

The Influence of Age and Sex on Early Clinical Results After Hip Resurfacing

An Independent Center Analysis

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Abstract: Patient selection is critical to the excellent medium-term clinical results after hip resurfacing. We assessed the influence of age and sex on early survivorship and functional outcome by comparing 100 female hips resurfaced with male hips resurfaced for the same period. In patients older than 55 years, Harris hip score improved to 97.4 in males compared with 91.2 ($P < .01$) in females with a revision rate of 2.2% and 7.4%, respectively. There was no correlation between age and functional score. Three percent of females and 1.3% of males sustained a femoral neck fracture. Hip resurfacing provides excellent early functional recovery in males and females. However, the revision rate in older females is high. Changes to surgical technique may minimize the risk of early failure in this group. **Key words:** hip resurfacing, metal-on-metal.

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Total hip arthroplasty (THA) is a successful operation for middle to late age with more than 90% to 95% survival rates at 10 years [1,2]. Implant survival after THA in younger patients is lower [1,2]. Despite high-wear characteristics with earlier generations, metal-on-metal (MonM) hip resurfacing has become popular for the treatment of younger patients [3]. Resurfacing is recommended for active people who would otherwise receive a conventional THA but who are likely to outlive all currently available THA implants [4].

The advantages of hip resurfacing over THA include proximal femoral bone preservation, optimization of stress

transfer to the proximal femur and reproduction of normal hip biomechanics, greater implant stability, and perceived ease of revision [5,6]. Clinical function is thought to be better with a large femoral head [7] and patients report less limp [8]. Large diameter bearings also reduce the risk of dislocation, with reports of less than 1% [9]. Medium-term results are encouraging, with 94.4% to 99.8% survivorship at 2 to 6 years for the treatment of young patients [10-12]. In a retrospective age and sex-matched series, resurfaced patients had significantly better activity levels and quality of life than THA patients [13].

The ideal candidate for hip resurfacing is a young active male with normal proximal femoral bone geometry and quality. Absolute contraindications include elderly patients with osteoporotic bone and impaired renal function [6]. Patient selection appears to be critical to the success of these implants. Most patients who undergo THA are female, in all age groups [1]. However, female numbers are low in the published resurfacing literature (21%-27%) [10-12].

Fractured femoral neck is the most common complication of resurfacing with reported rates of 0% to 6% [10-15]. Concerns regarding female hip resurfacing have focused on the risk of fracture as a result of poorer bone density. Some groups suggest a lower age ceiling for

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female resurfacing [11]. Beaulé et al [16] showed that females may be at higher risk of early failure.

The influence of age and sex on clinical outcome and survivorship after hip resurfacing is still not clear. With the exception of Siebel et al [14], who compared early revision rates, to our knowledge there are no reported comparisons of hip resurfacing in males and females. Much of the resurfacing literature principally documents the outcome and survival of young men. Ng et al [17] showed that females have significantly lower functional scores after THA when compared with men. This study aims to give a clearer picture of the effects of age and sex on outcome after hip resurfacing.

Materials and Methods

Between April 2004 and January 2007, the first 254 consecutive hips in 231 patients were resurfaced by the senior surgeon (AVFN) at an independent center. AVFN is an experienced hip resurfacing surgeon with a previous series of more than 150 Birmingham hip resurfacings (BHR).

All patients were followed up prospectively. The mean age at the time of surgery was 56 years (range, 28-74 years). There were 154 male and 100 female hips. Mean follow-up time was 28 months (range, 12-45 months). The diagnosis was primary osteoarthritis in 164 patients (67%). There was no history of osteoporosis or renal failure in this cohort. Patient demographics, diagnosis, American Society of Anesthesiologists (ASA) grade, and Charnley walking grade were recorded.

There was no specific selection criteria, but young and active patients with end-stage primary and secondary osteoarthritis were considered for resurfacing. Bone quality was assessed radiographically, and patients offered a resurfacing were told that a final decision on the type of implant (resurfacing or THA) would be made based on the intraoperative findings. Large cysts and avascular necrosis of the femoral head were not contraindications. Patients were not routinely scanned for osteoporosis. No patients reported previous metal sensitivity reactions.

The articular surface replacement (ASR) resurfacing prosthesis (Depuy International Ltd, Leeds, United Kingdom) was used for the duration of the study. Design changes over earlier designs (such as the BHR) include a lower radial clearance to reduce wear and a shallower cup to preserve acetabular bone stock [18]. Early outcome data from the inventors' series of 300 has been reported [14]. The design of the prosthesis and the surgical technique did not change throughout the study period.

At the time the patient was listed for theater and during the consenting process, patients were made aware of the limited knowledge regarding the implant and the results of contemporary MonM articulations. Potential problems and theoretical risks associated with metal ions were discussed. Femoral neck fracture was quoted as 1.5% to 2%. All patients agreed to long-term clinical and radiologic follow-up.

All procedures were performed by the senior author. Patients were given a second generation cephalosporin antibiotic perioperatively and 2 further doses postoperatively as a prophylactic measure. Ten patients had bilateral simultaneous resurfacings. All other patients underwent a unilateral resurfacing procedure. The posterior approach was used. The external rotators were detached. In all cases, the acetabular component was implanted first with a press fit by underreaming the acetabulum by 1 mm, according to manufacturer's recommendations. The femoral head was sized according to neck diameter and then carefully reamed to avoid neck notching. The femoral head was then prepared. Any cysts were curettaged and grafted (using reamed bone), and the head cleaned with jet lavage. Low-viscosity vacuum-mixed cement was poured into the femoral component that was then firmly tapped onto the reamed femoral head. The head was then reduced, and the external rotators reattached. The wound was closed in layers without a drain.

To reduce the risk of a thromboembolic event, patients were given calf pumps during their inpatient stay and compression stockings from the day of surgery for 6 weeks. High-risk patients were given subcutaneous low-molecular-weight heparin for 6 weeks, as per hospital guidelines. Postoperatively, patients were allowed to fully weight bear immediately unless there was an intraoperative concern. For example, in patients with large cysts or if the femoral neck was notched, touch weight bearing was advised for 6 weeks. All patients were told to avoid high-impact sports such as jogging, tennis, and squash for 6 months. After this period, all restrictions were lifted.

Clinical assessment was made preoperatively and at 1 year postoperatively using the Harris hip score (HHS) and the University of California Los Angeles (UCLA) activity score. Hips revised before the 1 year review were excluded from postoperative functional assessment. At follow-up, patients were also asked to rate their satisfaction with the procedure (numerical scale 0-4). Patients scoring 3 or 4 were deemed "highly satisfied." Complications were recorded. Acetabular inclination angle was measured on postoperative radiographs.

Patients were divided into 4 groups based on age (≤ 55 and >55 years) and sex. Of the younger patients, 45 hips were female and 59 were male. The older groups consisted of 55 females and 95 males (Table 1).

The Mann-Whitney *U* test and analysis of variance testing was used to calculate differences between groups. Spearman rank correlation coefficients between HHS and various clinical parameters were calculated. Kaplan-Meier implant survivorship was plotted for each group. All analyses were performed by the SSPS for Windows (version 16.0) statistical package (SSPS Inc, Chicago, Ill).

Results

There were no patients lost to follow-up, and there were no deaths. Hips of 8 patients have been revised

Table 1. Demographic and Outcome Data

	Mean age (range), (y)	N	Fails	Mean follow-up (range), (mo)	Median Femoral Head (mm)	Mean BMI (kg/m ²)	Osteoarthritis (%)	Mean ASA Grade	Charnley Grade A (n [%])	Mean Preoperative HHS	Mean Postoperative HHS	Mean Increase in HHS	Mean Preoperative UCLA	Mean Postoperative UCLA	Highly Satisfied (%)
Young females	48 (28-55)	45	2	27 (12-45)	46	28.6	60	1.4	16 (36)	45.0	95.6	47.9	4.0	6.9	36/44 (82)
Young males	48 (31-55)	59	0	31 (12-45)	51	26.5	63	1.4	26 (48)	51.2	96.4	41.0	4.0	7.9	59/59 (100)
Older females	60 (55-69)	55	4	27 (12-45)	46	26.4	72	1.6	25 (46)	48.6	91.2	48.9	3.2	6.3	43/51 (84)
Older males	62 (55-76)	95	2	30 (12-45)	51	27.4	71	1.7	32 (35)	55.9	97.4	41.4	4.2	7.5	90/93 (97)

(3.3%). Five patients sustained femoral neck fractures (2.0%). Hips of 3 patients were revised for persisting severe pain (1.2%). There was one deep wound infection that was successfully treated with a wound debridement and intravenous antibiotics. There were no known thromboembolic events.

At 1 year review, overall mean HHS for males was 97.0 and for females, 90.7. Mean acetabular inclination angle in males was 47.4° and in females, 48.9° (overall, 48.0°; range, 31°-63°).

Harris hip score in young males was 96.4, and UCLA activity score was 7.9. There was a 100% implant survival rate (Fig. 1). All patients reported high satisfaction. In the older males, HHS improved to 97.4 and UCLA activity score to 7.5. Ninety-seven percent were highly satisfied. There were 2 femoral neck fractures. One patient was left with a superior neck notch after an intraoperative femoral jig failure. Despite limited weight bearing, he sustained a neck fracture at 3 months postoperatively. The second male had a spontaneous fracture at 12 months. Both were revised before 1 year review.

In young females, mean HHS improved to 95.6 and UCLA activity score to 6.9. There was one spontaneous neck fracture at 12 months. Eighty-two percent were highly satisfied. In the older females, mean HHS was 91.2 and UCLA activity score 6.3 at the 1 year review. Eighty-four percent were highly satisfied. There were 2 spontaneous fractures at 3 and 12 months. The second patient was reviewed at 1 week before their fracture and reported no problems and a HHS of 100. Both patients had a femoral neck notch intraoperatively. Fig. 1 shows a Kaplan-Meier survival plot for the 4 patient groups. Results are summarized in Table 1.

The older female group had significantly lower HHS when compared with the 2 male groups ($P < .01$). However, there were no significant differences between the groups when improvement in HHS was calculated. In all patients, there was no significant correlation between HHS and age ($r = 0.042$; $P = .29$). This was also true when females were analyzed separately ($r = 0.041$; $P = .36$). Young females had a significantly higher body mass index (BMI) than older females ($P = .04$), but there was no significant correlation between HHS and BMI in all females ($r = 0.190$; $P = .08$). Older females had significantly lower preoperative UCLA activity scores compared with males ($P = .01$ for both groups) and significantly lower postoperative scores when compared with all groups (all $P < .05$). There were no significant differences in functional outcome between patients with osteoarthritis and those with other diagnoses ($P = .84$) and between Charnley walking grade A patients and other grades ($P = .22$). Except for sex and implant size (a function of sex), there were no other significant differences in HHS between the groups, and no other significant correlations.

Four patients had a HHS less than 50 at follow-up (all female). One patient was satisfied with the resurfacing but was restricted by bilateral knee osteoarthritis. Hips of the other 3 patients were revised because of persisting severe groin pain. The original indication for resurfacing was

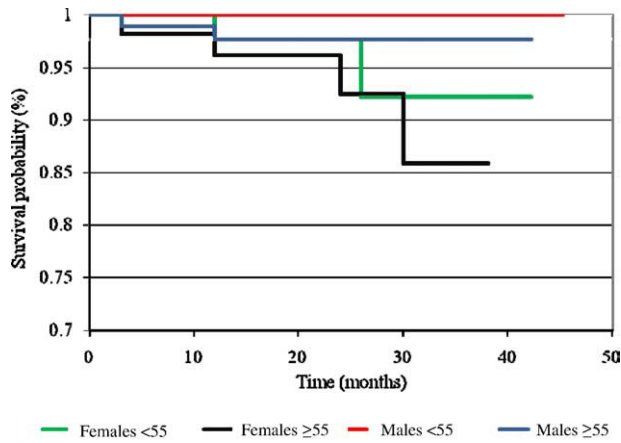


Fig. 1. A Kaplan-Meier survival plot of all groups.

osteoarthritis in all 3 patients. These patients classically improved after surgery but then presented complaining of difficulty in getting into and out of their car and pain restricting flexion beyond 30° on straight leg raise. The first patient was 56 years old with a BMI of 31 kg/m² and an ASA grade of 1. She underwent local anesthetic injection of her psoas tendon for a possible tendonitis, but despite an initial improvement, symptoms subsequently worsened. Hip aspiration was performed to rule out infection. This revealed copious amounts of green-gray colored aseptic fluid. A decision was taken to explore and revise the implant because of possible infection. At revision, there was gross swelling of the pseudocapsule, and a similar green-gray fluid was found surrounding the implant and tracking into the psoas tendon (Fig. 2). The other 2 patients were 36 and 61 years old, both ASA 1, with BMIs of 26 kg/m² and 38 kg/m², respectively. They both had similar findings at aspiration and revision, with varying degrees of tissue necrosis found around the implant. The acetabular cup was found to be loose in one patient, and radiographic review subsequently identified subtle cup migration. Histopathologic analysis of

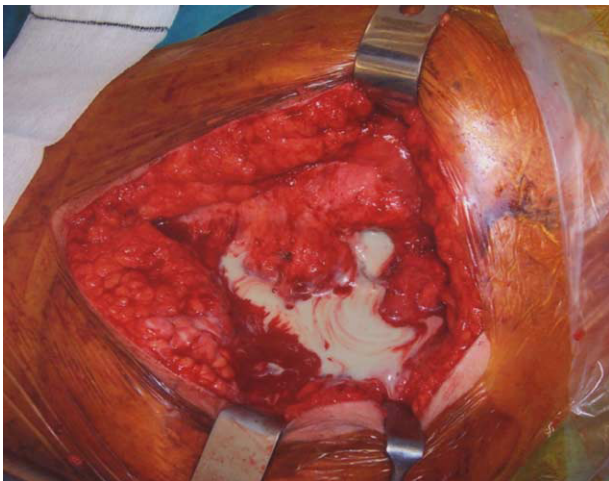


Fig. 2. Aseptic fluid released from the pseudocapsule at revision of the MonM ASR resurfacing implant in patient with ALVAL.

tissue samples from these patients consistently showed tissue necrosis, cuffs of lymphocytes (Fig. 3), and sheets of histiocytes containing large unidentified black particles, probably metal particulate debris. In addition, the tissue from around the loose implant showed high numbers of lymphocytes and vascular tissue ulceration. There were no organisms grown from any of the fluid or tissue samples in any of the patients.

All patients with neck fractures had successful femoral revision to an uncemented THA comprising a modular ASR XL head on an S-ROM (Depuy International Ltd, Leeds, United Kingdom) femoral stem. The acetabular cup was left in situ. Hips of patients revised for pain received a THA with an S-ROM stem and a ceramic Pinnacle (Depuy International Ltd, Leeds, United Kingdom) head and cup. At latest follow-up review, all 3 patients had a HHS greater than 80.

Discussion

Despite lower postoperative HHS and satisfaction scores in females compared with male patients, improvements in functional scores after resurfacing do not significantly differ between the sexes. Ng et al [17] has

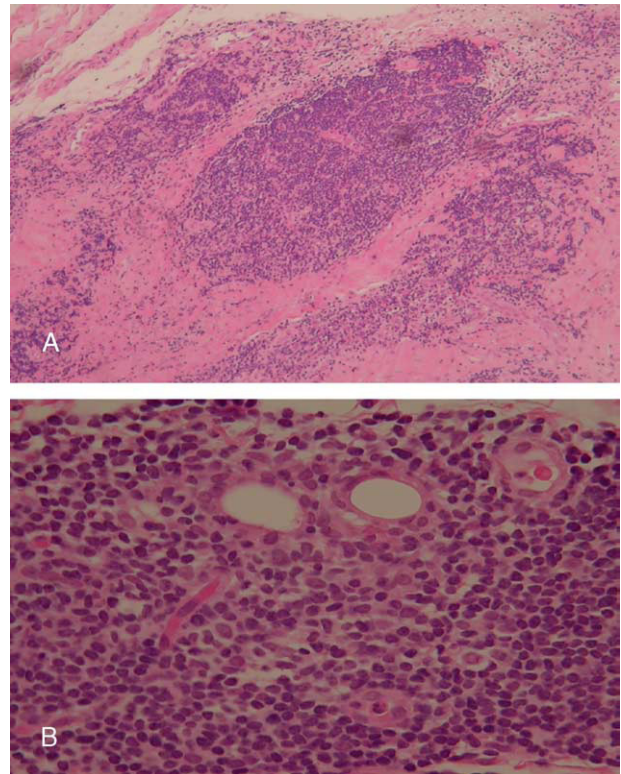


Fig. 3. Photomicrography of tissue samples from revision of a loose MonM ASR (hematoxylin and eosin). A, The thick cuff of perivascular lymphocytes that is typically seen in layer 3 or the vascular layer of neocapsules formed around metal on metal prostheses (×20 magnification). B, Large, dense perivascular cuffs of lymphocytes (×40).

previously reported similar significant differences in postoperative scores after THA. The postoperative HHS in both the male groups was extremely encouraging and justifies its continued use. The results in our male cohort mirrors the published data for hip resurfacing (in which there are only small numbers of females). In 154 hip resurfacings performed on male hips, there were only 2 fractures in the older group and 100% survivorship in the younger group. However, as expected, older females (who have not traditionally been candidates for resurfacing) did have a higher complication rate and lower mean HHS than the other groups. It must be stressed that, despite this, 83% of this group have a good or excellent HHS (>80), and 84% were highly satisfied with the outcome.

There were no statistically significant associations with age, ASA status, Charnley grade, diagnosis, and the functional outcome. Poorer bone quality in the older female patient has been cited as a cause of fracture in this group. In our study, the rate of fracture was 3.6% in the older female group. However, the overall fracture rate was 2.0%. These figures are comparable to reports in the literature from independent units with other resurfacing implants and similar to the inventors' experience of 300 ASRs (1.7%) [14]. Shimmin et al [15] showed that female patients had twice the risk of fracture as males, and notching of the neck was a risk factor for fracture. In 3 cases (of 5 fractures), the neck had been notched at the time of surgery. We question the rationale of continuing with a resurfacing procedure once a notch to the femoral neck has been identified and suggest that surgeons should consider conversion to THA at this point.

Three female patients were revised because of persisting undiagnosed pain. Although an improvement was apparent after treatment of tendonitis in one, this was short-lived. Microbiological analysis of tissue samples was negative. In the 1970s, there was a high incidence of prosthesis failure after implantation with MonM bearings [19]. Obliterative vascular changes, local bone necrosis, and loosening of the metal prosthesis have previously been described around metal implants [20]. More recently, Jacobs and Hallab [21] described an aseptic lymphocyte-dominated, vasculitis-associated lesion (ALVAL) in the tissue around MonM bearings. Characteristic microscopic appearances have been seen around many different MonM implants and may represent a natural reaction to metal wear debris [21]. The histologic changes identified on samples taken from around the loose implant in our series showed ALVAL. The other 2 patients with revised hips had well-fixed cups, and tissue analysis revealed changes similar to ALVAL. These changes may be attributable to high levels of metal wear debris. Running-in wear can produce a gray fluid [22], and this may explain the macroscopic findings, but not pain. It is more likely that symptoms are the result of an excess of inflammatory fluid around the hip joint resulting in tissues stretched under tension.

Are the failures in our group caused by a hypersensitivity reaction to "normal" levels of metal wear particles,

or is this a local reaction to excess metal debris from a high-wear bearing, eventually resulting in osteolysis? The answer to this is not clear. Vendittoli et al [23] analyzed cobalt and chromium levels in patients resurfaced with an implant similar in design to the ASR. Their results showed that inclination of the acetabular component correlated significantly with metal ion levels at 1 year postoperatively. High cup inclination angles result in component malalignment and possibly accelerated wear. An open cup angle of more than 50° has been associated with dramatically elevated metal ion blood levels in patients with MonM bearings [24]. Given the spread of inclination angles seen in the literature (23°-63°), many surgeons may inadvertently place their cups at angles more than 50°. The range of inclination angles was similar in our patients. Inclination angles were 50°, 54°, and 55° in our problem patient group. However, 98 patients had a cup inclination angle greater than 50° without symptoms.

The population studied in this article represents a normal district hospital workload rather than the specially selected patient groups described in much of the resurfacing literature. The senior surgeon was prepared to offer resurfacing to patients who may fall outside the inclusion criteria of specialist centers because of his experience and the perceived benefits. An upper age limit was not set, but the decision to offer resurfacing was based on physiologic age. Moreover, this is a consecutive series of all ages, all diagnoses, and all activity levels included rather than a specific subset of patients from a larger study. To this end, we feel the early results of this new prosthesis are extremely encouraging in male patients. Our fracture rates across all groups are comparable to the published data. However, we have some reservations about resurfacing hips of older females until there is clearer data on risk factors for implant failure. Ultimately, these problems may be technique-specific rather than sex-specific.

Implant survival in the female group may be compromised by inadequate patient selection, inaccurate surgical technique, implant problems, or a combination of these factors. Surgical inexperience and higher failure rates in resurfaced hips of females may explain some disappointing joint register results [25]. Awareness of notched necks and early conversion to THA and further investigations of cup positioning may ultimately reduce the failure rates. Our data help to understand the excellent results published in the literature in principally younger male cohorts. We are committed to long-term follow-up of our patients to enhance our knowledge of these implants, improve our selection process, reduce failure rates, and ultimately perform the most suitable operation for each individual patient.

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