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Femoral Revision in Hip Resurfacing Compared With Large-Bearing Metal-on-Metal Hip Arthroplasty

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Abstract: It has been suggested that revision of the femoral component of hip resurfacing after femoral failure would be straightforward and have an outcome comparable to primary total hip arthroplasty (THA). We have compared the outcome of femoral side–only revision resurfacings to the results of primary modular large-bearing metal-on-metal THA. Fourteen consecutive patients underwent revision surgery of the failed femoral component, to a cemented tapered stem (CPT, Zimmer, Warsaw, Indiana) with a large modular metal head (Smith and Nephew Orthopaedics Ltd, Memphis, Tennessee, or Adept, Finsbury Orthopaedics, Surrey, England). The acetabular component was found to be well fixed, well orientated, and was left in situ. The 14 matched patients in the primary THA group received the same components. At a mean follow-up of 49 months (range, 30-60 months), clinical outcome measured using the Oxford and Harris Hip Scores showed no significant difference ($P = .11$, $P = .45$, respectively). Operative time and blood loss were comparable for both groups. We conclude that revision of the failed femoral resurfacing component gives excellent results. **Keywords:** failed hip resurfacing, metal-on-metal bearing, revision surgery, hip arthroplasty.

In the last 10 years, hip resurfacing has become a popular option for the treatment of younger patients with hip osteoarthritis. Medium-term follow-up has shown that the modern bearings are more successful than previous generations of resurfacing implants, probably due to improvements in design and manufacturing [1-3].

The suggested advantages of hip resurfacing arthroplasty are femoral bone conservation, increased stability, and reproduction of anatomic hip biomechanics [4]. However, unique complications of the hip resurfacing arthroplasty are femoral neck fracture, avascular necrosis of the femoral head, and femoral neck bone resorption. If any of these occurs, hip resurfacing offers the possibility of a theoretically "straightforward" femoral revision. As the femoral canal is not violated during the resurfacing procedure, it is postulated that the outcome of revision surgery should be equivalent to that of a primary hip arthroplasty [5].In 2003, large modular metal-on-metal (MoM) heads (Smith and Nephew, Memphis, Tennessee) became available. Therefore in the event of femoral resurfacing component failure, the acetabular component could be retained and a standard femoral stem inserted creating a hybrid large-bearing MoM total hip arthroplasty (THA; see Figs. 1 and 2). The aim of this study was to investigate whether femoral revision using these components was as successful as if the same components were used in primary hip arthroplasty.

Patients and Methods

The senior author (JML) performed 529 MoM hip resurfacings (Birmingham Hip Resurfacing arthroplasty, Smith and Nephew Orthopaedics Ltd, or Adept,

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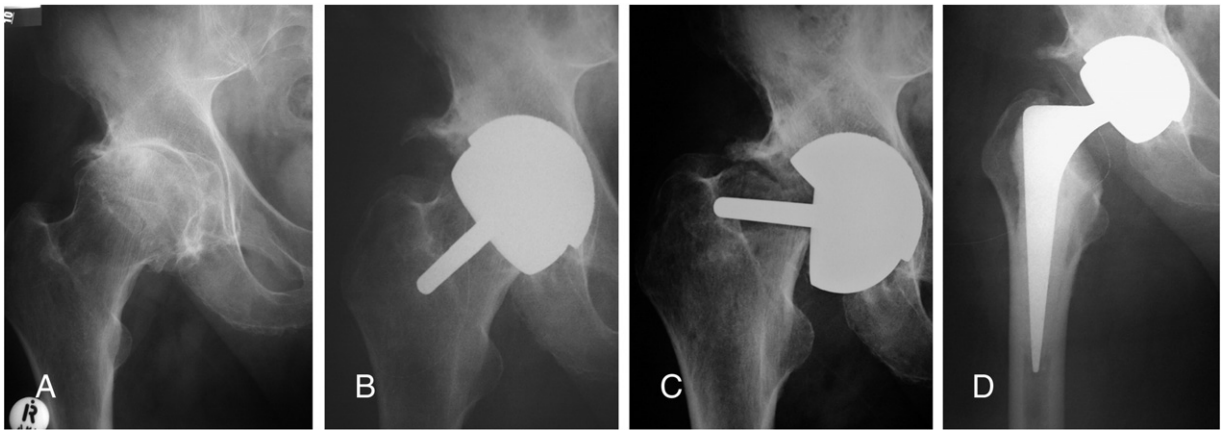

Fig. 1. Revision of failed resurfacing. (A) Preoperative radiograph demonstrating osteoarthritis. (B) Postoperative hip resurfacing. (C) Failure of the femoral component after fractured femoral neck. (D) Postoperative radiographs after revision to hybrid THR.

Finsbury Orthopaedics, Leatherhead, UK) between December 1998 and September 2006. All of these components were manufactured by Finsbury Orthopaedics and have the same articulating geometry and clearance. The indications for their use were the same, as was the operative technique.

Of these, 22 hips (4.16%) in total have been revised. The reasons for revision are as follows: 3 deep infections, 2 cup failures, 1 cobalt chrome metal allergy, and 16 femoral component failures. The causes of femoral component failure were as follows: 8 femoral neck fractures (2 following trauma), 3 cases of significant femoral neck resorption (2 with associated fracture and 1 with pain), and 3 cases of avascular necrosis (1 associated with a fracture and 2 femoral component migrations). Fourteen of these 16 patients underwent revision surgery after November 2003, when the large modular metal heads became available for use (see Table 1). The other 2 patients required revision prior to November 2003 and therefore underwent revision of both the femoral and acetabular side to a hybrid THR with a metal/polyethylene bearing.

Fig. 2. Four-year follow-up radiograph.

The Revision Group

The revision group consisted of 10 males and 4 females. The mean age at the time of revision was 60 years (48-69 years). The mean time from the resurfacing to revision was 15.6 months (range, 1-38 months). However, the mean time to revision in females was 29 months (range, 12-38 months) and in males it was 10.1 months (range, 1-34 months). See Table 1 for patient demographics.

Surgical technique. The patient was positioned in the lateral decubitus position and a standard posterior approach to the hip was carried out using the previous incision. Multiple specimens were taken for bacteriology after which intravenous antibiotics were administered. The femoral component was removed without any difficulty and a standard neck cut using a bone saw was made. The acetabular component was found to be well fixed with an acceptable abduction angle [6] and no metallic wear was apparent on the bearing surface in

Table 1. Patient Demographics

	Primary THA Group	Revision Group	*P* Value
Age	60.1 (53-68)	60.2 (53-69)	.97
Male/female	10:4	10:4	
Time to revision	N/A	15.6 (1-38)	
Indication for surgery	10 Osteoarthritis	7 Femoral neck fracture	
	4 Avascular necrosis	2 Avascular necrosis	
	2Femoral component migration		
	3 Femoral neck resorption		
Head diameter	46.6 (42-54)	46.3 (42-54)	.85
Outer cup diameter	54 (48-62)	53.3 (48-62)	.66

Mean (range).

all cases and was therefore left in situ. The femoral shaft was prepared in the usual manner and a CPT stem (Zimmer, Warsaw, Indiana) was inserted using contemporary cementing techniques. The modular large metal head corresponding to the acetabular inner diameter was selected with the appropriate neck length for stability and leg length. The wound was washed with chlorhexidine using pulse lavage and closed in layers over a suction drain.

Intraoperative blood loss was calculated by measuring volumes of blood from the suction devices and the weighting of swabs. Operative time was also recorded.

Matched Control

The revision group was matched with a cohort of 14 patients from a pool of 150 who had undergone a hybrid THA, using the same large MoM bearing as a primary procedure, during the same period. The senior author offers this alternative procedure to patients who are deemed not to be suitable for hip resurfacing, usually because of age and lack of adequate bone stock in the femoral head. The patients were matched for age, sex, and preoperative Oxford and Harris Hip Scores. The primary group consisted of 14 patients (10 men, 4 women), with mean age of 60 years (range, 49-68 years).

The THA was carried out through a standard posterior approach. The femoral components were inserted as described in the revision group.

All patients in both groups were assessed clinically by 3 of the authors (SG, BB, and JML) and their outcomes recorded using the Oxford [7] and Harris Hip Scores [8] preoperative and postoperatively and any complications were noted.

An anteroposterior plain radiograph of the pelvis and a horizontal-beam lateral view of the hip were obtained and radiological assessment was performed by 2 of the authors (SG, BB). We noted any radiolucent lines measuring more than 1 mm around the acetabular component in the zones of DeLee and Charnley [9]. Femoral radiolucent lines were analyzed as described by Gruen et al [10]. A radiolucent line was recorded only if it occupied at least 50% of the zone.

The radiographs of the pelvis and affected hip were also studied to assess cup, femoral, and total offset as described by Jolles et al [11] as well as the acetabular abduction angle. The femoral offset represents the perpendicular distance from the femoral axis to the center of rotation of the femoral head. The cup offset is the distance from the medial border of the teardrop to the center of rotation of the acetabulum which corresponds to the center of rotation of the femoral head, parallel to Hilgenreiner's line. Total offset was defined as the sum of the femoral and acetabular offsets.

Intra-observer variation was determined from 10 randomly selected sets of radiographs measured initially and after several weeks by 2 of the authors (SG, BB). Interobserver variability was determined using the same 10 radiographs, assessed independently and analyzed by the Pearson correlation coefficient. Scores between 0.61 and 0.80 represented good and those greater than 0.81 excellent correlation.

Statistical analysis

Analysis of the outcome scores was performed using the statistical software packages SPSS version 15.0 (SPSS, Inc, Chicago, Illinois). A 2-sample *t* test was used and a *P* value ≤.05 was taken to be statistically significant. The radiological measurements were compared with a paired *t* test and a *P* value ≤.05 was taken to be statistically significant. The revision and the primary group were compared by a ratio of the postoperative measurements divided by the control measurements using an unpaired *t* test.

Results

The mean length of follow-up following revision was 49 months (range, 30-60 months) and 48 months (range, 36-58 months) in the primary group.

Outcome measures

No statistical significant difference in Oxford and Harris Hip Scores was found between the revision group and the primary group both preoperatively and postoperatively (see Table 2).

Intraoperative

The mean blood loss was 412 mL (300-700 mL) in the revision group and 370 mL (300-500 mL) in the primary group ($P = .36$). There was a significant difference in mean operative time between the groups ($P < .05$), with a mean of 67 minutes (48-80 minutes) in the revision group and 77 minutes (60-90 minutes) in the primary group. No intraoperative technical difficulties were experienced during surgery in either group.

Complications

Three patients (2 femoral migrations and 1 early fracture) reported that the resurfacing had never "felt right" and all symptoms had resolved following revision.

There were no significant intraoperative or postoperative complications. Three patients in the revision group initially complained of clicking which settled, and 1 of squeaking, which had been present since resurfacing

Table 2. Clinical Outcome Scores

	Oxford Score	Harris Hip Score
Primary group—Preoperative	46 (33-57)	32.3 (14.1-48.4)
Revision group—Pre BHR	42 (33-50)	34.1 (17.7-41)
P Value	0.22	0.64
Primary group—Postoperative	18.1 (12-27)	93.2 (85.3-100)
Revision group—Postoperative	17.8 (12-23)	91(83.2-100)
P Value	0.89	0.46

BHR, Birmingham Hip Resurfacing.

Table 3. Mean (Range) Offset Measurements (cm)

	Cup Offset	Femoral Offset	Total Offset
Pre-resurfacing	3.99 (3.4-4.3)	4.80 (4-5.1)	8.79 (7.4-9.3)
Post-resurfacing	4.02 (3.6-4.4)	4.72 (3.6-5.2)	8.74 (7.2-9.3)
Post BHR revision	4.02 (3.6-4.4)	4.81 (4.2-5.3)	8.84 (8.1-9.5)
Pre-THR	3.94 (3.5-4.4)	4.83 (4.1-5.9)	8.70 (7.3-9.2)
Post-THR	3.90 (3.0-4.3)	4.86 (4.1-5.8)	8.76 (7.4-9.5)

that continued despite revision. One patient experienced trochanteric pain, which had also been present since the resurfacing, but has required no further intervention. One patient had Brooker grade 2 heterotopic ossification [12], but is now symptom free. Within the primary group, there were no significant intraoperative or postoperative complications either. Two patients noted several episodes of squeaking which resolved, and one patient noted a clunking sensation especially when standing from a sitting position.

Radiographic Analysis

Interobserver and intra-observer variability was good or excellent in all measurements. The total offset was initially decreased following the resurfacing and then increased following revision (neither was significant, $P = .28$ and $P = .56$, respectively). After primary THA the total offset increased; however, the results were not statistically significant ($P = .65$; see Table 3). The mean acetabular abduction angle was 44.8° (37°-55°) in the revision group and 45.5° (37°-60°) in the primary group. This was not a significant difference ($P = .77$).

No lysis or signs of loosening were seen around any of the femoral or acetabular components.

Discussion

In the event of failure of the resurfacing femoral component, options for treatment depend on the mode of failure. Cossey et al [13] and Cumming et al [14] reported the successful treatment of acute, undisplaced femoral neck fractures after hip resurfacing with a period non–weight bearing alone. Sherman et al [15] in 1989 described the removal of all components in the event of loosening of an older design of resurfacing, with preservation of the femoral stump for articulation with the native acetabulum in 5 patients. Four patients in this series had a "satisfactory" outcome; however, the one patient who sustained a femoral neck fracture had a poor outcome. Patients with displaced fractures, femoral head/neck resorption, avascular necrosis, and significant femoral component migration can be treated with either conversion to a THA, with revision of both components, or revision of the femoral component, mating the modular femoral heads with the acetabulum (as in our series).

Capello et al [16] reported 23 cases of failure of "second-generation" hip resurfacings. Twenty-two were the Indiana conservative hip (Depuy, Warsaw, Ind) and 1 was a Wagner hip (Aesculap-Werke, Tullinger, West Germany). However, the majority of these failures involved acetabular component failure often with significant osteolysis, making the revisions much more complicated. Only one hip in this series was salvaged by the use of a compatible femoral stem without the need for acetabular revision. The clinical results following revision to a THA from the older generation resurfacings were nonetheless encouraging if compared to a revision of a stemmed hip arthroplasty. Bradley and Freeman [17] also reported good results after the revision of 28 failed ICLH resurfacings (Imperial College-London Hospital, London, UK) hip, and it was concluded that the results appeared to be better than those of revising a stemmed femoral prosthesis. One other article has recently been published addressing this issue in the "third-generation" hip resurfacings. Ball et al [5] reported their results of conversion of 21 failed Conserve Plus resurfacings (Wright Medical Technology, Inc., Arlington, Tenn), 18 of which were converted for isolated femoral failure. These were compared to a control group consisting of a mixed group of conventional hip arthroplasties. Complication rates were high in both groups, including 4 femoral nerve palsies, 3 femoral fractures, 1 deep infection, and an operative time of nearly 3 hours in both cohorts. This clearly compares poorly to our series and may not compare to a UK practice; however, it does seem to confirm that revision of a failed resurfacing is comparable to a conventional hip arthroplasty.

At present, we have had a low failure rate of primary hip resurfacing that is comparable to other published series [3,18-20]. Our results show that revision of the failed femoral component to stemmed prosthesis with a compatible large metal head gives excellent results, which are indeed comparable to a primary THA using the same bearing.

We acknowledge that our study has 2 main weaknesses. The numbers are small and a larger series could possibly identify a difference between the groups; however, we have fortunately not had any further femoral failures. The follow-up is still relatively short; however, this is unavoidable as the large modular metal heads only became available for our use in 2003. We could have included all the authors' resurfacing revisions that occurred prior to 2003 in this study, therefore increasing length of follow-up and numbers; however, we aimed to compare a MoM THR and a MoM THR that comes about through revision of the resurfacing femoral component. This direct comparison can therefore only be made if the end implant is the same.

On radiographic analysis, total offset was reduced after resurfacing but increased by revision to THA. Cup offset was increased after resurfacing and therefore also after revision, as this remained in situ. An increase in femoral offset by revision to a femoral stem led to an increase in the total offset. This is essentially the same finding as Loughead et al [21] who compared the offset in

Birmingham Hip Resurfacing and hybrid THA. They reported a decreased offset after resurfacing but an increase in cup offset. In their THA group, cup offset was decreased but femoral offset was maintained.

We conclude that revision of hip resurfacing to a hybrid THA with a MoM bearing is easy to perform and has given early to mid-term results which are comparable to those obtained after primary large-bearing THA. Clinicians are therefore justified in pursuing this method of management in cases of femoral revision in hip resurfacing, provided the original acetabular component is well fixed, well orientated, and wear free.

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