Revision of Hip Resurfacing Arthroplasty

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Abstract

Metal-on-metal (MOM) hip resurfacing has become an increasingly popular treatment for young, active patients with degenerative disease of the hip, as bearing surfaces with better wear properties are now available. One proposed advantage of resurfacing is its ability to be successfully revised to total hip arthroplasty (THA). In addition, radiographic parameters that may predict failure in hip resurfacing have yet to be clearly defined.

Seven MOM resurfacing arthroplasties were converted to conventional THAs because of aseptic failure. Using Harris Hip Scores (HHS) and Short Form 12 (SF-12) questionnaire scores, we compared the clinical outcomes of these patients with those of patients who underwent uncomplicated MOM hip resurfacing. In addition, all revisions were radiographically evaluated. Mean follow-up periods were 51 months (revision group) and 43 months (control group).

There was no significant difference between the 2 groups' HHS or SF-12 scores. There was no dislocation or aseptic loosening after conversion of any resurfacing arthroplasty. Valgus neck-shaft angle (*P*<.03) was associated with aseptic failure of MOM hip resurfacing.

Conversion of aseptic failure of hip resurfacing to conventional THA leads to clinical outcomes similar to those of patients who undergo uncomplicated hip resurfacing. The orientation of the femur and the components placed play a large role in implant survival in hip resurfacing. More work needs to be done to further elucidate these radiographic parameters.

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Metal-on-metal (MOM) hip resurfacing has become an increasingly popular treatment for young, active patients with degenerative disease of the hip, as bearing surfaces with better wear properties are now available.[1-4] In removing less femoral bone than in conventional total hip arthroplasty (THA), this technique preserves proximal femoral bone and potentially allows for easier revision. To our knowledge, however, that advantage has not been proved in the long term. Other benefits, such as low dislocation rates and normal biomechanical properties of the hip, are being debated.[5-8] Accurate restoration of femoral offset and accurate restoration of leg length are other proposed benefits.[9]

As it is feasible to perform revision surgery after failed hip resurfacing arthroplasty, it is important to understand the reasons for and results of revision. In the past, metal-on-polyethylene bearings were difficult to revise because of acetabular-side complications associated with cement, osteolysis, and polyethylene wear. To our knowledge, only 4 reports have specifically addressed revision of failed hip resurfacing procedures.[5,10-12] The "revisability" of hip resurfacing was recently addressed by Ball and colleagues,[12] who concluded that conversion of a hip resurfacing arthroplasty for femoral-side failure to a THA is comparable to primary THA.

Short-term data on complications of current-generation hip resurfacing are beginning to emerge. Whereas THA failure results from dislocation, osteolysis, or infection, resurfacing arthroplasties appear to fail by different modes.[13] Hip resurfacing is subject to unique complications, such as femoral neck fracture, avascular necrosis, femoral or acetabular loosening, and malalignment of components in a small but important number of cases.[14-16] Risk factors, such as head cysts, excessive or inadequate cement penetration, notching of the femoral neck, and osteopenia, have all been implicated in fracture of the femoral neck after hip resurfacing.[17] The cause for the other complications, however, has remained elusive. Radiographic parameters that may predispose to failure are beginning to emerge but are still poorly understood.[18,19]

In the study reported here, we compared results of revision of MOM hip resurfacing arthroplasty to THA with results of primary resurfacing arthroplasty. In addition, we sought to define specific radiographic parameters that may predict aseptic failure in MOM hip resurfacing arthroplasty.

Figure 1. Anteroposterior neck-shaft angle.

Figure 2. Anteroposterior stem-shaft angle.

Patients and Methods

Between January 2002 and February 2007, Dr. Kraay and Dr. Goldberg performed 92 primary MOM hip resurfacing hip arthroplasties. The first 50 of these cases were part of a US Food and Drug Administration multicenter investigational device exemption study of the Conserve Plus prosthesis (Wright Medical Technology, Arlington, Tenn). Institutional review board approval was obtained for this study.

In all cases, the technique described by Amstutz and colleagues[20] was used. Postoperative management included 6 weeks of weight-bearing restriction, plus 3 weeks of thromboembolic prophylaxis (oral warfarin therapy) initiated on the operative day. Infection prophylaxis included 24 hours of intravenous antibiotics. All patients participated in inpatient physical therapy programs after surgery until discharge.

Revision Group

Eight (8.7%) of the 92 patients underwent revision to THA during the study period. There were 3 femoral neck fractures, 2 loose femoral components, 2 loose acetabular components, and 1 loose femoral component that developed a deep infection after revision. Each case was revised through a posterolateral approach using the implant of the surgeon's choice (Table I). All patients underwent revision of the femoral side; only 3 underwent revision of the acetabulum. The revision that developed an infection after revision was excluded from the postoperative analysis.

Control Group

We selected the first 50 consecutive surface replacements that did not require a revision in our series as control patients after performing an a priori power analysis based on a 5-predictor model (α, 0.05; anticipated effect size,

Table I. Clinical Data of 7 Revisions of Metal-on-Metal Hip Resurfacing Arthroplasties

Sex (y)	Age	Time to Revision (mo)	Type of Failure	Angle (°) Neck Shaft	Angle (°) Neck Stem	Pollard Class	Revision Implant Used[a]
M	56.2	19.1	Femoral component loosening	145	135	2	Zimmer VerSys tapered stem/Trilogy acetabulum
M	42.8	14.3	Femoral neck fracture	141	141	3	Wright Conserve total femoral stem
F	45.8	16.6	Acetabular component loosening	145	145	0	Zimmer VerSys tapered stem/Trilogy acetabulum
M	49.0	12.2	Femoral component loosening	145	145	2	Wright Conserve total femoral stem
F	37.7	26.8	Acetabular component loosening	150	150	3	Zimmer VerSys tapered stem/Trilogy acetabulum
M	53.8	8	Femoral neck fracture	137	138	1[a]	Wright Perfecta stem/Conserve head
M	56.2	19.1	Femoral neck fracture	144	143	2	Wright Perfecta stem/Conserve head

[a]Zimmer (Warsaw, Ind), Wright Medical Technology (Arlington, Tenn).

Table II. Preoperative Clinical Features of Revision and Control Groups

Feature	Group: Revision	Group: Control
Patients, n	8	50
Mean age, y	49.6	50.4
Females, n (%)	2 (25)	17 (34)
Follow-up, mo (range)	51 (41-67)	43.8 (24-67)
Diagnoses, n (%)		
Osteoarthritis	6 (75)	42 (84)
Osteonecrosis	1 (12.5)	1 (2)
Posttraumatic arthritis	0	2 (4)
Hip dysplasia	1 (12.5)	5 (10)
Body mass index	28.2	28.3
Mean time to revision (mo)	13.5	Not applicable

0.35; statistical power, 0.8), which suggested that a minimum sample of 42 controls would be adequate to determine significant differences between groups.

Clinical Evaluation

Pain and functional outcomes were evaluated with Harris Hip Scores (HHS)[21] and Short Form 12 (SF-12) questionnaire scores.[22] Results were obtained before surgery and then annually or at each follow-up visit. All postoperative pain and functional outcomes evaluations for the revision group were performed after revision.

Radiographic Evaluation

All patients' radiographs were retrospectively evaluated. For each patient, anteroposterior (AP) and cross-table lateral radiographs were obtained at each clinical visit. AP neck-shaft angles (Figure 1), AP stem-shaft angles (Figure 2), lateral neck-shaft angles, lateral stem-shaft angles, and acetabular cup inclination were recorded at each visit. We defined AP neck divergence as the difference between the neck-shaft angle and the stem-shaft angle in the AP plane, lateral neck divergence as the difference between the neck-shaft angle and the stem-shaft angle on the lateral view, and cup divergence defined as the difference between acetabular cup inclination and 40° of abduction. Radiologic appearance in the revision group was classified according to the method of Pollard.[23]

Statistical Analysis

Unpaired, 2-tailed Student t tests were used to compare variables between the 2 study groups; a paired Student *t* test was used within groups. All Ps under .05 were considered significant. In addition, a multivariate analysis was used to correlate various demographic factors, such as body mass index, age, and sex.

Results

Mean follow-up periods were 51 months (range, 33-61 months) for the revision group and 48 months (range, 29-71 months) for the control group. There was no difference in sex, diagnosis, body mass index, or age between the 2 groups ($P<1.0$) (Table II).

Outcome Measures

There were no significant preoperative differences between the 2 groups with respect to overall HHS, its Functional component, or the SF-12 Physical and Mental components. However, both groups made significant improvements with respect to postoperative overall HHS and its Functional component, and both groups made postoperative SF-12 improvements, but these were not significantly different between groups (Table III).

Radiographic Outcomes

Mean AP neck-shaft angles were 148.8° (revision group) and 138.5° (control group) ($P<.03$). AP stem-shaft and cup-inclination angles were not significantly different

Table III. Summary of Clinical Findings: Index Surgery Scores for Both Groups

Score	Group: Revision	Group: Control	*P*<
Harris Hip Score			
Preoperative	58.4	54.3	.54
Follow-up	91.4	96.2	.65
P<	.001	.0001	
Functional score			
Preoperative	30.2	32.2	.53
Follow-up	42.6	45.2	.32
P<	.00035	.0001	
SF-12 Physical component			
Preoperative	45	44.3	.56
Follow-up	56.53	51.6	.32
P<	.73	1.0	
SF-12 Mental component			
Preoperative	55.8	52.9	.47
Follow-up	56.5	50.1	.56
P<	.86	1.0	

Abbreviation: SF-12, Short Form 12 questionnaire.

Table IV. Summary of Radiographic Findings

Angle	Group Revision	Control	*P*
Neck shaft (°)	143.8	138.5	<.03
Stem shaft (°)	142.3	138.9	<.21
Cup inclination (°)	38.8	43.2	.194

between the revision and control groups. These findings are summarized in Table IV.

Complications

There were no perioperative mortalities and no hip dislocations in either group. The control group had 5 cases of heterotopic ossification, all less than Brooker grade II. At last follow-up, there was no significant heterotopic ossification in the revision group. As already stated, 1 patient in the revision group developed a deep infection after revision—leading to implant removal—and was excluded from the analysis.

Discussion

MOM hip resurfacing is becoming an increasingly popular option for young patients, for whom THA has been associated with early failure.[23] Current-generation MOM hip resurfacing arthroplasties have been theorized to be superior to past-generation hip resurfacing implants, which fell out of favor because of acetabular wear, component loosening, and femoral fracture.[23] The continuing concern with modern resurfacing implants is their failure—with aseptic loosening of the femoral component and femoral neck fracture being the most common mechanisms—and need for revision. This study supports the finding that clinical outcomes after revision of a hip resurfacing arthroplasty to a THA are similar to those after a primary hip resurfacing arthroplasty.

One benefit of hip resurfacing is that, should it fail, revision surgery is feasible. Ball and colleagues[12] showed that conversion of hip resurfacing to THA is similar to primary THA with respect to operative time and blood loss. They found that clinical results as measured by hip scores and quality-of-life scores suggest that good to excellent results may be achieved in the short term. Our investigation supports the revisability of aseptic failure of hip resurfacing, as these patients did as well as their unrevised peers with respect to HHS and SF-12 scores and suffered no dislocations. The anatomy of the proximal part of the femur is also largely maintained after hip resurfacing.[8] Thus, conversion to THA after failed hip resurfacing is likely to be similar to a primary THA—a finding supported by the clinical outcomes of this study. This is in contrast to patients who require revision THA, for which dislocation and aseptic loosening rates can be higher and the procedure itself more technically demanding.[13,24] Failure of the surface replacement nevertheless requires additional surgery. With the revision rate being higher for hip resurfacing than for conventional THA, the inherent risks of revision surgery, such as increased rate of infection, including 1 in 8 in this study, need to be considered.[25]

Table V. Radiographic Difference Between Mean Neck and Stem Angles

Divergence	Group Revision	Control	Difference	*P*<
Cup (°)	1.17	3.2	2.03	.23
Anteroposterior neck (°)	1.8	2.28	0.48	.81
Lateral neck (°)	3.2	3.1	0.1	.96
Combined (°)	5	5.38	0.38	.89

Beaule and colleagues[18] showed that patients who had an adverse outcome in surface arthroplasty of the hip were more likely than the control cohort to have a varus stem-shaft angle. Others have shown that valgus orientation may be biomechanically favorable with respect to fracture resistance in patients with normal bone mineral density.[26] However, correlation with preoperative neck-shaft angle was not addressed in either of these studies. Our review of radiographic parameters in our patients with aseptic failure showed that preoperative valgus neck-shaft angle was significantly associated with need for revision (Table IV). Excessive valgus orientation of the femoral component or poor technique can result in notching of the femoral neck, which has been implicated in fracture.[5,10,26,27] None of the patients in our revision group, however, showed radiographic evidence of notching. The radiographic findings in our study are consistent with what has been suggested in the literature—that orientation of the femur and the components placed play a large role in implant survival.[28,29] Further work should be done to better elucidate how the anatomy of the femur, specifically a valgus neck and standardized measurements in the sagittal plane, may predispose select patients to failure after hip resurfacing.

Reported rates of revision after hip resurfacing are 3% or less.[1,5,11] Our experience with this procedure demonstrated an overall revision rate of 8.7%. Interestingly, 6 of the 8 cases that were eventually revised were performed during our first year of experience. This finding suggests that, as with other procedures, there may be a steep learning curve associated with successful outcomes in hip resurfacing.[30,31] In addition, there may be an obligatory early failure rate given the nature of surface replacement, which retains the femoral neck and allows for a limited area of fixation.

The accuracy of implant placement has been a source of considerable research in hip resurfacing.[32-34] In our study, implant placement was on average within accepted parameters (Table V). Furthermore, radiographic divergence was within the measuring error of radiographs about the hip.[35] This suggests that component position was successful and equivalent between the revision and control groups; the cause of failure remains unclear.

Limitations of this study are its retrospective design, length of follow-up, and small sample size. Length of follow-up was unavoidable, given that these cases were initiated in 2002. Long-term outcome studies should be performed to fully assess the effects of revision surgery in young, active patients who have undergone hip resurfacing. The small number of revisions (8) reflects the overall failure rate and the learning curve of this procedure. The 1 patient who developed an infection after revision was excluded from outcomes analysis. Development of infection after revision is consistent with the increased rate of infection in revision THA. Infection continues to cause poor outcomes and failure of surgical interventions and should not be minimized when discussing treatment options with patients who have hip arthritis or require revision surgery.[36-38]

Conclusions

Conversion of hip resurfacing arthroplasty to THA for aseptic failure will have clinical outcomes similar to those of uncomplicated hip resurfacing. Moreover, this study showed a significant association between valgus alignment of the femoral component among failed hip resurfacing in this series. These factors may need to be considered in patient selection.

Authors' Disclosure Statement

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Commentary

Wera and colleagues have demonstrated several important points regarding the adoption of modern metal-on-metal hip resurfacing. First of all, it is notable that the failure rate in the short- to mid-term (mean of 51 months) is quite high (8 of 92, or 8.7%), indicating the presence of a learning curve. The failures included 3 femoral neck fractures, 3 femoral loosenings, and 2 acetabular loosenings. The learning curve is not only technique oriented but involves understanding and refining patient selection.

Hip resurfacing continues to evolve with a greater insight of the factors that may influence outcomes (eg, gender, diagnosis, radiographic parameters). Through scientific studies examining the role of patient factors, we have begun to realize the importance of implant size, patient gender, and preoperative diagnosis.

Secondly, the study was able to identify that a preoperative valgus neck-shaft angle has a significant association with the need for revision; although it is unknown why this may be, I suspect that this may be a surrogate measure for other factors.

It is through studies such as this one that we will continue to advance our knowledge of parameters that predict favorable results. Fortunately, Wera and colleagues have demonstrated that those patients who underwent revisions of failed resurfacing had outcomes equivalent to those of patients who had primary hip resurfacings, achieving an important: the goal of "not burning any bridges."

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