HIP JOINT RESURFACING

MINIMUM 20-YEAR FOLLOW-UP

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ABSTRACT

Hip joint resurfacing is an attractive concept because it preserves rather than removes the femoral head and neck. With a more natural arthroplasty there is the promise of better function, and a less difficult revision if it is needed later. This report will be the first long term report on the results of total hip resurfacing. 445 patients (561 hips) were followed for a minimum of twenty years. Only 23 patients were lost to follow up. The average age at surgery was 52.

More than 84% percent of patients were followed until their death. A femoral prosthesis with a small curved stem was used in all patients. Three different types of acetabular reconstruction were employed. In the first cases, before polyethylene was available, polyurethane, polyacetal and nylon were used. Next, metal-on-metal was used. Polyethylene either secured with cement or as the liner of a two piece porous-coated implant was next. The short term results were excellent with all acetabular combinations. The long term results were not with the exception of metal-on-metal. None of the 121 patients (133 hips) who received a metal-on-metal prosthesis experienced failure or a complication. The failure rate with cemented polyethylene at 20 years was 41%. Surgical complications were infrequent. Hip resurfacing using a metal-on-metal articulation with a stemmed femoral component is a durable and successful procedure. It is technically demanding.

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INTRODUCTION

Hip joint resurfacing maintains the natural size of the femoral head and neck. Proprioceptive feedback from the preserved metaphyseal bone and joint capsule continue and there is normal biomechanical function.[8,26] The resurfaced hip is stable and capable of an excellent range of motion. With a limited amount of implanted material, infection if it occurs, can be dealt with easily. Because the femur is not decapitated, hip resurfacing is less invasive (rather than small incision) surgery. There is less pain and blood loss from resurfacing compared to conventional replacement with an earlier return of function. Unique disadvantages are the possibility of a femoral neck fracture or a collapsed femoral head from osteonecrosis.

The first total hip resurfacing arthroplasty was developed by Charnley in 1951 using a polytetrafluorethylene-on-polytetrafluorethylene (Teflon or Fluon) bearing. This failed due to osteonecrosis of the femoral head. The poor wear characteristics of the Teflon became apparent later when Charnley used it as the bearing surface of a conventional total hip replacement.[4,5,9] This report includes cases from the second attempt at a total hip resurfacing.

Hip joint resurfacing was popular in several centers in the 1970's, in Europe, Japan, England, and the United States. Initial promising results gave way to unacceptable failure rates, owing to acetabular loosening and/or wear. Less commonly femoral neck fracture, osteonecrosis, or loosening of the femoral component occurred. [1,3,9,10,11,13,14,25]

Resurfacing was largely abandoned again until the 1990's except by a few, including the current authors. It was resurrected 10 years ago for the same initial reasons that made it attractive. [2,8,22] Young patients still fear the difficulty of treating a failed intramedullary, stem supported hip prosthesis. With the newer hip joint resur-

FIG. 1

Photograph of a contemporary metal-on-metal surface replacement.

facing prostheses, the short term results are favorable *(Fig 1)*.[2,8,22] The long term results with these implants, however, are not known. The purpose of this report is to provide long term information.

METHODS

The authors performed 561 total hip joint resurfacing procedures in 445 patients. 312 femoral hemi-resurfacing procedures were performed that are not included in this report. The underlying diagnosis was osteoarthritis in 334 patients (75 percent); osteonecrosis in 44 (10 percent); post traumatic arthritis in 31 (7 percent); inflammatory arthritis in 18 (4 percent) and developmental dysplasia in 18 (4 percent) patients.

227 patients were women and 218 were men. The mean weight was 84 kg (range, 50-107 kg). The mean age was 52 years (range, 30-74 years). 97 patients were 30-40 years old, 118 were 40-50 years old, 109 patients were 50-60 years old, 100 were 60 to 70 years old, and 21 patients were 70-74 years old.

The surgical procedure was consistent. An anterolateral approach without trochanteric was used in each case. The hip was dislocated anteriorly and the femur was prepared. The femoral head was downsized when possible using great care not to notch the femoral neck. The zenith of the femoral head was removed at an approximate 140 degree angle to the neck. All at risk bone was removed. Cylinder and chamfer cutters completed the femoral head preparation *(Fig 2)*.[24] An effort was made to insert the femoral stem close to the center of the femoral neck. Prostheses were placed using an interference fit, cemented, or porous-coated technique.

Implants Used

The first acetabular surface used was polyurethane. This acrylic was prepared at the time of surgery and shaped to the femoral prosthesis. It was prepared from powder and liquid and performed as both the anchoring cement for the femoral side and an articular replacement for the acetabulum. Although it was "plastic" it was a fairly rough finish. Nylon and polyacetal were also used for the acetabulum with polyurethane used as the cement.

All the metal-on-metal implants were made of cobalt chromium *(Fig 3)*. They were placed without cement on the acetabular side and with or without cement on the femoral side.

Polyethylene, when it became available in the 1970's, was used in a thickness of 4.5 mm. Later the thickness was increased to 6.0 mm. It was cemented in place using polymethylmethacrylate. The two-piece metal polyethylene component was porous coated with openings for adjunctive screw fixation *(Fig 4)*.

Follow-Up

Patients were followed prospectively and were asked to return at one year, two years, five years, and every five years thereafter. When this was not possible, patients were asked to answer a letter questionnaire or were contacted by telephone and interviewed using a standard telephone

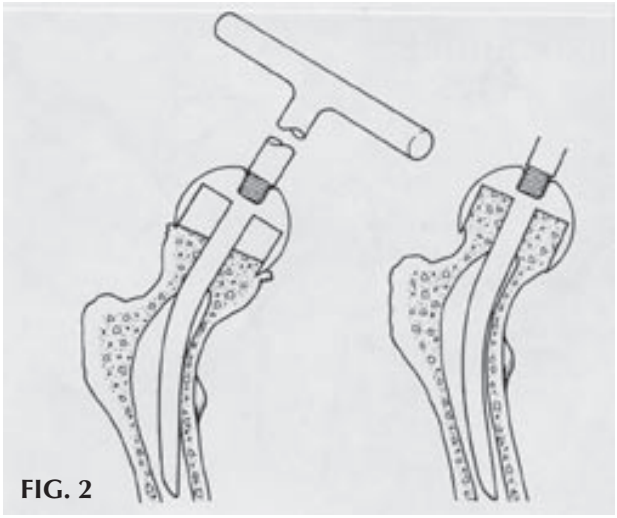

FIG. 2

Line drawing of preparation of the femoral head for a hip resurfacing.

FIG. 3

Photograph of the metal-on-metal hip resurfacing in this report.

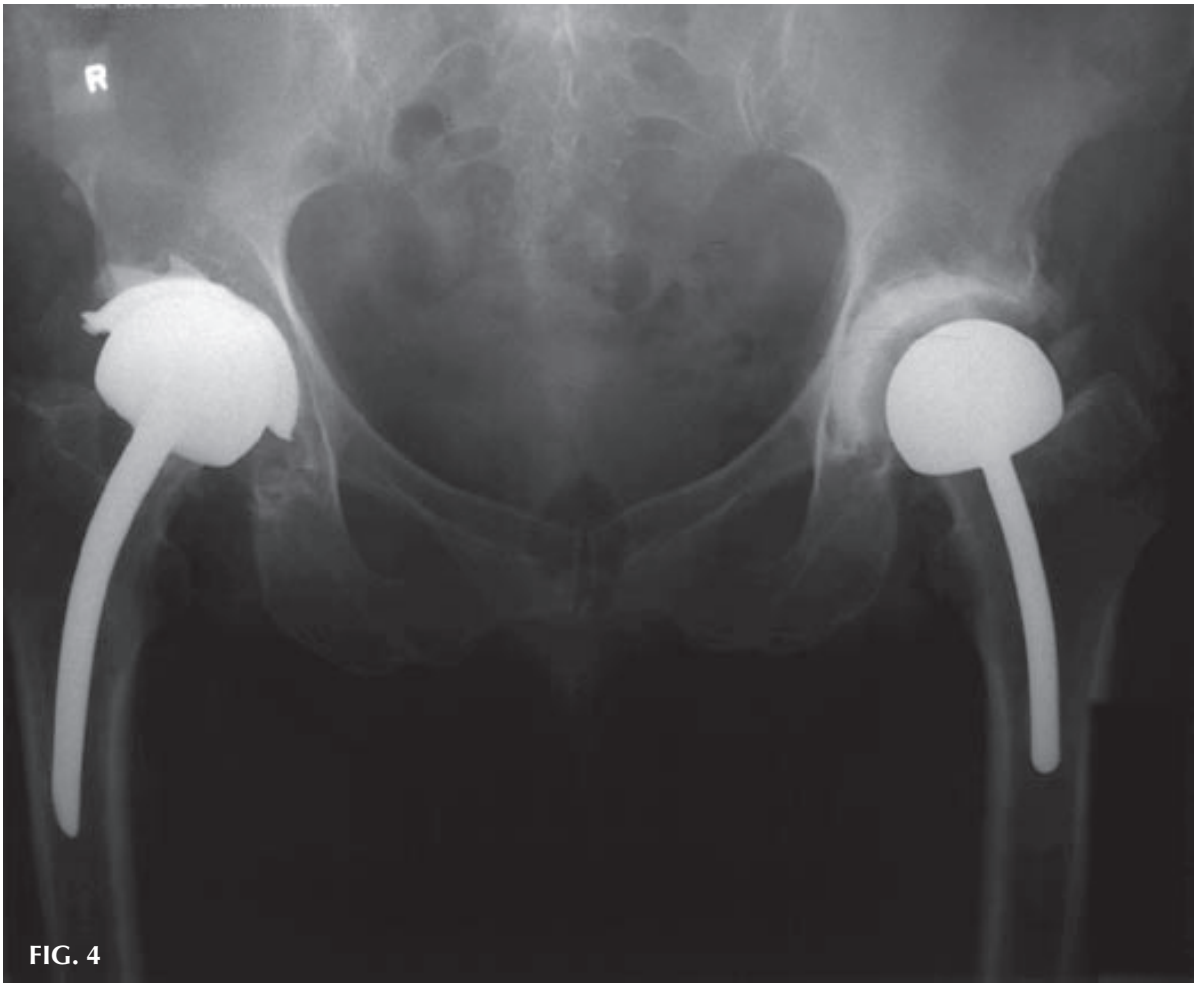

FIG. 4

Radiograph of a cemented polyethylene cup on one side and a cementless acetabular prosthesis on the other.

questionnaire. Patients were specifically queried about whether they had had additional surgery on their hip. If they had, information about that subsequent surgery was obtained. Dates of death were obtained either by direct communication with the family or by way of the Social Security network.

Implant survivorship was estimated with the use of the Cox proportional-hazards model and was adjusted for correlated data — that is, for two hips in a patient who underwent bilateral surface replacement arthroplasty. Patients were censored at death or at revision. End points included revision or removal of either component for any reason. Ninety-five percent confidence intervals were calculated for the Kaplan-Meier survivorship estimates. [16] The survival until death was compared with the expected rate of survival in an age-and-gender matched population of white United States citizens. [20] The survivorship analysis was calculated for different groups depending on the type of acetabular reconstruction employed.

RESULTS

CLINICAL RESULTS

At the time of minimum twenty-year follow-up the average age of the 71 patients who were still alive was 75 years (range, 53-94 years). In the group of 374 (84 per cent) patients who had died, the average age at the time of death had been 80 years (range, 58 to 99 years). Nineteen patients died in the first five years after the resurfacing; 24 between five and ten years; 54 between ten and twenty years; 166 between twenty and thirty years; and 111 more than thirty years after the resurfacing.

A deep infection developed in eleven (2 percent) patients at some time during the follow-up period. A dislocation occurred in 5 (less than one percent). A periprosthetic fracture occurred in 16 (3 percent) at some time during the follow-up period. Ten of these (1.7 percent) were femoral neck fractures.

Patients (hips) were assessed for pain at least two years

after the resurfacing. 459 (82 percent) patients experienced no pain; 85 (15 percent) slight pain; 11 (2 percent) moderate pain; and six (1 percent), severe pain.

254 (57 percent) patients were active and participated in athletics or strenuous work. 147 (33 percent) performed moderate work and claimed no limitations in activity; 22 (5 percent) were semi-sedentary and 22 (5 percent) were sedentary.

427 (96 percent) patients were satisfied with their resurfacing; nine (2 percent) were dissatisfied because of a limp or weakness; and nine (2 percent) were dissatisfied because of pain. There were 27 patients with a resurfacing on one side and a conventional total hip replacement on the other. All indicated that the resurfacing was the better hip.

RADIOGRAPHIC ANALYSIS

Eleven (2 percent) of patients had unsatisfactory positioning of the femoral component. In twelve (2 percent) the femoral neck was notched. A femoral neck fracture occurred in three of these patients. In six (1 percent) the femoral component was incompletely seated because of inadequate resection of the femoral head or poor cement or insertion technique. Five hips had varus positioning of the femoral component. The acetabular component was in an unsatisfactory position in 12 hips. In six patients both components were unsatisfactorily positioned. The hip resurfacing failed in 17 hips with components in an unsatisfactory position.

DEXA scans were performed in forty patients. In 31 the femoral neck bone remained equal to the unresurfaced contralateral side. In five the bone density increased and in four it decreased.

REVISION OF THE RESURFACING PROSTHESIS

One hundred forty revision procedures were performed. **No** metal-on-metal prostheses were revised and only one metal-on-urethane required revision. Therefore, all but one revision procedure involved a metal-on-polyethylene articulation.

Revision procedures included removal of both components and insertion of a new resurfacing prosthesis in two patients. Revision of just the acetabular prosthesis alone was performed in 21 hips. 117 hips were converted to a conventional total hip replacement.

The mean follow up for the entire series was 26 years (range, 20 to 41 years). The results at final follow up were separated by the type of acetabular component used. Polyurethane, polyacetal and nylon procedures were aggregated together (24 patients, 26 hips). The average follow-up for this group was 24 years (range, 11 to 31 years). All these acetabular prostheses failed due to wear. The bearing surface disappeared radiographically over time *(Fig. 5)*. The hips then functioned as a hemiarth-roplasty. Only one patient came to revision. Conversion to a metal-on-metal surface replacement was performed with a good result. The average time for failure was 4.1 years. All these patients were followed until their death.

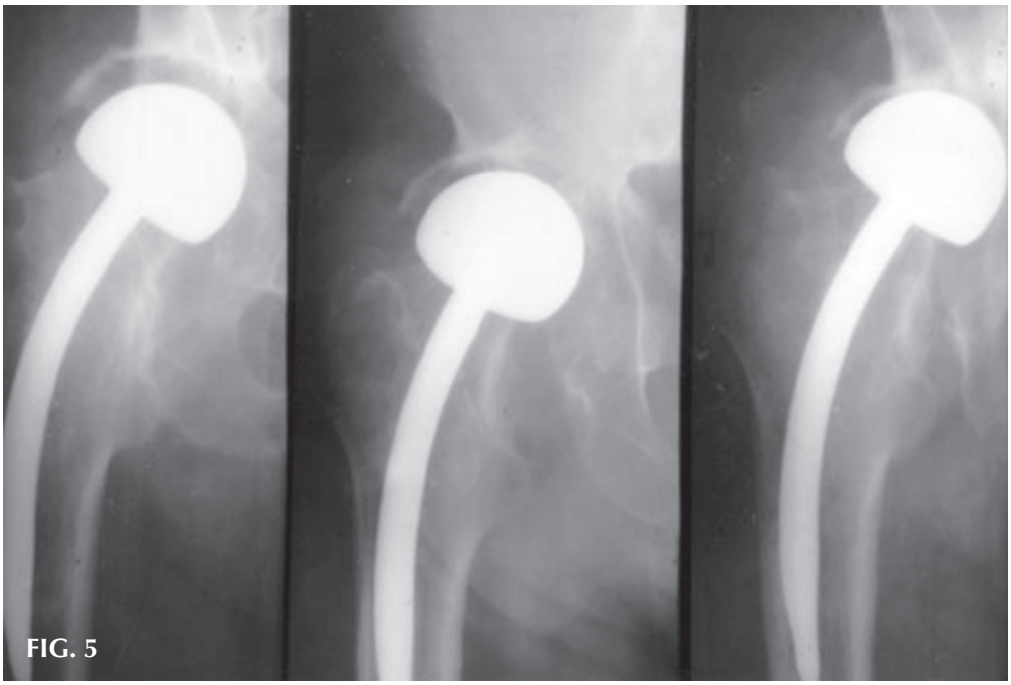

FIG. 5

Radiograph of a polyurethane acetabular resurfacing disappearing over time.

For patients with metal articulating directly with metal, there were **no** failures. The average follow up was 27 years. The result was excellent in each patient. Patients were followed until their death or in the case of four surviving patients a minimum of 20 years. The longest follow-up was 41 years and average age at the time of surgery was 48 years.

227 patients (282 hips) received a cemented polyethyl-

ene acetabular prosthesis. 116 (41 per cent) failed. Loosening of the acetabulum was the reason in 81 hips and wear of the polyethylene was the reason in 35. The femoral prosthesis was also loose in eight patients. There were six femoral neck fractures in this group. 105 hips were revised.

83 patients (118 hips) received a two piece cementless acetabular prosthesis. Forty (34 percent) failed. Failure was due to loosening with migration in 12 hips and polyethylene wear in 28 hips. Revision surgery was performed in 35 hips. There were 15 patients with a cemented polyethylene prosthesis on one side and a cementless two piece acetabular prosthesis on the other.

SURVIVORSHIP ANALYSIS

The Kaplan-Meier method was used to calculate the probability of survival from the time of the initial arthroplasty. Survivorship curves, with 95 per cent confidence intervals, were calculated using failure for any reason. The probability of retention of the prosthesis at the latest follow-up evaluation was 99 percent for metal-on-metal; 46 percent for cemented metal-on-polyethylene, and 61 percent for cementless metal-on-polyethylene. Because all the polyurethane, polyacetal and nylon patients had complete wear through the survivorship calculation was not necessary for these patients.

DISCUSSION

To determine survivorship over a long period of time, we followed a large series of total hip resurfacing procedures. By following the patients for a minimum of twenty years or until revision or death, we were able to determine the lifetime risk of failure. The high rate of follow-up, the large number of patients, and the fact that most patients were followed until death improved the validity of the survivorship estimates.

The survivorship data in this series show more failures in the early years when compared with conventional hip replacement. [27] This was because of failure from unsatisfactory component positioning and wear through of early acetabular resurfacing choices. It is safe to say that exposing and positioning the acetabular component with the femoral head in the way is difficult. Also, the preparation of the femoral head is demanding.The survivorship free of revision data was nearly linear over the later years.

Dislocations were much less common with resurfacing than with conventional replacement. The larger head size is a reason. The anterior approach is another. Few infections occurred and they were easily treated because of the minimal penetration of the prosthesis into the medullary space and the significant remaining proximal femoral bone.

Femoral neck fracture can occur after hip resurfacing but this a rare complication. [21] A femoral stem used in conventional hip replacement can also fracture. [5,27] Periprosthetic fractures including the femoral neck do occur after hip resurfacing but just at the same rate (3 percent) as with conventional hip arthroplasty.

Young age has been recognized to have a negative effect on the durability of a hip prosthesis in most previous studies, but not all.[17] Gender has been shown to have a negative effect on the durability of total hip prostheses. Compared with women, men have a twofold increase in the rate of implant failure from aseptic loosening. [17,27]

A number of implants, back in the day, have resurfaced the femoral head. An early implant was the cup arthroplasty.[12] This was an interposition device rather than one fixed to bone. Some cup arthroplasties worked well but others failed because of the inability to replace and maintain the articular barrier between the metallic femoral surface and acetabulum. Also, there were difficulties in obtaining and maintaining mobility and even distribution of weight on the femoral bone and prosthesis. Gerard used a metal-on-metal resurfacing prosthesis but did not fix the acetabular component to the pelvis. [11]

Most early resurfacing implants called for hemi spherical preparation of the femoral head followed by placing a hemi-spherical shaped femoral implant. These sometimes loosened due to the shear. [3,10,14,25] In this series, we converted a hemisphere to a flat topped cylinder which provides compressive resistance stability. [18,24] Also, a short, curved stem on the prosthesis adds varus stability without stress relieving the proximal femur. [7]

A well performed femoral resurfacing only rarely fails over time. This was true when an interference fit technique was used before either cement or porous coating was available. There is no advantage to using porous coating on the femoral implant nor disadvantage to using cement. Cement provides immediate stability.

The difficulties with hip resurfacing have been primarily on the acetabular side. Originally, Charnley used polytetrafluorethylene and it failed. [4,5] In this report, polyurethane, polyacetal and nylon failed every time. With polyurethane though, there is no osteolytic reaction and patients functioned generally well as it wore away. The patients had some pain and the radiograph looked as though a hemi-arthroplasty had been performed. The polyurethane was crude and it has now been reformulated. The wear characteristics so far, seem favorable.

Cemented polyethylene acetabular components were

unsuccessful in this report and others.[3,10,13,14,23] They both loosened and wore through. Osteolysis developed in many instances. Metal backed cemented polyethylene sockets were not used in this report and they failed in other reports when they were used. [19,23] A cross linked polyethylene acetabulum may work better particularly when used with a ceramic femoral prosthesis *(Fig. 6)*.

Theoretically, avoiding a hard-on-hard joint surface has advantages. The strain distribution on the acetabular aspect is adversely affected by the stiffness of a metal component.[15,26] Unfortunately, to use the softer polyethylene either a thin implant prone to wear or loosening or too much acetabular bone had to be removed. With metal-on-metal it is possible to couple thin heads of large diameter. This means many more patients have the appropriate geometry for hip resurfacing.

It is noteworthy that the metal-on-metal prosthesis that was successful in this report was the second material tried. When polyethylene became available metal-on-metal was largely abandoned for a number of years until the drawbacks of polyethylene coupling became apparent. Metal-on-metal is now the most popular option *(Fig. 7)*. While none of the newer components have yet accomplished more than a 10 year follow up, they vary only slightly from the prosthesis described in this report. [2,8,22] The superior articulating characteristics of the metal surfaces available today suggest that excellent longevity can be expected. Ion release exists with metal-on-metal but its significance remains unknown and no difficulties relative to this issue were identified our long term series. [6]

Hip resurfacing can be a successful and gratifying procedure. It is different and more difficult than conventional hip replacement. Good bone quality is required. Restitution of significant preoperative limb length inequality is not possible. Some acetabular deformities cannot be addressed. Hip resurfacing is an attractive option for a young patient fearing a potentially difficult future revision. Resurfacing procedures should be carried out in centers where definite interest and experience in the technique exists.

FIG. 6

Photograph of a modular ceramic stem femoral hip prosthesis.

FIG. 7

Radiograph of a contemporary metal-on-metal resurfacing prosthesis.

"The superior articulating characteristics of the metal surfaces available today suggest that excellent longevity can be expected."

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