Treatment of the young active patient with osteoarthritis of the hip

A FIVE- TO SEVEN-YEAR COMPARISON OF HYBRID TOTAL HIP ARTHROPLASTY AND METAL-ON-METAL RESURFACING

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We compared the five- to seven-year clinical and radiological results of the metal-on-metal Birmingham hip resurfacing with a hybrid total hip arthroplasty in two groups of 54 hips, matched for gender, age, body mass index and activity level.

Function was excellent in both groups, as measured by the Oxford hip score, but the Birmingham hip resurfacings had higher University of California at Los Angeles activity scores and better EuroQol quality of life scores. The total hip arthroplasties had a revision or intention-to-revise rate of 8%, and the Birmingham hip resurfacings of 6%. Both groups demonstrated impending failure on surrogate end-points. Of the total hip arthroplasties, 12% had polyethylene wear and osteolysis under observation, and 8% of Birmingham hip resurfacings showed migration of the femoral component. Polyethylene wear was present in 48% of the hybrid hips without osteolysis. Of the femoral components in the Birmingham hip resurfacing group which had not migrated, 66% had radiological changes of unknown significance.

Premature failure of cemented total hip arthroplasty (THA) in active men under 50 years of age is predominantly because of aseptic loosening of the acetabular component.¹⁻⁵ As a result, porous-coated, uncemented, metal hemispherical acetabular components with press-fit polyethylene liners were introduced, combined with a cemented stem as the 'hybrid hip'^{6,7} and were widely used, particularly in younger patients. Femoral bone-conserving metal-on-metal hip resurfacing was introduced in the early 1990s,^{8,9} but the results have been reported largely from the inventing centres¹⁰⁻¹² with follow-up periods of less than five years.¹³⁻¹⁵

The aim of this study was to compare the functional results, failure rates and impending revisions in hybrid THAs and Birmingham hip resurfacing in young active patients.

Patients and Methods

This study compared 54 of the first 63 metal-on-metal Birmingham hip resurfacings performed by the senior author (GCB) with 54 hybrid THAs reviewed retrospectively in patients matched for gender, age, body mass index (BMI) and activity level. We previously reported very early clinical results.¹⁵

Original study groups. Between January 1996 and April 2001, 54 hips in 53 patients (13 women/13 hips and 40 men/41 hips) under-

went hybrid THA using the cemented CPT stem (Zimmer, Warsaw, Indiana), with an uncemented acetabular component and a press-fit polyethylene liner. The uncemented acetabular components included 29 Harris-Galante II (Zimmer), 16 ABG II (Stryker Orthopedics, Mahwah, New Jersey), seven Zweymuller (PLUS Orthopedics, Rotkreuz, Switzerland), one PFC (DePuy International, Leeds, United Kingdom) and one Hedrocel (Implex Corp, Allendale, New Jersey). In 45 hips a 28 mm modular metal femoral head was used and in nine, a ceramic head.

Between August 1999 and April 2001, 63 hips were resurfaced using the Birmingham hip resurfacing (Midland Medical Technologies, Birmingham, United Kingdom). This comprised a cemented femoral component and an uncemented hemispherical flanged hydroxyapatite- and porous-coated acetabular component. On no occasion during this period did the senior author (GCB) decide intra-operatively that a case was unsuitable for resurfacing and perform a THA instead. Of the 63 hips, three were revised for fracture of the femoral neck (two within six weeks of implantation and the other at one year because of avascular necrosis). They were included in the results as failures but excluded from further follow-up. There were six hips not available for follow-up, leaving 54 surviving Birmingham hip resur-

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Table I. Summary of pre-operative diagnoses

Pathology	Number of hips (%)	
	Hybrid group	Resurfacing group
Osteoarthritis	40 (74)	42 (78)
Avascular necrosis	7 (13)	4 (7)
Developmental dysplasia	3 (6)	3 (6)
Rheumatoid arthritis	1 (1)	0 (0)
Others*	3 (6)	5 (9)

* slipped capital femoral epiphysis; Perthes' disease; ankylosing spondylitis; post-traumatic osteoarthritis

facings in 51 patients (11 women/13 hips and 40 men/41 hips).

The patients having hybrid THAs were matched with those having Birmingham hip resurfacings for gender, age at surgery (within five years), BMI (within 5 kg/m²) and pre-operative activity level before it was limited by symptoms. Activity was graded using the University of California at Los Angeles (UCLA) activity score,¹⁶⁻¹⁸ which ranges from one point (inactive) to ten points (regular impact sport). We matched patients within two points on the scale. The mean age of the hybrid THA patients was 50.4 years (21 to 66), mean BMI was 27.0 kg/m² (18.5 to 37.0) and the mean pre-operative activity level was 8.9 points (6 to 10). The mean age for the Birmingham hip resurfacing patients was 49.8 years (18 to 67), mean BMI was 25.7 kg/m² (19.7 to 35.1) and mean activity 9.0 points (6 to 10).

The pre-operative pathology was predominantly osteoarthritis (Table I). All operations were performed using a posterior approach, which in the resurfacing group, was extensile. Thromboprophylaxis comprised the use of foot pumps and compression stockings and was identical

for both groups. No hybrid THA patients had required further surgery following their index procedure before recruitment to the study. All patients were allowed full weight-bearing immediately post-operatively. Birmingham hip resurfacing patients commenced impact activity at three months, but hybrid THA patients were advised to avoid heavy manual work and impact sports permanently.

Retrospective review. All patients were invited to attend outpatient clinics, where they completed a questionnaire recording complications of their hip arthroplasty, the Oxford hip score,¹⁹ the UCLA activity score,¹⁶ and the EuroQol quality of life score.²⁰ The Oxford hip score is a validated patient-based outcome measure which is sensitive to clinically important changes and is scored from 12 (asymptomatic) to 60 (severe). The UCLA activity score was used with modifications for the British population.¹¹ The EuroQol EQ-5D and EQ-visual analogue scores (EQ-VAS) are derived from a self-reported health status questionnaire and are valid and reliable in both population studies and other patient groups.^{21,22} Patients were also asked specifically about running, jogging, sporting activity and heavy manual work within the last four weeks. The medical notes were checked to ensure that no complications or reoperations had been missed. Anteroposterior (AP) and lateral radiographs were taken and compared with pre- and post-operative (24 hours, 3 months and at follow-up) radiographs (Table II). Changes around the femoral and acetabular components of the hybrid hips were described on the AP radiographs using the zones of DeLee and Charnley²³ and Gruen, McNeice and Amstutz,²⁴ and on the lateral radiographs according to Johnston et al²⁵ for the femoral component and from zones IV to VI from anterior to posterior around the acetabular component. Linear

Table II. The radiographic variables examined

Group	Radiograph	Variable	Site
Hybrid	Follow-up	Lucent lines (> 1 mm)	Femoral and acetabular components
		Migration	
Resurfacing	Pre-operative	Osteolysis	By zone
		Linear polyethylene wear	Femoral head/liner
	Post-operative	Neck-shaft angle	Femoral head and neck
		Femoral offset	
		Presence and size of femoral head cysts	
		Seating	Acetabular component
	Follow-up	Abduction angle	Femoral component
		Stem/shaft angle	
		Femoral offset	
		Notching	
	Follow-up	Uncovered reamed bone	Femoral and acetabular components
		Stem tip position on lateral	
		Lucent lines (> 1 mm)	
		Migration	
	Follow-up	Osteolysis	By zone
		Change in density of trabeculation and cortical hypertrophy	Femoral neck

Table III. Linear polyethylene wear in the hybrid group

Acetabular component	Number	Mean follow-up (mths)	Incidence of polyethylene wear (%)	Range (mm)	Mean linear wear (all liners, mm/yr)
Harris-Galante	26	88.6	16 (62)	1 to 2.5	0.12
Others	25	70.6	13 (52)	0.5 to 1	0.07

polyethylene wear was measured by the method of Dorr and Wan.²⁶ Changes around the femoral component of the Birmingham hip resurfacings were described on the AP¹² (zones 1 to 3) and lateral radiographs (assigned zones 4 to 6 from anterior to posterior). Changes around the acetabular component in the Birmingham hip resurfacings were assigned as for the hybrid hips. The surface arthroplasty risk index,²⁷ a predictor of failure validated in 400 resurfacings,¹² was calculated for each patient and correlated with the radiological findings.

The six Birmingham hip resurfacing patients who were unavailable for follow-up at the time of our first study¹⁵ completed the postal questionnaires but were not reviewed radiologically.

Approval for the study was obtained from the local research ethics committee.

Statistical analysis. The data were analysed by medical statisticians (MS, EW) using the STATA v8.0 package (Stata-Corp LP, College Station, Texas), using the Wilcoxon signed-rank test for comparison of Oxford hip and UCLA activity scores, the chi-squared test for comparison of participation in sports, running and heavy manual work, and the Mann-Whitney U test for EuroQol scores. The EQ-5D scores were adjusted for gender and age and were compared between groups. The EQ-VAS were compared directly between groups. A *p* value of < 0.05 was considered to be significant.

Results

In the hybrid THA group, three patients had died but there was no other loss to follow-up. The medical records of these three patients revealed a satisfactory clinical performance at their latest review, giving 100% retrieval. There were, therefore, 51 hybrid THAs available for review. The mean follow-up was 80 months (42 to 120). In the Birmingham hip resurfacing group, one patient was lost to follow-up having emigrated. His medical records revealed satisfactory clinical and radiological results one year post-operatively, so 53 of the 54 hips were available for review (98%). One patient refused further radiographic study. The mean follow-up was 61 months (52 to 71).

Functional outcome scores. There was no significant difference between the median Oxford hip score in the 51 hybrid THAs (14, mean 18.5; 12 to 41) and the 53 Birmingham hip resurfacings (13, mean 15.9; 12 to 42) (*p* = 0.139).

The Birmingham hip resurfacing patients had a significantly higher level of activity than those with hybrid THAs. The median UCLA activity score in the hybrid THA group was 7 (mean 6.8; 3 to 10) and in the Birmingham hip resur-

facing group the median was 9 (mean 8.4; 4 to 10) (*p* < 0.001).

The quality of life scores were better in the Birmingham hip resurfacing group. The mean EQ-5D score was 0.78 (0.06 to 1.00) in the hybrid THA group and 0.9 (0.08 to 1.00) in the Birmingham hip resurfacing group (*p* = 0.003). The mean EQ-VAS was 69.3 (15 to 100) in the hybrid THA group and 82.3 (20 to 100) in the Birmingham hip resurfacing group (*p* = 0.001).

More patients with the Birmingham hip resurfacing ran, participated in sport and carried out heavy manual work than those with THA. During the four weeks before review, seven of 51 (13.7%) hybrid THA patients and 31 of 53 (58.5%) Birmingham hip resurfacing patients had run (*p* < 0.001), 17 (33.3%) hybrid THA patients and 39 (73.6%) Birmingham hip resurfacing patients participated in sport (*p* < 0.001) and 20 (39.2%) THA patients and 32 (60.4%) Birmingham hip resurfacing patients performed heavy manual work (*p* = 0.049).

The six Birmingham hip resurfacing patients who did not attend follow-up in our first study¹⁵ completed questionnaires. None had required further surgery. The median Oxford hip and UCLA scores were 12.5 and 8, respectively.

Radiological outcomes

Hybrid total hip arthroplasties (THAs). Of the hybrid THA group two patients (4%) had lucent lines around the femoral component. In the first, these were in Gruen/Johnston zones 2, 3 and 8, and in the second 1, 4 and 8. The mean stem subsidence was 2 mm (0 to 5). There was no migration into varus or valgus.

A further four patients (8%) had lucent lines around the acetabular component. These were in DeLee and Charnley zones I and IV, III and VI, III, and III and VI, respectively (zones as per DeLee and Charnley and additional three zones for the lateral radiograph). No components had migrated. Linear polyethylene wear occurred in 29 liners (57%) (Table III). There was no significant difference in the incidence or rate of wear among the various component designs.

Osteolysis occurred in nine patients (18%), six of whom had a Harris-Galante II (Zimmer), two an ABG II (Stryker Orthopaedics) and one a Zweymuller (PLUS Orthopaedics) component. All nine had polyethylene wear ranging from 0.5 mm to 2.5 mm. Of the osteolytic areas, seven were femoral only, one acetabular (DeLee and Charnley zone II) and femoral, and one purely acetabular (DeLee and Charnley zone II). Femoral involvement was isolated to Gruen zone 7 in all patients except one, who also had involvement of

Gruen zone 1. The mean age of the patients with osteolysis was 47 years (27 to 59) and mean follow-up was 83 months (46 to 108). Only three (33%) of these patients had Oxford hip scores above 22. Of the patients with osteolysis, three revisions have been planned and the remainder are under annual review. One further revision is planned in the hybrid group for recurrent dislocation.

Birmingham hip resurfacings. Pre-operatively, three patients had single femoral head cysts larger than 2 cm in diameter, nine had single cysts larger than 1 cm and four had two cysts larger than 1 cm. Post-operatively, 19 acetabular com-

Table IV. Our classification of radiological appearance of femoral component after metal-on-metal resurfacing

Classification	Radiological appearance
Type	
0	No change
1	Pedestal sign but no migration
a	Sclerotic line confined to curved tip of stem
b	Sclerotic line confined to distal 1 cm of shaft of stem
c	Sclerotic line $\pm$ symmetrical lucent lines, extending proximally beyond distal 1 cm of shaft
2	Migration, usually into varus with asymmetrical lucent lines
3	Displaced fracture

Fig. 1

The subclassification of pedestal signs into type-a, type-b, and type-c.

Fig. 2

Type-a pedestal sign.

Fig. 3

Type-b pedestal sign.

Fig. 4

Type-c pedestal sign.

Fig. 5a

Fig. 5b

Migration of the femoral component; a) early post-operative radiograph of a 52-year-old man; b) at 60 months there was varus migration but an Oxford hip score of 14 and a UCLA score of 8.

ponents (35%) were completely seated, and the mean abduction angle was 42° (30° to 56°). The mean stem/shaft angle was 6.6° valgus relative to the pre-operative neck/shaft angle (7° varus to 23° valgus). Three hips were positioned in 5° or more of relative varus. The stem position was in the central third on the lateral view in 48 hips (89%) and in the anterior third in the remaining six (11%). There was no significant change in femoral offset before or after surgery. Minor medial notches occurred in five patients, but laterally, there were none. Uncovered reamed bone was apparent on post-operative radiographs in ten hips (19%); in five this was medial, two anterior, two lateral and one posterior. On follow-up radiographs all acetabular components were osseointegrated, with no migration or lucent lines.

Femoral component migration in Birmingham hip resurfacings (Table IV). A total of 16 femoral components (31%) were unchanged from the post-operative radiographs (type-0). A total of 31 femoral components (60%) demonstrated a sclerotic line commencing at the tip of the stem and extending symmetrically towards the head for a variable distance (type-1, the 'pedestal sign', Figs 1 to 4). In some of these cases lucent lines were present, but these were symmetrical with no evidence of migration. We subdivided the pedestal signs into type-1a, type-1b and type-1c according to the progression of the sclerotic and lucent lines towards the head. Type-1a (Fig. 2) was limited to the tip of the stem, type-1b (Fig. 3) commenced at the tip of the stem and extended 1 cm proximally, and type-1c (Fig. 4) extended more than 1 cm. In five of 52 hips (10%), femoral

components with lucent lines had migrated (type-2), four into varus (Fig. 5) and one into slight valgus. In none of these patients was there clinical suspicion of infection, but in one the appearances suggested a malunited fracture (Fig. 6). All but one had satisfactory Oxford hip scores (12 to 18). One patient with an Oxford hip score of 40 had radiographic appearances suggestive of avascular necrosis (Fig. 7) and has now been revised. None of these five patients was notched, had uncovered reamed bone, was in varus, or was anteriorly or posteriorly malaligned on early post-operative radiographs. On pre-operative radiographs two of them had two cysts larger than 1 cm in diameter and one patient had a single cyst larger than 1 cm. One 46-year-old man at 58 months follow-up, with an Oxford hip score of 12 and a UCLA activity score of 10, had a 1 cm diameter area of osteolysis apparent on the lateral radiograph in zone 4 adjacent to the stem, but no other radiological changes. Both higher activity level ($r = 0.43$, $p = 0.002$) and medial femoral neck remodelling (cortical hypertrophy and increased density of trabeculation (Fig. 8)) ($p = 0.013$) appeared to be associated with increasing radiological change (Table V). The mean surface arthroplasty risk index was 2.56 (0 to 6) in the 52 resurfaced patients with follow-up radiographs available for study. A surface arthroplasty risk index greater than three occurred in eight patients who were thus categorised as 'high' risk.¹² Three of the 'high'-risk patients (37.5%) had type-1c or type-2 changes on their follow-up radiographs, compared with 11 of 44 (25%) of 'low'-risk patients. The mean surface arthroplasty risk index of all patients with type-1c or type-2

Fig. 6a

Fig. 6b

Migration of the femoral component, with appearances suggesting a malunited fracture; a) early post-operative radiograph of a 46-year-old man; b) at 65 months, varus migration and malunion but with an Oxford hip score of 12, and a University of California at Los Angeles score of 10.

Fig. 7a

Fig. 7b

Migration of the femoral component with avascular necrosis; a) early post-operative radiograph of 44-year-old man; b) at 60 months there was varus migration and avascular necrosis. The femoral component was probably loose, with an Oxford hip score of 40 and a University of California at Los Angeles score of 9.

changes was 3.07 (1 to 5), compared with 2.37 (0 to 6) for the rest of the group.

Complications. In the hybrid THA group three patients dislocated once and one was a recurrent dislocator who is awaiting revision. There were three superficial wound infections, two deep-vein thromboses (DVT), one pulmon-

ary embolism and one temporary sciatic nerve palsy. Two patients had trochanteric bursitis which was treated with steroid injections. In total, four of 51 hips (8%) await revision, three for osteolysis and one for recurrent dislocation.

In the Birmingham hip resurfacing group there were no dislocations, two DVTs, one pulmonary embolism and one

Fig. 8a

Fig. 8b

Remodelling of the femoral neck. Figure 8a demonstrates the post-operative radiograph; and b) the radiograph at 64 months showing an increased trabecular density.

Table V. Summary of radiological findings in the resurfacing group

Radiological appearance	Number of hips (% of 52 reviewed in study)*	Mean age at surgery (yrs)	Proportion of males (%)	BMI† (kg/m ²)	Mean follow-up (mths)	Mean Oxford hip score	Mean UCLA‡ score	Incidence of medial cortical hypertrophy (%)
Type 0	16 (30.8)	50.3	56.3	25.6	63.8	16.6	7.6	18.8
Type 1a	6 (11.5)	44.5	83.3	26.6	61.0	14.7	7.7	50.0
Type 1b	16 (30.8)	47.8	81.3	26.0	59.3	14.1	9.0	50.0
Type 1c	9 (17.3)	51.3	77.8	24.8	58.2	14.8	8.9	55.6
Type 2	5 (9.6)	51.0	100	26.5	61.6	19.6	9.2	80.0
Type 3	3 (-)	51.7	66.7	27.0	-	-	-	-

* percentages are given for the 52 hips reviewed in the study. The three hips with type-3 appearance were not included in the calculation

† BMI, body mass index

‡ UCLA, University of California at Los Angeles

superficial wound infection. One patient had psoas impingement but declined surgical release. Of the 63 hips, four (6%) have been revised for failure of the femoral component, two at six weeks, one at 12 months and one at 62 months. No hip in either group has required any other surgery.

Early fractures of the femoral neck. The first hip revised for an early fracture of the femoral neck within six weeks was in a 61-year-old man with osteoarthritis, whose femoral component had been placed in relative valgus of 5°; the femoral neck was notched and had uncovered reamed bone posterolaterally. The second hip was in a 57-year-old man with a history of juvenile chronic arthritis with coxa vara and a bowed femur. Resurfacing was chosen rather than hybrid THA in order to eliminate the potential technical problem of inserting a stemmed femoral component. The

Birmingham hip resurfacing femoral component was placed in a central position with no notching or uncovered reamed bone, but because of the coxa vara it was not possible to position it in relative valgus. The third hip, in a 37-year-old woman with osteoarthritis, fractured secondary to avascular necrosis at one year after surgery. The femoral component had been placed in 2° relative valgus with no notch or uncovered reamed bone.

Discussion

A review between 2000 and 2002²⁸ concluded that there was “no clear consensus as to component choice or optimum fixation method in the younger patient”. Of the acetabular components 74.2% were uncemented and resurfacing accounted for 18.8% of procedures. In 78% of cases, polyethylene was the acetabular-bearing surface.

In our hybrid THAs the revision or intention-to-revise was 8% (four of 51 surviving hips) because of osteolysis secondary to polyethylene wear or recurrent dislocation. Of 63 original Birmingham hip resurfacings, four (6%) were revised because of femoral component failure. Both groups also demonstrated impending failure on surrogate end-points. Of the 51 hybrid THAs, six (12%) had lesser degrees of osteolysis, and revision to prevent further bone loss is anticipated. Of the 52 Birmingham hip resurfacings with radiographic, mid-term follow-up, four (8%) demonstrated femoral component migration, which may fail by becoming painful or by resulting in a displaced fracture. Finally, changes were recorded in both groups, the significance of which is unknown. Polyethylene wear was recorded in a further 20 (39%) hybrid THAs, a proportion of which will develop osteolysis. Pedestal signs were noted around 31 (60%) of the Birmingham hip resurfacing femoral components and it is unknown how these will progress.

This study was retrospective, although the differences between THAs and Birmingham hip resurfacings were minimised by matching cases. All operations were performed by a single specialist hip surgeon using the same approach. The follow-up of the hybrid THAs was slightly longer than that of the Birmingham hip resurfacings.

The acetabular components of the hybrid THAs were heterogeneous, but there was no difference in the incidence or rate of wear between the different designs, suggesting that the weakness is in the polyethylene rather than in the component design. Wear rates were slightly higher in the Harris-Galante II (Zimmer) group, but their follow-up was longer.²⁹ The Birmingham hip resurfacings were within the senior author's learning curve for the procedure, there may be a higher rate of technical error due to inexperience. This may have biased the rate of revision.^{12,30-32}

The clinical results of the hybrid THAs are comparable with those of other medium-term reports in young patients.^{5,33-39} However, polyethylene wear and osteolysis are a cause for concern. This review confirmed our previous observation¹⁵ that a third of these patients refused to moderate activity likely to increase wear. Wear and osteolysis tend to be asymptomatic and increase with time,^{29,40} emphasising the need for regular long-term follow-up. The problems and degree of osteolysis represent the minimum that is truly present.⁴¹ Polyethylene preparation and storage have changed since this study⁴² and highly cross-linked polyethylene has now been introduced. This results in less wear debris⁴³ but the release of biologically active particles may be proportionately higher, leading to similar overall osteolysis.⁴⁴ As a result, we have stopped using polyethylene in young active patients and instead employ ceramic-on-ceramic or metal-on-metal bearings.

The early results of metal-on-metal resurfacing have been encouraging. Early fractures are rare. Roentgen stereophotogrammetric analyses suggest that the femoral component is stable after two years.^{45,46} Excellent functional results

have been reported.¹¹⁻¹⁵ Our results, and those from Birmingham¹⁰ suggest that the early excellent clinical performance of the Birmingham hip resurfacing is maintained at five years in the majority of patients. However, neither the Birmingham¹⁰ nor the Australian¹³ series reported adverse radiological features. Amstutz et al,¹² using the Conserve Plus (Wright Medical Technology, Arlington, Tennessee) prosthesis, noted radiolucent lines in over 25% of hips, in all three femoral component zones (our type-1b and type-c) in 2.9%, and migration of femoral components (type-2) in 3.9%. We suggest that these and the radiological signs we describe, represent avascular necrosis. Little et al³¹ noted loosening in only one of 13 retrieved specimens, but 12 demonstrated avascular necrosis. Late avascular necrosis leading to displaced fracture is a recognised and possibly inevitable complication of resurfacing.^{10-12,15,30,31}

In our hips with pedestal signs or migration, there was increased density of femoral neck trabeculation and medial cortical hypertrophy. Remodelling on plain radiographs was also noted by Yishida et al,⁴⁷ who observed a mean increase in bone mineral density in Gruen zone 7 of 11% in a series of 13 Birmingham hip resurfacings. They did not, however, compare this with radiological changes around the stem.

If avascular necrosis is responsible for these radiological changes, the effect of the surgical approach used must be considered. The posterior approach is recommended for resurfacing, as it preserves abductor function and with a large head, dislocation is rare. However, it devascularises the femoral head, possibly permanently.⁴⁸ Comparison with resurfacings performed through a transgluteal approach would clarify this concern.

We have compared two of the strategies used in the management of osteoarthritis in young active patients. Other options include ceramic-on-ceramic THA.^{49,50} Metal-on-metal bearings could be used with a stem, but a failed Birmingham hip resurfacing can easily be revised to this option and it would be sensible to reserve this for failed Birmingham hip resurfacings or femoral heads unsuitable for resurfacing. Regardless of the reservations detailed in this study, the results of hip arthroplasty in younger patients are better than those previously reported with cemented total hip replacement,⁵¹ in which there was a 14% revision rate after five years and 50% survival after 15 years.⁵² Longer follow-up may establish whether the change of practice recorded here represents a true advance.

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