA on the other were enrolled prospectively. The THR and HRA procedures were spread evenly over time during the study and both procedures were offered the entire time of the study with no change in the pattern of offering HRA and THR. No patient refused participation. The author informed patients about HRA and cementless THR with written, web-based, and verbal information. Eight patients were excluded because of death (n=4) or lost to follow-up (n=4) before 7 years; these were the only patients with an HRA on 1 side and THR on the other who were excluded. Twelve patients with complications were included (Table 1).

Complication	THR	HRA
Revision	13	7
Dislocation	1	0
Infection	3	3
Periprosthetic fracture	1	2
Nerve injury	1	1

Thus, there were 324 patients in the final study group (Table 2). Of these, 156 patients received their HRA first and 168 had their THR first. Data of 20 patients who experienced a failure after ≥ 7 years were included in the study and the last recorded examination data before failure were used. Seven years was chosen to assure that patient preference did not change over time.

Table 2. Demographic data.

Variable	Result
Age (mean years) (range)	48.5 (32 - 62)
Women (n)	161
Men (n)	169
Non-binary (n)	2
Preoperative HHS (mean) (range)	52 (30 - 70)
Preoperative WOMAC (mean) (range)	49.7 (29 - 71)
Preoperative UCLA (mean) (range)	5 (3 - 7)
Right/left HRA (n)	162/162
Physically demanding work	20%
Participates in adventure sports	81%

Inclusion criteria for HRA were age 20 - 65 years, English speaking or access to an interpreter, advanced disability from bilateral hip osteoarthritis, and a femur that would allow femoral component placement without notching[16,19,22]. Exclusion criteria were body mass index (BMI) > 40 kg/M^2, follow-up < 7 years, poor femoral bone quality as indicated by femoral head cysts > 1 cm or osteonecrosis, low bone density, and leg-length discrepancy > 3 cm.

Femoral head size was not considered in selecting patients for HRA. To be included, both hips needed to be candidates for HRA. Each patient was informed in advance if an HRA or THR would be performed. Reasons that HRA was not performed were denied insurance authorization for 66 (20%) patients, logistical (i.e., resurfacing implants were back ordered for 94 (29%) and changed choice for 164 (51%).

All procedures were performed by the author, an experienced THR and HRA surgeon, using similar intraoperative protocols and the same postoperative protocols. Patients were not restricted from activity after either procedure. Intraoperative technique varied only with respect to placing a stemmed THR versus a resurfacing femoral component. Metal-on-polyethylene HRA has been available since the 1970s. Patients served as their own internal controls, which eliminated variability by differences in age, BMI, gender, comorbidities, and activity level.

Implants

When the study began in 1998, all femoral stems and some resurfacing femurs were Biomet, which became Zimmer-Biomet in 2015. Two cementless 2-piece polyethylene acetabular components were used: Stryker Trident PSL® with the 3.8 mm X3 Polyethylene liner (Stryker, Mahwah, NJ, USA) or the Endotec BP (Endotec, Sante Fe Springs, CA, USA. The highly cross-linked polyethylene was a minimum thickness of 3.6 mm at the dome and 2.7 mm at the periphery. The shell was 2 mm thick with 1 mm of porous coating and an inner/outer diameter difference of 10 mm. (Fig. 1).

Fig. 1. This photograph of the resurfacing prosthesis shows a two-piece, titanium-backed, highly cross-linked acetabular component and a titanium nitride-coated cementless femoral component.

The resurfacing femoral stem was either Biomet Recap® or Endotec BP™ and was placed from neutral to 15° of valgus relative to the native femoral neck. The femoral component for THRs was the Biomet Taperloc®.

The surgical procedure has been described previously[23]. The THRs used a proximally porous wedge-shaped femoral stem. The femoral head was 42 mm - 52 mm in diameter in 2 mm increments for HRA and most THRs. Femoral heads of 32 and 36 mm were also used for THR. The femoral head was either delta ceramic or magnesium-stabilized zirconium (Fig. 2). The femoral head of both the HRA and most THR prostheses reasonably matched the natural femoral head size by intent.

Fig. 2. This femoral prosthesis is used for total hip replacement. The modular femoral head is magnesium-stabilized oxidized zirconium.

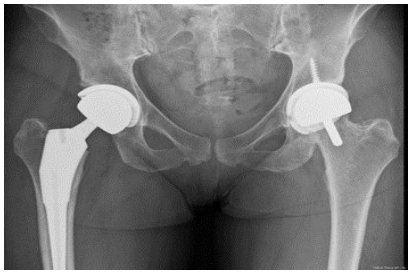
Follow-up Assessments

Postoperative examinations and interviews were conducted by physical therapists not involved in the patients' care who were blinded to which procedure the patients received. Patients were not informed during this study which hip they received. They were told and consented for just one specific procedure (HRA or THR but not both) at the time of their surgery. They were routinely shown their radiographs during follow-up visits by their surgeon and were correctly informed during their postoperative care which hip had the THR and which had the HRA.

Follow-up examinations were conducted at 6 weeks, 3 months, and 1 year, and annually. Assessments included Harris Hip Scores (HHS) [24], Western Ontario and McMaster Universities Arthritis Index (WOMAC)[25] scores, and range of motion (ROM). Radiographs were assessed by an

orthopedic surgeon not involved in the patients' care (Fig. 3).

Fig. 3. This anteroposterior pelvis radiograph shows the resurfacing prosthesis on the left and the total hip replacement on the right.



At each follow-up, we asked, "Which is your better hip overall?" and the reason(s) for their preference. Themes were identified in their answers to semi-structured questions in support of their preference. Patients were asked independently which hip had the HRA and which had the THR.

Statistical Methods

In a discrete choice experiment, a sample size of 190 subjects using a parametric method was sufficient to detect a statistically significant difference in patient preference. This would allow a statistical power of 0.8 (statistical power level of 80%). This study enrolled patients until a statistically valid group was accrued to achieve an error rate of 0.05 (95% confidence level). The paired t-test was used for analysis of the continuous variables (SPSS, version 18.0; SPSS, Inc., Chicago, IL) and R version 3.4.3.

Results

The mean follow-up was 11 years (range, 7 - 21 years) and the mean time between arthroplasties was 1.3 years (range, 0.5 to 5 years). The mean age for THR was 48 and the mean age for HRA was 49. Of the 324 patients studied, 271 (84%) correctly remembered which hip had the THR or HRA and 53 (16%) incorrectly identified which hip had the THR or HRA at a mean of 11 years after the most recent surgical procedure. Of the 324 patients, 298 (92%) with an HRA on 1 hip and a THR on the other noticed a difference. When asked about preference, 278 (86%) preferred the HRA, 19 (6%) preferred their THR, and 26 (8%) had no preference (Table 3).

Table 3. Patients' reasons for preferring one hip over the other.

Preference Statement	**HRA (324)**	**THR (324)**	***P****
Better balance	143	9	<0.0001
Feels more natural	141	0	<0.0001
Better activity participation	139	6	<0.0001
Stronger on stairs	129	5	<0.0001
Fewer restrictions	81	5	<0.0001
Superior stability	65	6	<0.0001
More natural leg length	59	8	<0.0001
No reason given	47	14	<0.0001
Less limp	51	5	<0.0001
Feel less pain	41	8	<0.0001
Fewer clunks, pops, clicks	2	7	<0.0002
Less impingement	2	7	<0.0339

* Fisher's exact test

Table 4 lists the sports and activities in which the patients participated.

Sports and Activities	
Squash/racquetball	Jogging
Hockey	Golf
Soccer	Tennis
Martial arts	Cycling
Ballet	Yoga
Handball	Sailing
Surfing	Skiing
Horseback riding	

There was no difference in the hip scores between HRA and THR and all postoperative scores showed significant postoperative improvement ($P < 0.0001$; Independent-samples t-test) (Table 5).

Table 5. Mean score results and range of motion at last follow-up).

Score	**HRA**		**THR**	
	Preop	**Postop**	**Preop**	**Postop**
HHS	54.2	98.2	54.1	97.8
WOMAC	51.2	3.2	48.2	4.9
Flexion°	86	117	85	118
Abduction°	35	46	35	45

There may be a ceiling effect of the scoring scales. Also, the qualitative responses are not captured in the hip scores. There were no significant difference between the HHS, WOMAC, flexion, or abduction scores (Table 6).

Table 6. Functional scores improvement HRA vs. THR (mean improvement).

Score	HRA Preop	THR Postop	Difference	*P*
HHS	98.2 (44)	97.8 (43.7)	.4 (.3)	.2
WOMAC	3.2 (48)	4.9 (43.3)	1.7 (4.7)	.02
Flexion°	117 (31)	118 (33)	1 (2)	.4
Abduction°	46 (11)	45 (10)	1 (1)	.7

One-hundred thirty-six patients had the direct anterior approach for both hips and 188 had the superior approach for both hips. Table 7 compares the outcomes and preferences by surgical approach and THR femoral head size. There was no significant difference in hip preferences by surgical approach *(P* = 0.8).

Table 7. Outcomes and preferences by surgical approach and THR femoral head diameter.

Surgical Approach	THR n (%)	HRA n (%)	No Preference n (%)
Direct Anterior (n=136)			
Fair/poor	3 (2.6)	2 (1.8)	11 (7.0)
Preference	8 (6.1)	117 (85.9)	
Superior (n=188)			
Fair/poor	3 (1.8)	2 (1.2)	15 (7.9)
Preference	12 (6.1)	161 (85.8)	
Large Diameter (n=282)			
Fair/poor	4 (1.4)	4 (1.4)	22 (7.9)
Preference	21 (7.3)	239 (84.8)	
Small Diameter (n=42)			
Fair/poor	1 (4.8)	1 (2.4)	3 (7)
Preference	3 (7.0)	36 (86.0)	

P = 0.8, indicating no significant difference in preference by surgical approach.

Of 53 patients who incorrectly identified which hip received the HRA or THR, 44 (83%) preferred the HRA, 5 (9%) preferred their THR, and 4 (8%) had no preference. There was no significant difference between patients with correct/incorrect recall in preferring HRA (*P* = 0.72) (range, 7 - 20 years). Of 156 patients who received their HRA first, 132 (85%) preferred their HRA. Of 168 patients who had THR first, 142 (85%) preferred their HRA. Of 164 patients (51%) who chose HRA for 1 hip and THR for the other, 84 (51%) chose the HRA first and 80 (49%) chose the THR first and 141 (86%) preferred the HRA.

There were 7 HRA revisions: femoral neck fracture (n = 2), femoral head osteonecrosis (n = 1), acetabular loosening (n = 1), and infection (n = 3). There were 13 THR revisions: infection (n = 3), periprosthetic fracture (n = 4), acetabular loosening (n = 2), femoral loosening (n = 3) and dislocation (n=1). There were no HRA dislocations and 1 dislocation of a 36 mm THR. The mean time to revision for THR was 11 years and HRA was 12 years. No patient had complications on both sides. Patients with complications did not express a preference on this basis. Some complications occurred late such as loosening or femoral neck fracture and the patient's preference was formed before the complication. Ten patients with complications preferred the HRA.

Radiographic Assessments

The HRA acetabular components had a mean inclination of 40° (range, 30° - 57°) and a mean anteversion of 20° (range, 0° - 40°). The THR acetabular components had a mean inclination of 40° (range, 29° - 58°) and a mean anteversion of 20° (range, 10° - 30°). The mean neck shaft orientation of the femoral HRA component was 7° (range, 0°-15°) valgus compared to the femoral neck axis. There was no radiographic evidence of osteolysis. Radiolucent lesions were seen in 7 hips but preoperative radiographs showed that these were cystic acetabular lesions. Femoral neck impingement occurred in 30 (9%) of HRA patients.

Discussion

Patient preference studies can find patient-perceived differences between medical treatments and outcomes that look similar to health care professionals[26]. These studies have been useful in assessing different total knee replacement prostheses[27]. Qualitative analysis

showed patient preference is a different measure than quantitative results such as hip scores and patient-reported outcomes. The key question this study asked was do patients with an HRA on 1 side and a THR on the other side have a preference?

At first, this study may seem systematically biased in favor of HRA. To control for bias, independent, blinded, third-party examiners performed all the interviews, radiographic interpretations, and examinations. Also, well-designed qualitative questions and sufficient follow-up can reduce bias. There are reasons bias may not favor HRA: (1) a randomized trial comparing HRA to THR in different patients did not show any influence of patient preoperative preference on satisfaction, clinical outcome, and postoperative preference[3]; (2) the expectations patients have for HRA are higher than for THR[28]; and (3) patients do not always correctly recall which hip is the HRA[27,29].

Some studies comparing THR and HRA show no functional benefits and other studies show significant functional benefits in favor of HRA. Walking speeds, walking up hill, and single-leg activities are considered[2,3,5-8,10-13,30]. Specific functional testing is beyond the scope of this study but will be included in future reports.

Most patients preferred their HRA hip. Patient-reported outcomes showed good and excellent results for all but 7 THRs and 4 HRAs. Patients most often responded that their HRA felt more stable and natural and that they could do more with their resurfaced hip. Differences in subjective sense of stability and how the load transfer is accepted by the femur are possible explanations[2,3,5].

There are limitations to this work. Patients were enrolled prospectively but were not randomized. They received a resurfacing prosthesis if they chose it and it was available, which could result in selection bias[31-33]. The patients were told and the surgeon knew the type of implant used. It is unlikely that dominance of one leg over another explained the result, as there was an even balance in right and left hips treated with HRA and THR. There is no known literature showing patient preference for the right versus the left hip arthroplasty. Patients' mindset of preferring HRA and their belief that HRA would allow more freedom of motion activities could have affected their preference.

Comparing 2 different ways of performing a hip arthroplasty in the same patient eliminates patient-dependent variables. Comparison studies within patient groups (paired) can be advantageous, because fewer patients are required and confounding variables are controlled. Traditional parallel group trials can have a potential for bias[3-8]. The perception that HRA is less invasive because it does not sacrifice the femoral head can create positive selection bias by the patient. A qualitative study was embedded in this study; qualitative studies overcome the limits of quantitative work because they can explore why patients prefer 1 hip over another. Qualitative data analysis can be combined with quantitative analysis and has been used in the arthroplasty literature[20,21]. Bias can influence results even though the questioning and data collection were performed by blinded investigators not involved in the patients' care who followed grounded theory qualitative data collection methods.

The author has a long-term interest in HRA; therefore, another limitation of this work is his bias in favor of HRA. Even though Patients may also have a strong preference for the HRA procedure, yet prior studies have found no clear influence of preoperative preference bias on postoperative preference, satisfaction, and the early functional outcome in HRA[31]. Some patients would have chosen HRA for both hips, but a resurfacing implant was not available or it was denied by their insurance. Patients who incorrectly recalled which procedure they had on each side provide an interesting perspective on bias. It is important to note that the questioners were blinded to which hip was resurfaced and replaced. Also, during questioning, patients were not informed whether their responses were correct or incorrect. There was no difference in the preference for HRA between patients with accurate versus inaccurate recall of the prosthesis. This may suggest bias did not impact

their preference. Still, there was a preference for HRA over THR by patients with or without limited choice, full choice, and with and without full recall. Some patients do not correctly recall their surgical procedure[27,28] and retention of information during preoperative consent is also limited[34].

Studies with data from 2 joints in the same individual can introduce bias into the effect of treatment. This is particularly true when the joints are treated consecutively rather than simultaneously[32]. This bias would not explain a preference for HRA over THR since 1 method was not consistently performed before or after the other.

All prostheses in this study performed well. It is possible, however, for a patient to prefer a prosthesis that ultimately does not perform as well as another. A prior study including 27 paired bilateral patients found all patients preferred the HRA[15]. Several – but not all – comparison studies have found HRA has advantages over THR[3-8]. A study of preoperative preferences found that 31% of patients preferred HRA over THR and would pay more for HRA[35].

In conclusion, most patients in this study preferred HRA. Since essentially all current hip prostheses perform well, a paired bilateral study may be the optimal way to determine patient preferences and values of hip resurfacing compared to replacement.

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