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Original article

Conversion of hip resurfacing to total hip arthroplasty: is the outcome closer to primary or revision total hip arthroplasty?

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ABSTRACT

Background: Along with the advent of newer bearings, hip resurfacing (HR) is gaining renewed interest as a bone sparing alternative to conventional total hip arthroplasty (THA) in young patients. However, the outcome of conversion of failed HR to THA (HRc) remains sparsely described. This study aimed to compare the outcomes and complication rates of HRc to those of primary (pTHA) and revision THA (rTHA) to find out to which group HRc is most comparable.

Hypothesis: The study hypothesis was that the outcomes and complications rates of HRc were closer to those of pTHA than rTHA.

Materials and methods: Between 2001 and 2011, a continuous series of 207 HR were prospectively included in our institutional registry and retrospectively analyzed. Out of them, 17 HR (8%) were converted to THA. Propensity scores were used to match patients in the HRc group to the pTHA and the rTHA groups using a greedy 1:3 matching procedure (51 pTHA and 51 rTHA). Clinical and radiographic outcomes, perioperative data and complications were analyzed and compared between the three groups.

Results: No significant difference between HRc and pTHA was observed in terms of clinical and functional outcomes, duration of surgery, acetabular component diameter and length of hospital stay ($p = 0.13$ to 0.94). Perioperative blood loss was significantly lower for pTHA than for HRc ($p = 0.01$). HRc demonstrated significantly higher HHS and HOOS scores than for rTHA at one year ($p = 0.03$ and $p < 0.01$, respectively). Duration of surgery was significantly lower in HRc compared to rTHA ($p = 0.02$) while length of hospital stay was similar ($p = 0.84$). Complication rate was significantly higher in the rTHA group, compared to HRc and pTHA groups (37.3 vs. 29.4 vs. 11.8%, $p = 0.01$).

Conclusion: This study demonstrated that the clinical and functional outcomes of HRc were closer to those of pTHA than those of rTHA, though complication rate was higher than for pTHA.

Level of evidence: III; Retrospective comparative study

1. Introduction

Metal-on-metal (MoM) hip resurfacing (HR) gained popularity in the early 2000s as a potentially less invasive alternative to total hip arthroplasty (THA) [1]. Potential advantages of HR over conventional THA included bone stock preservation on the femoral side, ease of future revision, reduced risk of dislocation due to the larger head, greater resistance to wear and improvement in function and range of motion [2–5]. Therefore, HR was considered an attractive option to manage end-stage hip osteoarthritis in young and active patients practicing intensive sports activities and who were likely to require revision surgery within their lifetime [6–8]. However, despite these expectations, data from joint registries worldwide revealed less favorable outcomes than expected, with 10-year surgical revisions of RH MoMs ranging from 8 to 12%, while 10-year survival rates of conventional THA ranging from 94% to 96% [9]. Marshall and al [10] and Haynes and al [11] have reported earlier and higher-than-expected revision rates with HR compared to conventional primary THA (pTHA) related to femoral neck fractures, aseptic loosening and adverse reactions to metal debris (ARMD) that required conversion to THA. Because of the newer bearings that will be available in the near future, a potential increase in HR-utilization is possible. As such, evaluation of the outcomes of HR

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conversion (HRc) to THA becomes even more crucial in the decision-making process when considering HR in young and active patients [12,13]. To date, available literature on HRc is sparse and controversial, with clinical series reporting that HRc yields similar outcomes to pTHA. Some of the existing studies focused on femoral-only conversion, retaining in place the HR acetabular component [14,15]. Conversely, other studies suggested that conversion of failed HR could not be deemed equivalent to pTHA due to lower clinical and functional outcomes and higher revision rates, and should instead be considered similar to revision THA (rTHA) [3,12,16]. In addition, direct comparison of outcomes and occurrence of complications between HRc, pTHA and rTHA remains sparse in literature, particularly when considering HRc as the revision of both acetabular and femoral components. Therefore, this monocentric study with propensity-matching analysis aimed to compare the pre- to post-operative outcomes and complication rates of HRc with those of pTHA and rTHA.

We therefore determined whether (1) patients undergoing HRc with both component revision presented with functional outcome scores were comparable to patients undergoing pTHA or those undergoing rTHA; and whether (2) patients undergoing HRc with both component revision have perioperative characteristics and complication rates comparable to those of patients undergoing pTHA or to those of patients undergoing rTHA.

The study hypothesized that the outcomes and complications rates of HRc were closer to those of pTHA than those of rTHA

2. Materials and methods

2.1. Patients and group assignments

Between January 2001 and December 2011, a continuous series of 207 HR (Birmingham Hip Resurfacing®, Smith & Nephew Orthopaedics Ltd, Warwick, United Kingdom) was prospectively included in our institutional total joint registry. Among them, 17 HRc with both component revision (11 women; mean age = 68 years ± 9) were identified, representing a HR revision rate of 8% during this time period. The indications for HRc were adverse reaction to metal debris (ARMD) in 8 cases (47%), aseptic loosening on the femoral side in 4 cases (23%), femoral neck fracture in 2 cases (12%), persistent groin pain in 2 cases (12%) and recurrent dislocation in 1 case (6%) (Table 1). All the HRc were performed through a conventional postero-lateral approach by or under the direct supervision of a senior fellowship trained hip surgeon with revision of both acetabular and femoral components without cementation of the acetabular component and without associated surgical procedure under general or spinal anesthesia (Fig. 1). A conventional cementless acetabular component was used pressfitted without screw fixation in 10 HRc (59%; 6 April® cup, Symbios [Yverdon-les-Bains, Switzerland], 2 CLS Spotorno ® expansion cup, Zimmer Biomet [Warsaw, IN] and 2 Delta TT®, Lima Corporate [San Daniele del Friuli, Italy]). A monobloc cementless dual mobility cup was used in 7 HRc (41%; Symbol® cup, Dedienne santé [Mauguio, France]). On the femoral side, 7 shortened cementless femoral stems (41%; Symbol® stem, Dedienne santé [Mauguio, France]), 8 straight-tapered cementless femoral stems (47%; 6 Harmony® stem, Symbios [Yverdon-les-Bains, Switzerland] and 2 CLS Spotorno® stem, Zimmer Biomet [Warsaw, IN]), 2 single-wedge cementless femoral stems (12%; Master SL®, Lima Corporate [San Daniele del Friuli, Italy] were implanted (Fig. 1). We retrospectively reviewed and compared these patients undergoing HRc to patients undergoing a pTHA without prior hip surgery and to patients undergoing their first rTHA.

During the same period, a continuous series of 1127 pTHA, and 300 rTHA were prospectively included in our institutional total joint registry. All these procedures were also performed through a postero-lateral approach by or under the direct supervision of a senior fellowship trained hip surgeon. After using a propensity score and a 1:3 matching procedure, 51 pTHA (30 women; mean age = 67 ± 12 years) and 51 rTHA (33 women; mean age = 69 ± 12 years) were identified for comparison with the HRc group. Indications for pTHA were osteoarthritis in 33 cases (65%), femoral neck fracture in 8 cases (16%), avascular necrosis in 6 cases (12%) and developmental dysplasia of hip in 4 cases (8%). Indications for rTHA were aseptic loosening in 22 cases (43%), peri-prosthetic fracture in 10 cases (20%), ARMD in 9 cases (18%) and dislocation in 3 cases (6%). Comparative demographic and baseline outcome data are presented in Table 1. The bearings used for HRc, pTHA and rTHA are summarized in Table 2, no significant difference was found between the groups in terms of couple bearing (p = 0.15). At baseline, no significant difference in the patient demographics data was observed.

Table 1
Demographic data.

	HR conversion (n = 17)	Primary THA (n = 51)	Revision THA (n = 51)	*P*
Age (years)*	68 ± 9	67 ± 12	69 ± 12	0.687
Sex (Female/Male)	11/6	30/21	33/18	
BMI (kg/m^2)**	27.0 ± 5.1	24.2 ± 4.6	24.4 ± 4.1	0.186
Follow-up (months) *	95 ± 51	84 ± 51	85 ± 54	0.743
Indication for primary hip arthroplasty				
Hip osteoarthritis	14	33	30	
Femoral neck fracture	0	8	4	
Avascular necrosis	0	6	4	
Developmental dysplasia of the hip	3	4	9	
Other	0	0	4	
Indication for revision hip arthroplasty				
ARMD	8	NA	9	
Femoral neck fracture	2	NA	0	
Dislocation	1	NA	3	
Hip pain with blood ion elevation	2	NA	3	
Aseptic loosening	4	NA	22	
Periprosthetic fracture	0	NA	10	
Other	0	NA	4	

NA = not applicable.
* Values are expressed as mean ± SD.
** Values are expressed as median ± SD.

2.2. Variables and evaluation

Operative and anesthesiology reports were reviewed for assessment of the size of the acetabular components, duration of surgery from the skin incision to wound dressing, intraoperative bleeding by measuring fluid accumulation in the suction device after subtracting irrigation and weighing gauze swabs, and intraoperative complication. In-hospital records were reviewed for assessment of perioperative complications and length of stay. Patients returned for postoperative follow-up visits at 3 months, 6 months, 1 year and annually thereafter. Patients underwent a physical examination and their clinical outcome was evaluated with the Harris Hip Score (HHS) and the Hip and Osteoarthritis Outcome Score (HOOS). Plain anteroposterior and lateral radiographs of the pelvis and affected hip were obtained. Postoperative complications were collected through retrospective chart review.

2.3. Statistical analysis

As the HRc, pTHA, and rTHA groups were not randomly assigned, a propensity analysis was performed to account for potential confounding factors and selection biases [17]. Statistical analyses were conducted using SPSS software. A propensity score was computed using a multivariable logistic regression model with sex, age, BMI, and year of surgery as independent variables, which were known or suspected to influence

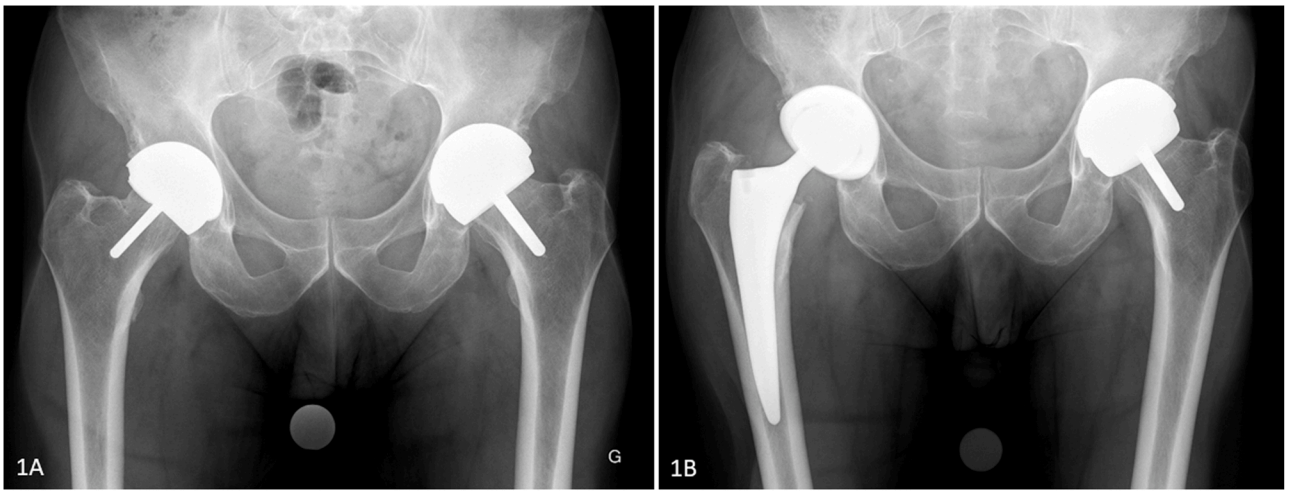

Fig. 1. Conversion of failed resurfacing (A) Right hip: Painful MoM HR with CoCr ion blood elevation and joint effusion 15 years after implantation in a 69 years old male patient (B) Right hip: conversion to THA with ceramic-on-XLPE bearing (40-mm diameter femoral head) at 3 years with conventional press-fitted acetabular component without screw and conventional cementless tapered-wedge femoral stem.

Table 2
Summary of the bearing surfaces.

Bearing	HR conversion n = 17 n (%)	Primary THA n = 51 n (%)	Revision THA n = 51 n (%)
Ceramic on ceramic	5 (29)	19 (37)	14 (28)
Ceramic on polyethylene	6 (35)	19 (37)	22 (43)
Metal on polyethylene	4 (24)	7 (14)	13 (25)
Metal on metal	2 (12)	6 (12)	2 (4)

The p-value is 0.1544.

group assignment or to affect the clinical outcome measures. Propensity scores were used to match patients in the HRc group to the pTHA and rTHA groups using a greedy 1:3 matching procedure for both primary and revision THA groups.

Data are presented as mean ± standard deviation. Comparisons of variables were performed using Wilcoxon-Mann-Whitney rank test with a level of evidence set at $p < 0.05$ (SPSS version 22 software, SPSS Inc., Chicago, IL).

3. Results

The mean follow-ups of the patients were 95 ± 51 months in the HRc group, 84 ± 51 months in the pTHA group, and 85 ± 54 months in the rTHA group without significant difference between groups ($p = 0.743$).

3.1. Clinical outcome

At latest follow-up, no significant differences were observed in terms of clinical and functional outcomes between patients in the HRc and the pTHA groups (Table 3), both regarding to the HHS (89 ± 10 vs. 89 ± 17, $p = 0.13$) and the HOOS scores (90 ± 12 vs. 87 ± 16, $p = 0.44$,) at one year. However, the HHS and HOOS scores were found to be significantly higher in patients who underwent HRc than those who underwent rTHA (89 ± 10 vs. 79 ± 23, $p = 0.03$ and 90 ± 12 vs. 75 ± 19; $p < 0.001$, respectively). All the HOOS subscales including pain, function in daily living, sports/activities and quality of life were significantly higher for patients in the HRc group compared to those in the rTHA group ($p = 0.004$, $p = 0.01$, $p = 0.003$, and $p = 0.02$, respectively).

3.2. Surgical outcome

No significant difference in terms of duration of surgery, acetabular component diameter and length of stay at the hospital was observed between patients in the HRc and pTHA groups ($p = 0.55$, $p = 0.17$, $p = 0.94$, respectively) (Table 4). However, intraoperative blood loss was significantly lower for patients who underwent pTHA compared to those who underwent HRc (439 ± 213 mL vs. 661 ± 336 mL; $p = 0.01$). In addition, no significant difference in terms of time to revision, blood loss, acetabular component diameter and length of hospital stay was observed between patients in the HRc group compared to those in the rTHA group ($p = 0.65$, $p = 0.98$, $p = 0.78$, $p = 0.84$) while significantly longer operative time was reported in patients who underwent rTHA compared to those who underwent HRc ($p = 0.02$) (Table 4).

Table 3
Comparisons of clinical and functional outcomes between HR conversion, primary THA group and revision THA groups.

	HR conversion (n = 17)	Primary THA (n = 51)	*P*	HR conversion (n = 17)	Revision THA (n = 51)	*P*
Harris Hip Score*	94 ± 10	96 ± 17	0.1392	94 ± 10	77 ± 23	0.0329
HOOS**	90 ± 12	87 ± 16	0.4488	90 ± 12	75 ± 19	0.0004
Stiffness*	90 ± 15	95 ± 13	0.3244	90 ± 15	85 ± 12	0.1504
Pain*	98 ± 7	98 ± 17	0.646	98 ± 7	85 ± 23	0.0037
Function in daily living*	94 ± 13	97 ± 18	0.9679	94 ± 13	87 ± 21	0.01
Sports, activities*	81 ± 17	83 ± 19	0.8383	81 ± 17	65 ± 18	0.003
Quality of life*	100 ± 23	90 ± 16	0.6696	100 ± 23	69 ± 21	0.0172

HOOS = Hip disability and Osteoarthritis Outcome Score.
* Values are expressed as median ± SD.
** Values are expressed as mean ± SD.

Table 4
Comparisons of perioperative parameters between HR conversion, primary THA group and revision THA groups.

	HR conversion (n = 17)	Primary THA (n = 51)	*P*	HR conversion (n = 17)	Revision THA (n = 51)	*P*
Time to revision (months)*	134 ± 68	NA	NA	134 ± 68	108 ± 94	0.650
Blood loss (mL)**	661 ± 336	439 ± 213	0.010	661 ± 336	784 ± 590	0.983
Duration of surgery (minutes)**	110 ± 49	102 ± 45	0.557	110 ± 49	153 ± 68	0.022
Acetabular component diameter (mm)*						
HR						
52 ± 4.2	56 ± 4.3	52 ± 4.2	0.173	56 ± 4.3	54 ± 5.6	0.785
Length of hospital stay (days)**	7.6 ± 2.5	7.7 ± 3.2	0.940	7.6 ± 2.5	8.1 ± 4.1	0.843

NA = not applicable.
* Values are expressed as median ± SD.
** Values are expressed as mean ± SD.

3.3. Complications

Regarding to the postoperative complications (Table 5), patients in the pTHA group had a significantly lower incidence of complications than those in the HRc and rTHA groups (6/51 [11.8%], 5/17 [29.4%] and 19/51 [37.3%]; p = 0.01, respectively). At latest follow-up, the rates of aseptic loosening and periprosthetic infection were significantly higher for patients in the rTHA group compared to those in the pTHA group (7 [13.7%] vs. 1 [2%], p = 0.07 and 6 [11.8%] vs. 1 [2%]: p = 0.13, respectively), while no case of aseptic loosening or periprosthetic infection was reported after HRc.

4. Discussion

Hip Resurfacing conversion has clinical and functional results close to those of primary THA and superior to those of revision THA. HR is an attractive bone sparing alternative to conventional THA especially in young and active patients [18]. HR is recently gaining renewed interest despite revision rates historically higher than conventional THA. According to 2022 Report of the Australian Orthopaedic Association National Joint Replacement Registry Register, HR increased by +43% from 2018 to 2021 (382 HR vs. 545 HR) [1,19,20]. Previous clinical series and registry reports have identified aseptic loosening after 7 years of implantation and femoral neck fracture as the primary causes for HRc [20–22]. Other causes for HRc include ARMD and painful hip with elevated blood metal ions [23]. Despite detailed literature examining the causes for HR failure, there is still controversy regarding whether HRc provides clinical and functional outcomes and complication rates closer to those of pTHA or of rTHA.

The most important finding of this comparative propensity-matching study was that HRc yielded clinical and functional outcomes close to those of pTHA, and superior to those of rTHA. Except for intraoperative blood loss, which was significantly higher for patients in the HRc compared to those in the pTHA groups, no significant difference in terms of duration of surgery, acetabular component diameter and length of stay at hospital was observed between patients in the HRc and pTHA groups. Similarly, intraoperative blood loss was also significantly higher for patients in the rTHA groups compared to those in the pTHA group that could be attributed to a more extensive surgical approach with large soft tissue related to a higher complexity of the procedure [24].

Importantly, no significant difference in terms of clinical and functional outcomes as evaluated with the HHS and HOOS scores was detected between the patients in the HRc and the pTHA groups. This result is supported also by Ball et al. [14] and Eswaramoorthy et al. [25], who reported that clinical and functional outcomes in patients undergoing HRc were comparable to those of patients undergoing pTHA. However, the study of Ball et al. focused on the femoral-only revision which supposedly presented with several advantages, including a less complex surgical procedure, shorter operative time and decreased blood loss and may thus introduce a bias for the lower morbidity observed in these specific patients undergoing HRc [26]. It is important to note that our study analyzed HRc with revision of both components. Conversely, Desloges et al. [12] and Bouveau et al. [16] reported lower WOMAC pain scores in patients undergoing HRc with revision of both components compared to patients undergoing HRc with femoral-only revision. This could be because younger patients in this group recovered more easily from this more complex operation. Further, when comparing HRc with rTHA, we observed significantly higher HHS and HOOS scores in the HRc group. This result suggested that HRc lead to superior functional outcomes and improved quality of life when compared to rTHA. These results are in agreement with Bradley and Freeman [27], who also reported better clinical outcomes in patients undergoing HRc compared to those undergoing rTHA.

A recent meta-analysis of randomized controlled trials by Palazzuolo et al. [8], described HR as a safe and effective alternative to THA, with no significant difference in the rate of complications and revision between HR and THA in young patients. Additionally, the survivorship at 10 years was reported to be 89% for MoM THA and 96% for MoM HR, significantly favoring HR over MoM THA at any time point. However, it should also be noted that these results only referred to the implants considered by the authors (Birmingham Hip Resurfacing) and may not be generalized to all of the existing HR constructs available in the market [28,29]. Failure rate due to ARMD was also significantly higher in MoM THA with respect to HR, highlighting the role of fretting corrosion at the head-neck junction with elevated ion levels and Co/Cr ratio dissociation in THA [30]. Even though that the current literature described HR as a safe and effective alternative to conventional THA and that we demonstrated HRc yielded outcomes comparable to those of pTHA, it is important to note that the number of HR arthroplasties decreased dramatically in recent years because of concerns over potential toxicity of metal ion levels, and regular monitoring of blood metal ion level is essential [31]. Since 2012, as a result of the reported failures and complications, the number of hip arthroplasty using the metal-metal bearing couple has fallen and MoM is not a standard of care anymore. In the United States, the use of large-head metal-on-metal THA fell from 20% in 2005 to less than 1% in 2012 [32]. However, despite the potential complications related to the metal-on-metal bearing, this study shows that patients who underwent HR in the past and will need revision surgery in the future can still achieve clinical outcomes similar to those of a pTHA. It should be noted that clinical trials on ceramic-on-ceramic hip resurfacing (cHRA) with the use of zirconia-toughened-alumina

Table 5
Comparison of postoperative complications between HR conversion, primary THA group and revision THA groups.

Post-operative complication	HR conversion (n = 17)	Primary THA (n = 51)	Revision THA (n = 51)	*P*
Dislocation	2	1	2	0.2163
ARMD	2	2	2	0.3921
Periprosthetic fracture	1	1	2	0.7082
Aseptic loosening	0	1	7	0.0713
Infection	0	1	6	0.1366
None	12	45	32	0.0112

(Biolox®delta) as a bearing alternative to MoM for HR are pending [33]. The utilization of this material for HR aims to avoid the issues associated with MoM, while endorsing the clinical and functional performance reported with MoM-HRA when compared to THA. In a recent study, Maslivec et al. conducted a matched control gait analysis to compare the gait function of female cHRA and THA patients using both subjective and objective outcome measures. Interestingly, the authors found no significant differences between female patients who underwent cHRA patients and healthy controls, while female patients who underwent conventional THA presented with significant gait alterations compared to healthy controls [34].

This study presented with some limitations. The limited sample size of patients included the HRc group may limit the generalizability of our results. However, at latest follow-up, only 17 out of the 207 HR that were prospectively included in our institutional joint registry were revised with no patient lost to follow-up. The retrospective analysis of the HRc might introduce bias and confounding factors. Additionally, the pTHA group included patients with initial diagnosis of femoral neck fracture. This might affect the outcomes achieved in our pTHA cohort. However, as matching of the patients was based on age, BMI, and gender, the fracture patients included in our series presented no substantial additional comorbidities that could affect the overall outcome of the pTHA cohort.

5. Conclusion

This comparative propensity-matching study demonstrated that HRc yielded clinical and functional outcomes close to those of pTHA, and superior to those of rTHA. Interestingly, the intraoperative blood loss during HRc was similar to that observed during rTHA and was significantly higher than during pTHA despite a duration of surgery similar to that of pTHA. Further studies with longer follow-up and larger cohort of patients are needed to assess long-term outcome and survivorship of HRc, thereby enabling a more accurate evaluation of its similarity to either primary or revision THA.

Ethical approval

The patient's informed consent and Institutional Review Board approval were obtained before initiating this study (CER-VD 2022–02069).

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Author contributions

These authors (Marion Mutschler, Allegra Massazza) contributed equally to this work and share first authorship. All authors contributed to writing the article.

Conflict of interest

J.W. has perceived royalties from Dedienne santé and works as a paid consultant for Stryker, Lima Corporate, Mathys and DePuy Synthes.

M.M. Conflict of interest: none.

A.M. Conflict of interest: none.

A.A. Conflict of interest: none.

M.P. Conflict of interest: none.

Artificial intelligence statement

No artificial intelligence was used for the writing of the submitted work.

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