Acta Orthop. Belg., 2015, **81**, 197-208

ORIGINAL STUDY

Efficacy of hip resurfacing arthroplasty : 6 year results from an international multisurgeon prospective cohort study

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Metal-on-metal hip resurfacing is undertaken worldwide. This procedure helps preserve femoral bone stock and allows patients to return to high activity sports. Most outcome studies are individual surgeon case series from single centers where the results and outcomes are evaluated by the same surgeon. One method of increasing the external validity of a follow-up study is to have a multi-centre study design with independent assessment of the outcomes. We present an independent assessment of eleven year follow-up of hip resurfacing outcomes from an international hip resurfacing register. The purpose of this study was to assess : Implant survival at maximum follow-up for revision due to any reason, implant survival at maximum follow-up for revision due to major causes of failure, hip function following hip resurfacing and factors affecting hip function, effect of gender and age on hip function and implant survival, effect of femoral component size on hip function and implant survival. 4535 patients (5000 hips) entered into the registry during 1997-2002 were studied. In summary, at a maximum follow-up of 11 years hip resurfacing has a good implant survival of 96.2% and excellent post-operative function. This is excellent given the international and multisurgeon nature of this cohort where majority of the surgeons were in their learning curve.

Keywords : hip ; arthroplasty ; outcome ; survival ; prosthesis.

INTRODUCTION

Total hip replacement (THR) is one of the most commonly performed orthopaedic operations in the UK (*40*) with similar numbers being operated around the world (*32*).

THR gives a marked improvement in function and the quality of life (*16,36,41,42*). However, THR is also associated with failures due to wear and component loosening which is directly related to patient's life style and age (*14,17,27,48*).

Metal-on-metal hip resurfacing is undertaken in many countries. Unlike total hip replacement where the head and neck of femur are excised, hip resurfacing involves reaming of the femoral head to

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No benefits or funds were received in support of this study.
The authors report no conflict of interests.

receive a short stem femoral head. This procedure helps preserve femoral bone stock and allows patients to return to high activity sports (38). The outcomes of this procedure reported so far have been varied (2,20,53). Most of these studies are individual surgeon case series from single centers where the results and outcomes are evaluated by the same surgeon. Results from such series can have poor external validity i.e. generalization to other centers can be difficult. One method of increasing the external validity of a follow-up study is to have a multi-centre study design with independent assessment of the outcomes. A joint replacement registry can help serve this purpose and we present an independent assessment of eleven year follow-up of hip resurfacing outcomes from an international hip resurfacing register.

The purpose of this study was to assess :

1. Implant survival at maximum follow-up for revision due to any reason.
2. Implant survival at maximum follow-up for revision due to major causes of failure.
3. Hip function following hip resurfacing and factors affecting hip function.
4. Effect of gender and age on hip function and implant survival.
5. Effect of femoral component size on hip function and implant survival.

METHODS

We set up an independent international register for collecting, analyzing and reporting outcomes following hip resurfacing. Between a 11 year period, 4535 patients from 37 different countries were entered into the register by 139 surgeons (BHR International Study Group). All patients gave written informed consent. Demographic and clinical details of each patient were provided by the operating surgeon. These details were stored on a secure electronic database and patients were approached annually to ascertain hip function, complications, revision and death. This was done via a standard questionnaire which included a Harris hip score (19) modified for patient self assessment. The Harris hip score has three separate domains that assess hip pain, patient mobility and hip range of motion. The patients were also asked to rate their satisfaction for the procedure in the same questionnaire. The questionnaire was posted with a stamped return envelope. In case the patients did not post a reply, they were contacted via email or telephone and any change in address was updated. In case this failed the operating surgeon was contacted and the surgeon helped to restore communication. This helped to ensure that lost to follow-up was minimized.

All patients were operated using the Birmingham Hip Resurfacing implant (Smith & Nephew, Warwick, UK). The acetabular component was cement less and the femoral component was cemented in all cases. Both components were made of cobalt chrome alloy. All patients were operated using the posterior approach.

All data was checked for errors and normality. The unadjusted Kaplan-Meier method (26) was used to calculate implant survival. Implant failure was defined as revision of the existing hip resurfacing to a different arthroplasty due to any reason. Implant survival for each patient was computed as the difference between date of operation and date of revision surgery. Log rank tests were used to compare the implant survival between male and female patients, developer surgeons and non-developer surgeons, different pre-operative diagnoses and different types of failures. Adjusted Cox proportional hazard model was used to analyze the risk of failure associated with the following four predictors : age, gender, pre-op diagnosis and surgeon (developer vs non-developers). The key assumption in the Cox models is that the hazard of any predictor variable is proportional over time. The proportional hazard assumption was checked using scaled Schoenfeld residuals.

The annual Harris hip score returned by each patient form a nested repeated measure where the longitudinal scores are nested within each patient. We used a statistical method that can cope with missing data, namely hierarchical regression or multilevel modeling (18,31,44). Because multilevel modeling is capable of handling missing data, all available data is used for analysis. Annual post-operative scores were used as dependent variables and age at operation, preoperative score, gender and surgeon were used as independent variables for this analysis. The model was fitted as follows :

$$Y_{ij} = \beta_{0j} + \beta_{1j} x_{ij} + \varepsilon_{ij}$$

Where Y_{ij} is a response variable for occasion or score i within subject or patient j and β_{0j} is the mean response for subject j and ε_{ij} is the random error at the occasion or score level. i ranges over 1….i level-1 units (scores in this study) and j ranges over 1….j level-2 units (patients in this study).

Recent reports have identified femoral component size as a predictor of implant survival (3,5) and the effect seen due to gender is actually due to the femoral component size. It is unclear if the femoral component size affects hip function. Femoral component size used in this study ranged from 38 mm to 66mm in increment of 2 mm. On the basis of femoral size the study population was divided into four groups as reported by the Australian Joint Registry (5). The femoral component size was subsequently added as a covariate in the multilevel regression model and the Cox proportional model.

Patient selection plays an important role in predicting outcomes of hip resurfacing (43,50). Reports from single surgeon series have shown that outcome of hip resurfacing is similar in young and old patients (35). We tried to establish if this is true for a multi-surgeon cohort. To find the right cut off age between the young and old patients we used hierarchical cluster analysis. This technique identifies groups of samples that behave similarly or show similar characteristics. The predicted scores from multilevel regression and survival probabilities calculated from Kaplan-Meier analysis were used for cluster analysis to generate two groups with similar scores and survival probabilities.

All statistical analysis was done using STATA 9.0 software package (STATA Corp, Texas, US). A p value of less than equal to 0.05 was considered significant in all analysis.

RESULTS

For this study, 4535 patients (5000 hips) entered into the registry during 1997-2002 were studied. The mean age of the patients was 52.6 years (13.3-87.8). There were 3039 men with a mean age of 53.4 years (16.2-87.8) and 1496 women with a mean age of 51.2 years (13.3-81.0). Four hundred and sixty-five patients underwent bilateral resurfacing (308 men and 157 women). The most common pre- operative diagnosis was primary osteoarthritis and accounted for 3451 patients (2408 men and 1043 women) (3807 hips). Pre-operative diagnosis is shown in Table I. The pre-operative diagnosis for 388 patients (420 hips) was missing. At the latest follow-up 215 patients were lost to follow-up and 150 patients had died, which leaves a remaining 4635 hips.

The average follow-up of this study was 8.6 years (5.9-11.3). The data collection stopped in 2008 due to funding issues. During this time 174 patients (174 hips) had a failed arthroplasty which were revised. Out of these 174, 54 patients (54 hips) had a revision due to a fracture of the femoral neck with majority of these fractures occurring within the first 6 months. The overall incidence of femoral neck fractures was 54/4635 i.e. 1.16%. The mean time to fracture was 13.1 months (0.2-81 months). Forty-five patients (45 hips) had a revision operation due to aseptic loosening of the prosthesis and the mean time to revision for loosening was 32 months (0.1-116 months). Thirteen patients (13 hips) had a dislocation giving an overall incidence of 0.26%. The other causes of revision are presented in Table II. At

Table I. — The pre-operative diagnosis of all the hips undergoing hip resurfacing arthroplasty classified according to gender

Diagnosis	Male	Female	hips	% (percent)
Primary Osteoarthritis	2650	1157	3807	76.14
Dysplasia	98	168	266	5.32
Osteonecrosis	167	68	235	4.70
Inflammatory Arthrtitis	72	44	116	2.32
Slipped Capital Femoral Epiphysis	50	9	59	1.18
Secondary Osteoarthritis	26	15	41	0.82
Trauma	16	7	23	0.46
Protrusio	2	13	15	0.30
Perthes disease	12	2	14	0.28
Idiopathic Chondrolysis	1	2	3	0.06
Synovial Osteochondromatosis	1	0	1	0.02
Not available	252	168	420	8.40

Table II. — Table showing detail breakdown of different causes of failures and revision for hip resurfacing arthroplasty

Revision reason	hips	% (percent)
Fracture femoral neck	54	1.08
Loosening	45	0.90
Collapse/Osteonecrosis	29	0.58
Infection	15	0.30
Dislocation	13	0.26
Pain	6	0.12
Allergic reaction	2	0.04
Acetabular fracture	1	0.02
Metal wear	1	0.02
Retroverted Socket	1	0.02
Cup impingement	1	0.02
No bone growth	1	0.02
cause not known	5	0.10

Table III. — Failures and revisions for different primary diagnosis for hip resurfacing arthroplasty

Diagnosis	hips	Failed
Primary Osteoarthritis	3807	119
Not available	420	26
Dysplasia	266	9
Osteonecrosis	235	14
Inflammatory Arthrtitis	116	3
Slipped Capital Femoral Epiphysis	59	1
Secondary Osteoarthritis	41	2
Trauma	23	0
Protrusio	15	0
Perthes disease	14	0
Idiopathic Chondrolysis	3	0
Synovial Osteochondromatosis	1	0

latest follow-up the implant survival for revision due to any reason was 96.2%. The majority of patients whose prosthesis needed revision had a pre-operative diagnosis of primary osteoarthritis (3%, n = 119), followed by osteonecrosis (6%, n = 14). The remaining pre-operative diagnoses for revised hips are shown in Table III. The pre-operative diagnosis for 26 revised hips was not available.

Two surgeons in this study were involved in the design and development of the implant and the surgical technique for the Birmingham Hip Resurfacing, who between them performed 2605 of the 5000 hip operations in this study. The failure rate among the hips implanted by the two developer surgeons was 1.95% (51/2605), whereas the failure rate among non-developer surgeons was 5.1% (123/2395). The implant survival for revision procedures was higher in patients from the developer surgeons (97.8%) compared to non-developer surgeons (94.3%) ($p < 0.001$) (Fig. 1). This was the case for all revision procedures including fracture neck of femur and aseptic loosening. This was reversed for osteonecrosis and femoral head collapse where the non-developer surgeons had a failure rate of only 0.41% (10/2395) and the developer surgeons had a failure rate of 0.73% (19/2605). This resulted in an implant survival of 99.6% for non-developer group and 99.1% for the developer group but this difference was not significant ($p = 0.216$). None of the patients treated by the developer surgeons had a dislocation.

The implant survival at 11.3 years in men (97.4%) was significantly higher than that in women (94.1%) ($p < 0.001$).

Using the Cox proportional hazard model we found a significantly higher risk of failure in female patients (Hazard ratio (HR) = 1.91) and patients treated by nondeveloper surgeons (HR = 2.61). Age and pre-operative diagnosis had no significant effect. We also analyzed the risk of neck fractures and observed that gender was not a significant predictor (HR = 0.13). but non-developer surgeons had a significantly higher risk of failure (HR = 3.37). None of the above predictors had a significant effect on failure due to femoral head collapse or osteonecrosis but a significant effect on failure due to aseptic loosening as seen in female patients (HR = 2.3) and patients operated by the non-developer surgeons (HR = 10.4) (Table IV). Schoenfeld residuals showed that covariate surgeon did not violate the proportional hazards assumption but gender significantly violated the assumption of proportional hazards (Table V). The significant difference in gender disappeared after adding femoral component size to the Cox model. The hazard ratio for gender was 0.81 (95% CI 0.35 -1.89). This was further verified

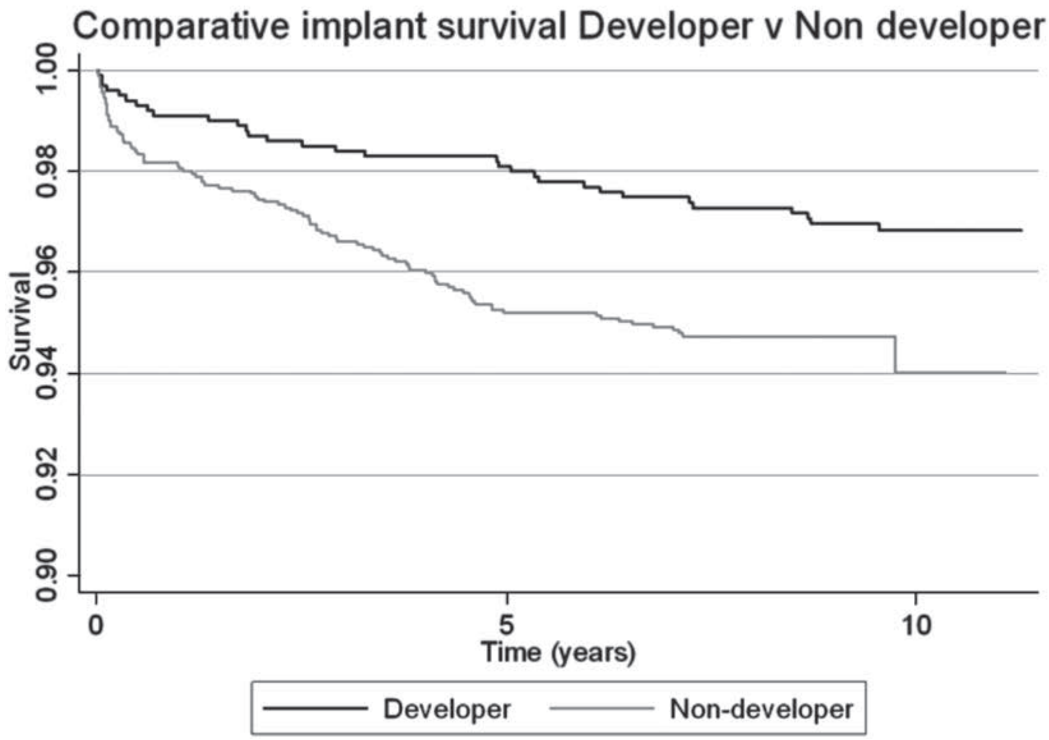

Fig. 1. — Kaplan-Meier survival curve comparing implant survival between developer surgeons and non-developer surgeons. X axis shows the analysis time : Y axis shows percentage implant survival. Srgcde 0 = developer surgeons Srgcde 1 = non-developer surgeons.

Table IV. — Multivariate Cox proportional hazard model for all failures, failure due to femoral neck fracture and aseptic loosening of the implant

Cox proportional hazard model					
variable	Haz. Ratio	Std. Err.	p	95% CI	
All failures					
gender	1.912	0.29	< 0.001	1.411	2.592
surgeon	2.613	0.45	< 0.001	1.867	3.657
age	1.003	0.008	0.73	0.988	1.018
After adding head size					
gender	0.81	0.35	0.63	0.35	1.89
Fracture neck of femur					
gender	0.132	0.23	0.25	0.004	4.053
surgeon	3.376	1.09	< 0.001	1.792	6.362
age	1.019	0.02	0.31	0.983	1.056
Aseptic Loosening					
gender	2.287	0.73	0.009	1.225	4.271
surgeon	10.419	5.58	< 0.001	3.644	29.786
age	0.985	0.015	0.31	0.956	1.014

Gender : male = 0 ; female = 1, Surgeon : developer surgeon = 0 ; non developer surgeon = 1.
p value of < = 0.05 was considered significant.

Table V. — Test of proportional hazards assumption

Test of proportional hazards assumption				
Variable	rho	chi2	df	p
gender	0.22594	8.71	1	0.003
surgeon	-0.06344	0.67	1	0.412
After adding femoral component size				
gender	-0.01125	0.01	1	0.934
surgeon	-0.17263	1.10	1	0.295

Time : Time

Variable	rho	chi2	df	p
gender	0.22594	8.71	1	0.003
surgeon	-0.06344	0.67	1	0.412
After adding femoral component size				
gender	-0.01125	0.01	1	0.934
surgeon	-0.17263	1.10	1	0.295

Test of proportional hazard assumption using schoenfeld residuals. Rho is the correlation between scaled schoenfeld residuals and time. P value < = 0.05 was considered significant and indicates violation of proportional hazards assumption.

Table VI. — Implant survival between men and women among different categories of femoral head sizes

	< 44	45-49	50-54	> 55
All patients	89.1	94.3	97.9	97.1
Men	84.1	93.5	97.6	96.7
Women	90.6	94.8	97.8	96.3
p	0.57	0.31	0.57	0.93

P < 0.05 is significant.

Table VII. — Size > 55 was taken as reference

Size	Hazard Ratio	Std. Err.	p	95% Confidence Interval	
45-49	1.21	0.82	0.78	0.32	4.54
50-54	0.27	0.17	0.04	0.07	0.95
< 44	2.32	1.74	0.26	0.53	10.11

P > 0.05 is significant.

by survival comparison between men and women, which showed no significant difference in all four categories of femoral head size (Table VI). The hazard ratio was highest for head size < 44 and lowest for head size 50-54 (Table VII).

The mean pre-operative Harris hip score was 59, which increased to 89.3 for the whole study population one year after the operation ($p < 0.001$). There was however a significant difference between the scores of men and women with the latter having a 1% decline over time as compared to the men ($p < 0.001$). The age at operation had no significant influence on the follow-up score ($p = 0.94$) but pre-operative score was strongly associated with a better post-operative score ($p < 0.001$). Patients operated by the two developer surgeons scored significantly higher than those operated by the non-developer surgeons ($p < 0.001$).

Using only the pain domain as dependent variable we found no effect of age on the follow-up pain score ($p = 0.18$). There was a significant difference between men and women with men scoring higher than women ($p = 0.001$). The patients treated by developer surgeons reported higher pain scores (higher score means more pain) as compared to the non-developer surgeons ($p < 0.001$). A higher pre-operative pain score gave a significantly higher post-operative score ($p < 0.001$). Similar results were observed for the range of motion domain with men scoring higher than women and patients treated by developer surgeons scoring higher than those treated by the non-developer surgeons ($p < 0.001$). As above there was no effect of age on follow-up score for range of motion ($p = 0.47$) (Table VIII).

We did observe a significant effect of age on the mobility domain, with increasing age resulting in a decrease in mobility score ($p < 0.001$). There was no significant difference in mobility follow-up score between men and women ($p = 0.23$) but there was a significant difference in mobility scores of patients treated by developer surgeons and non-developer surgeons ($p < 0.001$). The model could not be fit for the satisfaction domain due to multicollinearity. This was probably because all patients scoring the pleased and extremely pleased responses over the follow-up period.

Addition of femoral component size into the model had no effect on gender. The difference between men and women was significant as earlier. The overall hip function showed a depreciation of 0.1 points for 1 mm increase in femoral head size ($p = 0.06$).

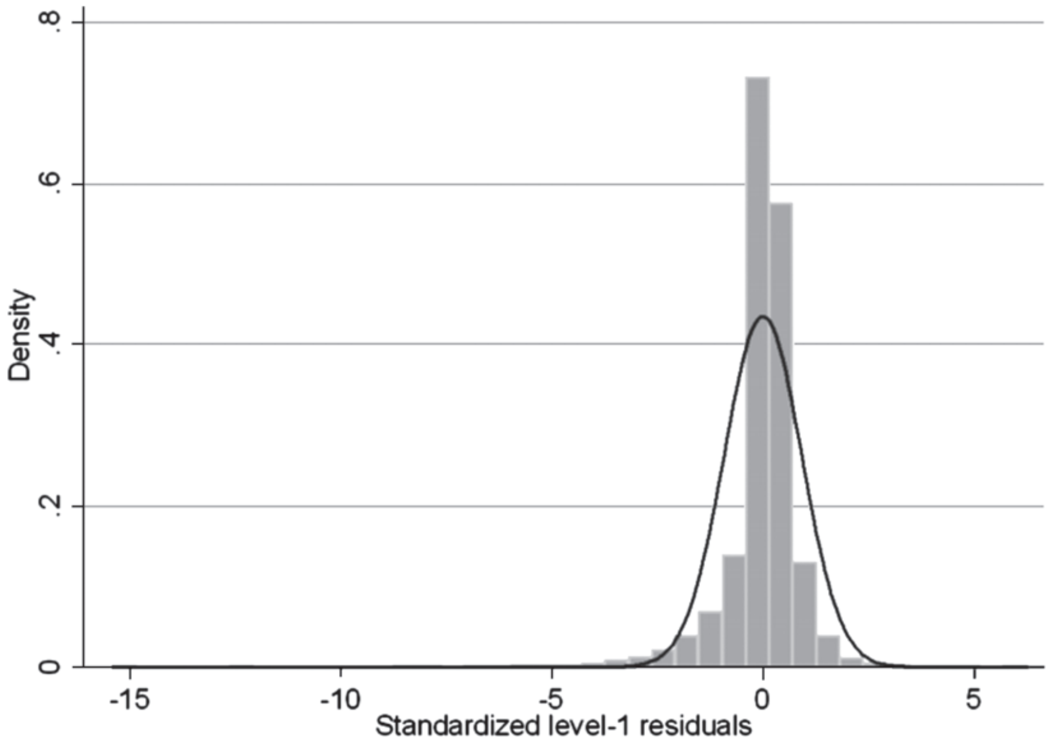

Fig. 2. — Histogram showing normal distribution of standardized level-1 residuals of multilevel regression for hip score.

Table VIII. — Multivariate hierarchical regression for individual domains of pain, range of motion and mobility of post-op hip function

variable	Coef.	p	95% CI	
Pain				
gender	-0.082	0.001	-0.129	-0.035
surgeon	-0.094	< 0.001	-0.146	-0.042
age	0.001	0.187	-0.001	0.004
pre-op score	0.058	< 0.001	0.040	0.077
Range of motion				
gender	-0.067	0.007	-0.115	-0.018
surgeon	-0.073	0.008	-0.126	-0.019
age	0.001	0.479	-0.001	0.003
pre-op score	0.084	< 0.001	0.064	0.104
Mobility				
gender	-0.054	0.231	-0.142	0.034
surgeon	-0.249	< 0.001	-0.346	-0.151
age	-0.007	< 0.001	-0.011	-0.003
pre-op score	0.124	< 0.001	0.101	0.148

Gender : male = 0 female = 1, Surgeon : developer surgeon = 0 non developer surgeon = 1.
A p value of < = 0.05 was considered significant.

Age

Hierarchical cluster analysis divided the study cohort into two groups with a mean age of 51 and 53 years respectively. The distribution of age within each group was similar (19.5-78) (13.3-74). These groups were the result of clustering based on post-operative function and implant survival. The age range in both groups was similar, which means that post-operative function and implant survival of this cohort is not influenced by age.

DISCUSSION

This is the first study to report clinical outcomes of hip resurfacing from an independent and multinational register with 4535 patients and an average of 8.6 years follow-up. The results from this multicentre study show that Birmingham hip resurfacing has an implant survival of 96.2% at maximum 11 years follow-up. There was a significant improvement in overall function from an average pre-operative score of 59 to an average of 89 one year post-operative with similar gains in individual domains of pain, mobility and range of motion.

There are several follow-up studies on hip resurfacing but it is difficult to compare them directly with our study as the majority report shorter follow-up times (*20,28,53*) as compared to our study or have fewer patients (*6*). The results of this study at 11 years follow-up are better than those in a study reporting the results of 1000 hips resurfaced using Conserve Plus (Wright Medical Tech. Arlington, TN) (*4*). This single surgeon series had an implant survival of 91.9% at eight years, with a loss to follow-up of 30 patients. A similar study design to ours with 37 surgeons undertaking 610 procedures, out of which 113 were done by trainee surgeons, reported an implant survival of 95% at 7 years (*52*). Two patients in that study were lost to follow-up. Both of these studies did not report a worst case scenario. If it is assumed that lost patients in both of these reports had all failed then adjusting for maximum follow-up, our results can be considered relatively better.

In accordance with guidelines published by the National Institute of Clinical Excellence (NICE), arthroplasty implants are required to have a survival of 90% for a minimum of 10 years (*39*). Our results at a maximum follow-up of 11 years are within this limit if it is assumed that the above mentioned 215 lost to follow-up have not undergone a revision. In a worst case scenario (*10*), if it is assumed that all of these 215 hips (200 patients) have failed then the implant survival for revision due to any reason was calculated to be 94.3% (Fig. 3). The results from our study are within the standard limit, demonstrating that the Birmingham hip resurfacing is a viable option for management of severe hip pathologies with good results at midterm follow-up. There are conflicting reports in the literature regarding this assumption of a worst case scenario, Murray *et al* (*37*) suggest that patients lost to follow-up have worst outcomes as compared to those who are assessed, whereas a similar comparison between attenders and non-attenders by Joshi *et al* (*24*) found that the patients not attending follow-up did not have poor results.

Lost to follow-up is a common occurrence in any long-term clinical study, especially multicentre studies with some studies reporting up to 13% patients lost to follow-up at 10 years (*1*). This might be the result of factors such as withdrawal from study, emigration, change of address and sometimes asymptomatic patients stop responding as they might believe follow-up is not warranted. The latter scenario does operate in cases where patients have to visit follow-up clinics and they choose not to attend because they prefer saving time, travel and wages (*11,49*). There is less chance of such a scenario in follow-up studies where postal questionnaires are used to assess the outcomes of hip arthroplasty e.g. the present study but still we had 4.4% patients who were lost to follow-up. Out of the 200 lost to follow-up in our study, 21 patients had withdrawn from the study, four had a change of address and one emigrated leaving 174 patients from whom we did not hear after the operation. In this situation it is possible that Wildner's hypothesis (*55*) is operating i.e. patients are silent because they are dissatisfied or silent because they are satisfied and do not want to be bothered.

Fracture of femoral neck is the most common complication following hip resurfacing, leading to

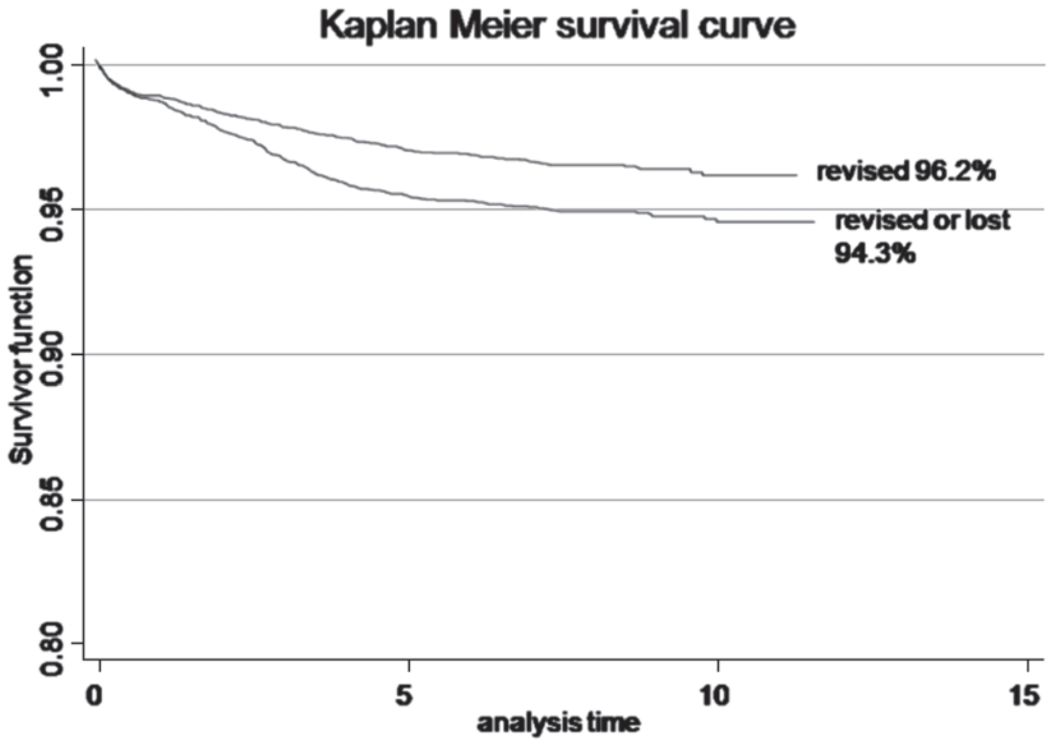

Fig. 3. — Kaplan-Meier survival curves depicting worst case scenario. If it is assumed all lost to follow-up patients had revision surgery, the implant survival is 94.3%.

revision. The overall incidence of fracture in our study (1%) has been similar to a recently reported single surgeon series (*4*) but low when compared to a multisurgeon cohort (*52*) who reports an overall rate of 1.96%. The reported incidence of this complication varies from as low as 0% to 4% (*2,7,8,28,53*). As this procedure is technically more challenging than a standard total hip arthroplasty, it is hypothesized that surgical technique is an important predictor of outcomes and therefore influences the rate of neck fractures. A recent study by Amstutz *et al* (*4*) reports a significant effect of surgical technique on prosthesis survival with similar views being echoed by other studies (*33*). We found significant hazard ratio of 2.61 when comparing developer surgeons to non-developer surgeons. Based on our results we agree with Marker *et al* (*33*) that surgical technique (developer surgeons and non-developer surgeons) is an important predictor of failure due to neck fractures and conclude that this outcome has a multifactorial risk.

Patient related factors such as age and gender are considered important predictors of outcomes following total hip arthroplasty (*23,25,46*) and dictate patient selection for these procedures. Recent evidence points to confounding of gender by the femoral head size and the effect of femoral component size on implant survival neutralizes the gender effect (*3,5,15,34*). Our results show an inverse relation between head size and implant failure. These results concur with previous reports that small head size predisposes to a higher risk of failure. Similar effects of femoral head size were not seen for post-op hip function. It has been shown that small head sizes have a greater run in wear (*30*). Are these failures due to local high concentration of metal ions ? The answer to this question is beyond the scope of present study. Secondly, is it appropriate to offer a traditional metal on polyethylene to patients with small femoral heads ? We think a comparative study between a small head metal-on-metal hip resurfacing and traditional metal-on-polyethylene hip replacement may shed some light on this issue. In view of these results, metal-on-metal hip resurfacing must be cautiously advised to patients with small femoral heads.

We found that age was not a significant predictor of post-operative function and our results echo the findings of McGrath *et al* (*35*) who reported comparable outcomes in below sixty and over sixty years old patients. It is possible that because of age, older patients are given more attentive and focused rehabilitation as compared to young patients thus improving their post-operative function to comparable levels (*47*). Hip resurfacing is a new technically demanding procedure. The results from developer surgeons (*53*) have been reported to be better than those from other centers (*4,21*). We found a significantly higher implant survival for all revisions for patients treated by developer surgeons, compared to those treated by non-developer surgeons. A similar difference was seen in post-operative function, with patients treated by developer surgeons scoring higher than those treated by non-developer surgeons. We believe these results are reflective of a learning curve in the trainee surgeons. We consider this is significant and has some important implications. First, this calls for training programs which include lectures and workshops to help new surgeons improve their skills for this procedure. Second, the initial results from new surgeons need to be interpreted with caution. This does not imply that the results from developer surgeons can be used as a benchmark for new surgeons. Our results show a significant difference between these two groups. But we have not compared both groups to an accepted standard. We suggest there is a need for a standard against which surgeons can compare and judge their outcomes. This will help to improve outcomes of this procedure in individual surgeons and benefit patients. Although, randomized controlled trials (RCT) are accepted as the best evidence to indicate the value of an intervention, they can lack generalizability and may provide a limited view of the effect of an intervention on outcomes in the population at large. Prospective cohort studies, in contrast, allow the therapeutic effect to be assessed under usual clinical conditions (*12,45*). Because of controlled conditions, benefits observed in an RCT may not be observed when the therapy is introduced in normal clinical practice (*9,51*).

The strength of our study is its multicenter character, which ensures a low incidence of selection bias. Selection bias can affect the validity of results in single surgeon series, making it difficult to generalize study findings. The international nature of this cohort further helps to improve the external validity of our results. Another advantage is the independent nature of data collection and analysis which helps to reduce surgeon induced bias in data collection and results reporting. One of the major limitations of our study from a clinical point of view is the lack of radiological follow-up. We report our results in a fashion similar to a joint registry and thus do not include radiographic data. However, unlike most registries our outcome centre collects annual hip scores. Subjective outcome measures have a high correlation with signs of radiological loosening (*13,22*). By combining a subjective outcome measure and actual loosening rates, the results from this study will therefore be useful even in the absence of radiological data.

It must be stated that there has been growing recent concers about the effect of elevated metal ions causing metal ion hypersensitivity, psedotumours, Aseptic lymphocyte-dominated vasculitis-associated lesion (ALVAL), early failure of MoM devices secondary to adverse reactions to metal debris, and metal staining of tissues and the development of osteolysis (*28,29,54*). This has led to some countries banning hip resurfacing outside research programmes.

CONCLUSION

In summary, at a maximum follow-up of 11 years hip resurfacing has a good implant survival of 96.2% and satisfactory post-operative function. This is acceptable given the international and multi-surgeon nature of this cohort where majority of the surgeons were in their learning curve. Patient selection is a critical factor that will govern the outcomes (*43*) of this procedure and further research is indicated in refining these criteria so that the incidence of post-operative complications can be reduced. Improvement in surgical technique has shown better outcomes and further input to train surgeons for this procedure will be helpful. Hip resurfacing is a established procedure and collaborative research in form of multinational data collection can help to identify and reduce potential risk factors as compared to single centre reports.

Acknowledgement

The authors would like to thank Miss. A. Mcfie and Miss. M. Griffiths for helping with data forms.

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