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Hip Replacement or Hip Resurfacing with a Highly Cross-Linked Polyethylene Acetabular Bearing

A Qualitative and Quantitative Preference Study

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Background: Most surgeons strongly prefer total hip arthroplasty (THA) over hip resurfacing arthroplasty (HRA). However, it is unknown whether patients prefer the results of 1 procedure over the other. The purpose of this study was to answer 3 questions: (1) Do patients with an HRA on 1 side and a THA 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 THA on 1 side and HRA on the other, with a highly cross-linked polyethylene acetabular component used for both. Patient preferences, Harris hip scores, and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores were recorded by blinded examiners. Patients provided reasons for their preference in semi-structured interviews using both quantitative and qualitative measures.

Results: The mean follow-up was 11 years (range, 7 to 21 years). Of 324 patients with complete data, 279 (86%) preferred the HRA, 19 (6%) preferred the THA, and 26 (8%) had no preference. The most common reasons for preference for the HRA were better balance (n = 143), felt more normal (n = 141), better activity participation/more reliable hip during sports (n = 139), and stronger on stairs (n = 129). A fair or poor outcome was reported by the patient after 4 HRAs and 7 THAs. The remainder of the patients reported improved function and satisfactory pain relief and range of motion for both hips.

Conclusions: In conclusion, most patients in this study preferred the side on which the HRA had been done. Since essentially all current hip prostheses perform well, a paired bilateral study may be the optimal way to determine patient preferences and values of HRA compared with THA.

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

Surgeons and some patients have preferences with respect to the type of hip implant arthroplasty[1]. Despite the success of total hip arthroplasty (THA), some younger and active patients have concerns about it meeting all of their functional and implant survivorship needs. The literature has described hip resurfacing arthroplasty (HRA) as having better functional outcomes, better durability, and better revision options compared with THA[2-9]. It also has been described as unproven and unnecessarily risky, with results no better than those of THA[10-14].

There are reasons beyond femoral bone conservation for surgeons to consider HRA. There is less stress-shielding of the proximal part of the 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 THA[16]. There are also disadvantages: the exposure required for HRA is a demanding surgical exercise, it is difficult to size HRA components correctly, and the large retained femoral neck can cause impingement. Also, the femoral neck can fracture and the femoral head under the resurfacing cap can degrade, necessitating revision[17-19].

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

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TABLE I Complications

Complication	No. THA	No. HRA
Revision		
Total	13	7
For dislocation	1	0
For infection	3	3
For periprosthetic fracture	4	2
For femoral loosening	3	0
For acetabular loosening	2	1
For femoral head necrosis	0	1
Nerve injury	1	1

Materials and Methods

This prospective, nonrandomized, single-center study was granted blanket approval by the institutional review board to study all patients who had received a polyethylene HRA. The patients were enrolled at the time that the care was provided. Patients provided written consent for either HRA or THA but not for both procedures, since patients were not blinded to which procedure they would receive.

The study participants were a subset of a larger group of 5,511 patients in whom I had performed HRA between 1998 and 2012; 1,296 of those patients had a staged bilateral HRA procedure whereas 332 received THA on 1 side and HRA on the other and were enrolled prospectively in the study. The THA and HRA procedures were spread evenly over time during the study, and both procedures were offered during the entire time of the study with no change in the pattern of offering. No patient refused participation in the study. I provided patients with written, web-based, and verbal information about HRA and cementless THA. Eight patients were excluded because they died (n = 4) or were lost to follow-up (n = 4) <7 years after the operation; these were the only patients with an HRA on 1 side and a THA on the other who were excluded. Twelve patients with complications were included (Table I). Of the 324 patients in the final study group (Table II), 156 received the HRA first and 168 had the THA first. Data on 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 as the minimum follow-up to ensure that patient preference did not change over time.

Inclusion criteria were an age of 20 to 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 a body mass index (BMI) of >40 kg/m^2, follow-up of <7 years, poor femoral bone quality as indicated by femoral head cysts of >1 cm or osteonecrosis, low bone density, and limb-length discrepancy of >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 THA would be performed. Reasons that HRA were not performed were denied insurance authorization for 66 patients (20%), logistical (i.e., resurfacing implants were back-ordered) for 94 (29%), and the patient's personal choice for 164 (51%).

All procedures were performed by the author, an experienced THA 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 placement of a stemmed femoral component for THA and a resurfacing femoral component for HRA. Metal-on-polyethylene HRA has been available since the 1970s. Patients served as their own internal controls, which eliminated variability due to differences in age, BMI, sex, comorbidities, and activity level.

Implants

When the study began in 1998, all femoral stems and some resurfacing femoral components were manufactured by Biomet, which became Zimmer-Biomet in 2015. Two types of cementless 2-piece polyethylene acetabular components were used: the Trident PSL with the 3.8-mm X3 polyethylene liner (Stryker) or the Endotec BP (Endotec). The highly cross-linked polyethylene had 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). The resurfacing femoral stem was either Biomet ReCap or Endotec BP and was placed in neutral to 15° of valgus relative to the native femoral neck. Biomet Taperloc femoral components were used for the THAs.

The surgical procedure has been described previously[23]. A proximally porous-coated wedge-shaped femoral stem was used in the THAs. The femoral head was 42 to 52 mm in diameter, with sizes available in 2-mm increments, in the HRAs and most THAs. Femoral heads of 32 and 36 mm were also

TABLE II Demographic Data for 324 Study Participants

Variable	Result
Age* *(yr)*	48.5 (32-62)
Gender	
Women	161
Men	161
Nonbinary	2
Preop. HHS*	52.4 (29-79)
Preop. WOMAC*	49.7 (29-71)
Preop. UCLA Activity Score	5 (3-7)
Right/left HRA *(no.)*	162/162
Physically demanding work *(%)*	20
Participates in adventure sports *(%)*	81

*The values are given as the mean with the range in parentheses.

Fig. 1

Fig. 2

Fig. 1 Photograph of a 2-piece HRA, with a titanium-backed, highly cross-linked acetabular component and a titanium nitride-coated cementless femoral component. **Fig. 2** Photograph of a femoral prosthesis used for THA. The modular femoral head is magnesium-stabilized oxidized zirconium.

used for THA. The femoral head was either delta ceramic or magnesium-stabilized zirconium (Fig. 2). The femoral head of the HRAs and most of the THAs reasonably matched the natural femoral head in terms of size by intent.

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 informed during this study regarding which hip prosthesis they received. They were told about, and gave consent for, just 1 specific procedure (HRA or THA but not both) before each operation. They were routinely shown their radiographs during follow-up visits by their surgeon and were correctly informed, during their postoperative care, regarding which hip had the THA and which had the HRA.

Follow-up examinations were conducted at 6 weeks, 3 months, 1 year, and annually thereafter. Assessments included the Harris hip score (HHS)[24], Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)[25], and range of motion. Radiographs were assessed by an orthopaedic surgeon not involved in the patients' care (Fig. 3).

At each follow-up, patients were asked, "Which is your better hip overall?" and the reason(s) for the patient's 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 THA.

Statistical Methods

In a discrete choice experiment, a sample size of 190 subjects using a parametric method was sufficient to detect a significant difference in patient preference. It was determined that this sample size 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 [CI]). The paired t test was performed for analysis of the continuous variables (SPSS, version 18.0; SPSS) using R version 3.4.3 (R Foundation for Statistical Computing).

Results

The mean follow-up was 11 years (range, 7 to 21 years) and the mean time between arthroplasties was 1.3 years (range, 0.5 to 5 years). The mean age at the time of the THAs was 48 years, and the mean age at the time of the HRAs was 49 years. Of the 324 patients studied, 271 (84%) correctly remembered which hip had the THA and which had the HRA and 53 (16%)

Fig. 3

Anteroposterior pelvic radiograph showing an HRA on the left and a THA on the right.

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TABLE III Patients' Reasons for Preferring 1 Hip Over the Other

Preference Statement	No.		P Value*
	HRA (324 Patients)	THA (324 Patients)	
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 exact test.

incorrectly identified which hip had the THA and which had the HRA at a mean of 11 years (range, 7 to 20 years) after the most recent surgical procedure. Of the 324 patients, 298 (92%) noticed a difference between the 2 hips. When asked about preference, 279 (86%) preferred the HRA, 19 (6%) preferred the THA, and 26 (8%) had no preference. The most common reasons for a preference were better balance, a more natural feel, better activity participation/more reliable during sports, and stronger on stairs (Table III). The patients participated in a variety of sports and activities, including squash/racquetball, hockey, soccer, martial arts, ballet, handball, surfing, horseback riding, jogging, golf, tennis, cycling, yoga, sailing, and skiing. There was no difference in the hip scores between the HRAs and THAs, and all postoperative scores showed significant improvement compared with preoperatively ($p < 0.0001$) (Table IV). 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 differences between HRA and THA with regard to the HHS, flexion, or abduction; the WOMAC score differed significantly between the groups ($p = 0.02$) (Table V).

The direct anterior approach was used for both hips in 136 patients, and the superior approach was used for both hips in 188. Table VI compares the outcomes and preferences by surgical approach and THA femoral head size. There was no significant difference in hip preferences by surgical approach ($p = 0.8$) or head size.

Of 53 patients who incorrectly identified which hip received the HRA or THA, 44 (83%) preferred the side that had had the HRA, 5 (9%) preferred the THA, and 4 (8%) had no preference. There was no significant difference in preference for the HRA between patients with correct and those with incorrect recall of which procedure was done in which hip ($p = 0.72$). Of 156 patients who received the HRA first, 132 (85%) preferred the HRA. Of 168 patients who had the THA first, 142 (85%) preferred the HRA. Of 164 patients (51%) who chose HRA for 1 hip and THA for the other, 84 (51%) chose the HRA first and 80 (49%) chose the THA first; 141 (86%) preferred the HRA.

There were 7 HRA revisions, which were due to femoral neck fracture ($n = 2$), femoral head osteonecrosis ($n = 1$), acetabular component loosening ($n = 1$), and infection ($n = 3$).

TABLE IV Scores and Range of Motion at Last Follow-up

Measurement	HRA*		P Value†	THA*		P Value†
	Preop.	Postop.		Preop.	Postop.	
HHS	52.4 (29-79)	98.2 (86-100)	<0.0001	51.4 (30-78)	97.8 (86-100)	<0.0001
WOMAC	51.2 (29-71)	3.2 (0-16)	<0.0001	48.2 (30-70)	4.9 (0-22)	<0.0001
Flexion *(°)*	86 (40-100)	117 (90-150)	<0.0001	85 (40-110)	118 (90-160)	<0.0001
Abduction *(°)*	35 7(30-55)	46 (30-70)	<0.0001	35 (30-60)	45 (25-65)	<0.0001

*The values are given as the mean with the range in parentheses. †Independent-samples t test.

TABLE V Functional Scores for HRA Versus THA

Measurement	Postop. Score*			
	HRA	THA	Difference	P Value
HHS	98.2 (44)	97.8 (43.7)	0.4 (0.3)	0.2
WOMAC	3.2 (48)	4.9 (43.3)	1.7 (4.7)	0.02
Flexion (°)	117 (31)	118 (33)	1 (2)	0.4
Abduction (°)	46 (11)	45 (10)	1 (1)	0.7

*The values are given as the mean with the standard deviation in parentheses.

There were 13 THA revisions, which were due to infection (n = 3), periprosthetic fracture (n = 4), acetabular component loosening (n = 2), femoral component loosening (n = 3), and dislocation (n = 1). There were no dislocations after HRA and 1 dislocation of a 36-mm-diameter head after THA. The mean time to the revisions of the THAs and HRAs was 11 and 12 years, respectively. No patient had complications on both sides, and those who did have a complication did not express a preference on that basis. Some complications such as loosening and femoral neck fracture occurred late, and the patient's preference was formed before the complication developed. Ten patients with complications preferred the HRA.

Radiographic Assessments

The HRA acetabular components had a mean inclination of 40° (range, 30° to 57°) and a mean anteversion of 20° (range, 0° to 40°). The THA acetabular components had a mean inclination of 40° (range, 29° to 58°) and a mean anteversion of 20° (range, 10° to 30°). The mean neck-shaft orientation of the femoral HRA component was 7° (range, 0° to 15°) of valgus compared with 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 the hips with an HRA.

TABLE VI Outcomes and Preferences by Surgical Approach and THA Femoral Head Diameter

	No. (%)		
	THA	HRA	No Preference
Surgical approach*			
Direct anterior (n = 136)			
Fair/poor outcome	4 (2.9)	2 (1.5)	
Preference	8 (5.9)	117 (86.0)	11 (8.2)
Superior (n = 188)			
Fair/poor outcome	3 (1.6)	2 (1.1)	
Preference	12 (6.4)	161 (85.6)	15 (8.0)
Femoral head diameter			
Large (n = 282)			
Fair/poor outcome	6 (2.1)	4 (1.4)	
Preference	21 (7.4)	239 (84.8)	22 (7.8)
Small (n = 42)			
Fair/poor outcome	1 (2.4)	0 (0)	
Preference	3 (7.1)	36 (85.4)	3 (7.1)

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

Discussion

Patient preference studies can reveal patient-perceived differences between medical treatments and outcomes that seem similar to health-care professionals[26]. These studies have been useful in assessing different types of total knee replacement prostheses[27]. Qualitative analysis showed that patient preference is a different measure than quantitative results such as hip scores and patient-reported outcomes[20,21]. The key question asked in the present study was: Do patients with an HRA on 1 side and a THA 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 of 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 with THA in different patients did not show any influence of patient preoperative preference on satisfaction, clinical outcome, or postoperative preference[3]; (2) patients have higher expectations for HRA than for THA[28]; and (3) patients do not always correctly recall their medical history[27,29].

Some studies comparing THA and HRA showed no functional benefits in favor of HRA and other studies showed significant functional benefits in favor of HRA with regard to walking speeds, walking uphill, and single-limb activities[2,3,5-8,10-13,30]. Specific functional testing was not performed in our study.

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

There are limitations to this study. Patients were enrolled prospectively but were not randomized. They received a resurfacing prosthesis if they chose it and it was available, which could have resulted in selection bias[31-33]. The patients were told, and the surgeon knew, the type of implant used. It is unlikely that dominance of 1 side over the other explained the results, as there was an even distribution of right and left hips treated with HRA and THA. There is no known literature showing patient preference for right versus left hip arthroplasty. Patients' mindsets of preferring HRA and their belief that HRA would allow more freedom-of-motion activities could have affected their preference.

Comparing 2 different types of hip arthroplasty in the same patient (paired analysis) eliminates patient-dependent variables, fewer patients are required, and confounding variables are controlled. Traditional parallel group trials 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. As has been previously done in the arthroplasty literature[20,21], the present study combined qualitative and quantitative analysis; qualitative studies overcome the limits of quantitative work because they can explore why patients prefer one hip over another. However, even though the questioning and data collection were performed by blinded investigators who were not involved in the patients' care and who followed grounded theory qualitative data collection methods, bias could still have influenced the results.

Because I have a long-term interest in HRA, another limitation of this work is my bias in favor of HRA. Even though patients may also have a strong preference for HRA, prior studies have shown no clear influence of preoperative preference on postoperative preference, satisfaction, or early functional outcomes of 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 company. Patients who incorrectly recalled which procedure they had 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 which was replaced. Also, during questioning, patients were not informed whether their responses with regard to which hip had which procedure were correct or incorrect. There was no difference in the preference for HRA between patients with accurate and those with inaccurate recall of which prosthesis was inserted in which hip. This may suggest that bias did not impact their preference. There was a preference for HRA over THA by patients whose choice of the type of prosthesis was limited, those with a full choice, and those with and without accurate recall of which prosthesis was inserted in which hip. 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 on 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]. However, this bias would not explain a preference for HRA over THA since 1 method was not consistently performed before or after the other.

Almost 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. In my prior study, all of 27 patients who had an HRA on 1 side and a conventional THA on the other preferred the HRA[15]. Several—but not all—comparison studies have shown HRA to have advantages over THA[3-8]. In a study of preoperative preferences, 31% of patients preferred HRA over THA and indicated that they would pay more for HRA[35].

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

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