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Hip resurfacing: mid-term results of the last-generation metal-on-metal devices

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Abstract Total hip resurfacing has long been conceptually attractive to both surgeons and patients. However, historically it has been plagued by limited durability and marked acetabular bone loss. The recent development of wear-resistant bearings such as metal-on-metal has led to renewed interest in hip resurfacing in the orthopaedic community. We report the clinical and radiological results of 350 consecutive surface arthroplasties performed in 325 patients (mean follow-up 20 months). Harris Hip Score increased over time from 57 pre-operatively to 98 at 2 years follow-up. Complication's rate was low. Four patients required revision surgery. The overall survival rate was 98.8%. Considering the positive results of more than 350 implants of our series, we now believe that there is evidence showing that this surgical concept deserves consideration, particularly when treating young patients with hip diseases.

Key words Hip resurfacing arthroplasty • Metal-on-metal • Osteonecrosis • Femoral head • Osteoarthritis

Introduction

The fascinating concept of hip resurfacing was resumed after the development of metal-on-metal (MOM) articulations for total hip replacement. Weber, with Sulzer Orthopedics, developed the Metasul bearing, a precisely engineered high carbon-containing, wrought Co-Cr alloy with excellent wear characteristics [1]. This durable low-wear bearing enabled Wagner and Wagner [2] to introduce a cementless MOM resurfacing system in 1991, where both components consisted of two layers: a titanium alloy metal backing and a Metasul articulation.

The results of these first-generation MOM hip resurfacing implants were quite poor. At the time, these failures were thought to be primarily caused by necrosis of the femoral head and fractures of the femoral neck. More recently it was shown that an important cause of these failures was the generation of large volumes of biologically active particulate debris, leading to bone loss and implant loosening. Howie et al. [3] examined 72 failed Wagner resurfacings and concluded that the bone destruction was consistent with wear particle-induced osteolysis, not avascular necrosis. These finding were confirmed in other similar studies [4, 5].

With the first generation of MOM hip resurfacing implants, although proximal femoral bone stock was well maintained, there was often significant loss of acetabular bone as a consequence of the excessive bone removal required to accommodate the acetabular component and the cement mantle. Loosening of the acetabular component due to excessive wear debris was a further cause of an even more severe lack of acetabular bone.

The other major mode of failure of the first-generation hip resurfacing procedures was femoral neck fracture. However, this complication was rare and caused by either an inappropriate surgical technique or osteolysis of the femoral neck due to the generation of wear debris.

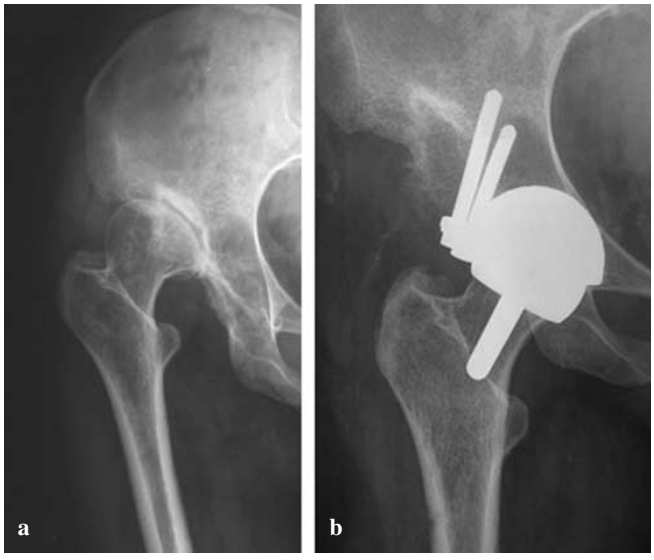

Fig. 1a,b *Congenital hip dysplasia in a 41-year-old woman.* **a** Preoperative radiograph. **b** BHR with the dysplasia cup fixed with two screws, 33 months after surgery

Subsequently, three major MOM resurfacing systems evolved: the Cormet-2000 manufactured by Corin Medical, the Birmingham Hip Resurfacing (BHR) manufactured by Midland Medical Technologies and the Conserve Plus manufactured by Wright Medical. By the end of 2004, all MOM hip resurfacing implants had in common a bearing made of high carbon-containing Co-Cr alloy, a cementless fixation of the acetabular component and a cemented fixation of the femoral component. However, there are also significant differences between these implants relating to the metallurgy and geometry of the bearing and aspects of the fixation of the acetabular and femoral components. The BHR also includes an acetabular component which can be fixed by means of supplementary screws for severe congenital hip dysplasia (Fig. 1), and a thicker acetabular component for hip osteoarthritis secondary to acetabular fractures. By using the latter it is possible to lengthen the limb.

Joint replacement provides a marked improvement in the quality of life of patients with hip diseases. However, young and active patients still pose a tremendous challenge to the orthopedic surgeon, as conventional joint replacement does not provide a lasting solution to their needs [6-8]. In addition, patient expectations have changed over the past decade such that modern prosthetic design must address both the low demand requirements of an elderly patient and the work and leisure aspirations of the younger patient.

Total hip resurfacing offers a suitable solution for young and active patients affected by osteoarthritis, avascular necrosis, epiphysiolysis, congenital hip dysplasia, rheumatoid arthritis, etc. The advantages of hip resurfacing over total hip replacement include wider range of motion, lower rate of dislocation, less wear, minimal bone resection, more anatomical restoration of leg length and femoral offset, easier revision and reduction of stress shielding in the proximal femur [9, 10]. We present our experience with hip resurfacing using the BHR implant: the aim of this study is to evaluate the clinical and radiological outcomes of 350 consecutive hip resurfacing implants at latest available follow-up.

Materials and methods

Between January 2001 and June 2006, we performed 350 consecutive surface arthroplasties with a BHR in 325 patients (25 bilateral), including 170 men and 155 women.

The most common indications for the procedure were primary coxarthrosis (52% of cases, Fig. 2) and congenital dysplasia of the hip (22%). Post-traumatic coxarthrosis, Perthes' disease, rheumatoid arthritis, avascular necrosis and epiphysiolysis (Fig. 3) were also indications for hip resurfacing. Severe femoral head cysts and osteopenia were considered contraindications to

Fig. 2a,b *Bilateral coxarthritis in a 50-year-old woman.* **a** Preoperative radiograph. **b** Bilateral BHR three (right) and four (left) years after surgery

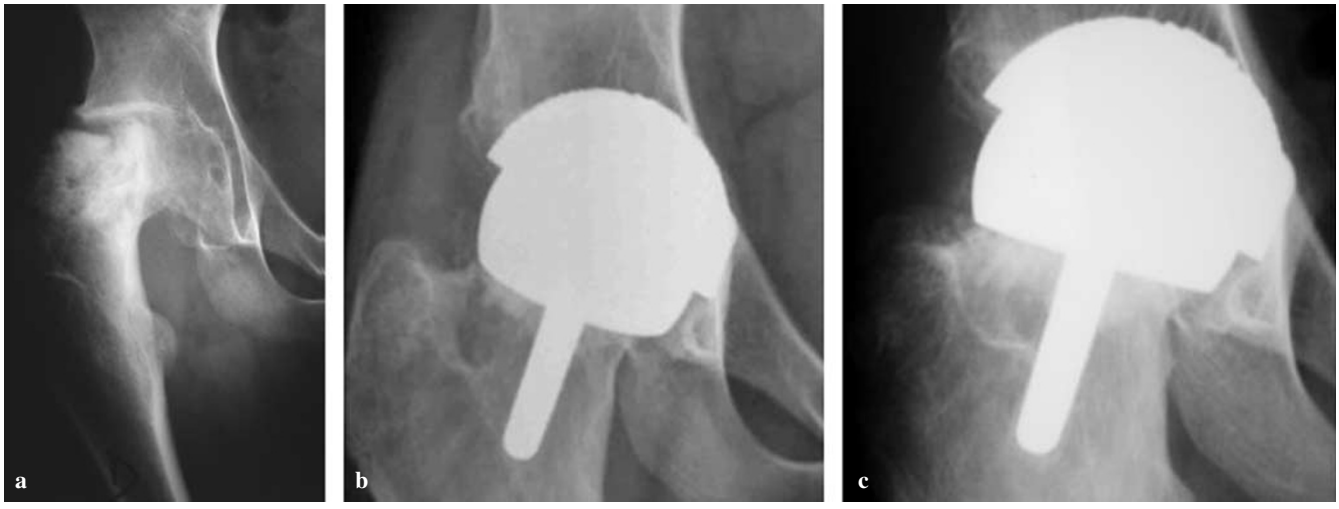

Fig. 3a-c *Epiphysiolysis in a 16-year-old boy*. **a** Preoperative radiograph. **b** BHR at the 6-month follow-up. **c** Radiographic appearance at 5 years

the procedure. All operations were performed with a posterolateral approach by two senior authors SG and AM. The average age of the patients was 51 years (range, 15–73). The mean follow-up period was 20 months (range, 3–66).

The Harris hip score (HHS) was determined for all patients before surgery and after 3, 9, 18 and 24 months. At the same scheduled follow-up visits, radiographs of the pelvis were taken. The position of the prosthetic components (Fig. 4) and the presence of areas of radiolucency were recorded. Rehabilitation included early mobilization after the first day and partial weight-bearing after the second day. The average hospital stay was 6 days (range, 3–8).

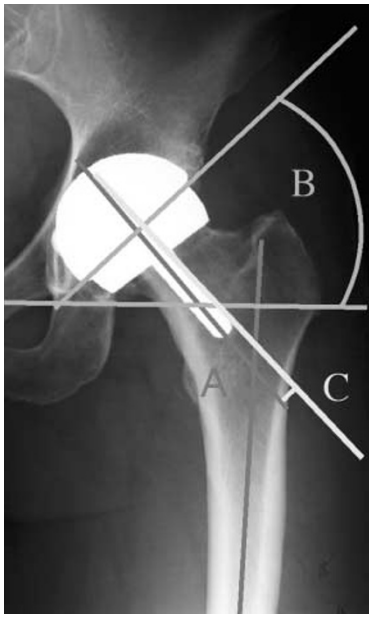

Fig. 4 Radiographic analysis. *A*, femoral component-shaft angle; *B*, angle of abduction of the acetabular component; *C*, femoral component-shaft angle minus femoral neck-shaft angle

Results

Hip resurfacing was performed in 350 hips (325 patients) over a 5-year period. Mean HHS was 57±23 pre-operatively (350 hips). It increased to 89±15 at 3 months (350 hips), 96±18 at 9 months (263 hips) and 98±13 at 18 (176 hips) and 24 months (107 hips). In 92% of resurfaced hips at the latest available follow-up, a normal range of motion was recorded (flexion ≥100°, extension ≥15°, adduction ≥25°, abduction ≥30°, internal rotation ≥25°, external rotation ≥25°) and patients reported a feeling of a normal hip. Radiographic analysis at the latest available follow-up showed no radiolucency around the prosthetic components. The femoral component was implanted in a slightly valgus position compared to the neck axis with an average angle of 8.2°±6° (range, 0°–15°). The acetabular component was implanted with an average angle of abduction of 47.5°±14° (range, 42°–60°).

Complications included 3 post-traumatic dislocations (0.85%), 1 non-traumatic dislocation (0.28%), 3 cases of transitory femoral nerve palsy (0.85%), 1 acetabular fracture (0.28%), and 3 vascular ruptures (0.85%) treated with angioplasty (superior gluteal artery, medial circumflex artery and internal iliac vein).

Four patients (1.14%) required revision surgery, 3 because of a fracture of the femoral neck that occurred within 2 months of surgery (Fig. 5) and one because of avascular necrosis confirmed at the histological analysis. In these cases revision was performed with an uncemented stem and a large diameter femoral head.

Considering our series of 350 consecutive hip resurfacing at an average follow-up of 20 months, the overall survival rate is 98.8%.

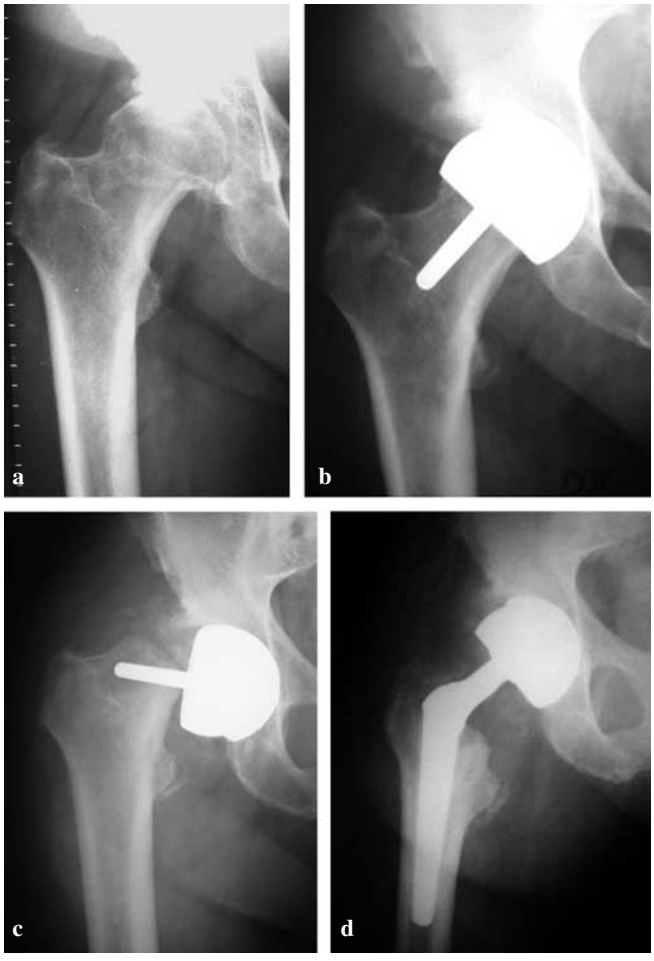

Fig. 5a-d *Osteoarthritis of the right hip in a 55-year-old man.* **a** Preoperative radiograph. **b** Radiograph taken immediately after surgery. **c** A femoral neck fracture 55 days after surgery. **d** Revision with a MOM total hip prosthesis

Discussion

Few papers have been published reporting results at medium term after modern MOM resurfacing of the hip. Daniel et al. [11] reported 446 hip resurfacings performed in 384 patients (302 men and 82 women) using BHR. The patients' mean age at operation was 48 years (range, 26–55), and the length of follow-up ranged from 1 to 8 years (mean, 3). Postoperative complications were rare; only one hip in a 54-year-old patient had to be revised eight months after the operation. The cause of failure was avascular necrosis of the femoral head. This hip was revised to a ceramic-on-polyethylene total replacement. The cumulative survival rate was 99.8%. Although only 9 patients were followed for 8 years, the 99.8% survival rate in this study of young patients with osteoarthritis is an important result especially if compared with the survival rate after total hip replacement in similar populations. According to the Swedish Hip Arthroplasty Registry [8], the 10-year survival rate of total hip replacements with modern cementing techniques is 81% in men and 80% in women under age 55 years.

Treacy et al. [12] reported a series of 144 consecutive MOM resurfacings of the hip with results similar to those of Daniel et al. [11], using the same type of implant. The mean age of the patients at implantation was 52 years. In this series, the minimum follow-up was 5 years, and the survival rate was 98%. Three patients were revised, two because of an infection and one because of a fracture of the femoral neck.

Amstutz et al. [13] reported a series of 400 hip resurfacings (355 patients) using the Conserve Plus implant. The patients had an average age of 48 years, 73% were men, and 66% had a diagnosis of osteoarthritis. Clinical and radiographic follow-up was performed at three months postoperatively and yearly thereafter. The majority of the patients returned to a high level of activity, including sports. 54% had UCLA activity scores >7. Kaplan-Meier survivorship analysis demonstrated that the rate of survival of the components at four years was 94%. For 12 hips (3%), conversion into total hip replacement was necessary. Seven of these 12 hips were revised because of loosening of the femoral component, 3 because of a femoral neck fracture, one because of recurrent dislocation, and one for a deep infection.

All 3 papers [11–13] showed that good results can be obtained at medium term following modern MOM hip resurfacings and that the incidence of complications is low. The results of our series (100 hip resurfacings at a minimum follow-up of two years) are in agreement with those reported in these papers.

MOM hip resurfacing is the fastest growing orthopaedic surgical procedure worldwide [14]. The studies cited in this paper [11–13] showed consistently positive results at the medium term and a low incidence of complications. Given this, we can state that hip resurfacing, a surgical concept which was completely discontinued in the 1980s, has been resurrected.

There are several points which deserve consideration. The first is its indication. This procedure is generally more indicated in young and active patients, a patient population which remains problematic in terms of functional results and, particularly, prosthesis durability when treated with conventional total hip replacement. However, whether or not hip resurfacing is a truly better indication for these patients remains to be shown. When a prosthetic procedure is indicated, the surgeon should always bear in mind that a future revision could become necessary. Because of this, maintaining the bone stock as much as possible is a sound and straightforward concept

we should always remember. Preserving the femoral head makes hip resurfacing attractive also for active patients of an older age. In these patients, evaluating bone mineral density preoperatively by dual-energy X-ray absorptiometry could help in order to exclude patients at risk of femoral neck fractures because of weak bone.

If preservation of bone stock is clearly advantageous on the femoral side, there are concerns with regards to the acetabular side. In a recent randomized study, Vendittoli et al. [15] found no differences in acetabular bone removal between total hip replacement and hip resurfacing.

When discussing hip resurfacing, several other questions are generally raised. What is the true incidence of avascular necrosis and fracture of the femoral neck? According to two studies [11, 16], the incidence is about 1% and this could even be reduced with a better patient selection and more accurate surgery.

Does it matter if serum cobalt and chromium levels rise after surgery? Medium-term results do not show any adverse effect; furthermore no differences have been found compared to standard MOM total hip replacement [17, 18].

More importantly, what is the long-term durability of hip resurfacing? And, in case a failed resurfacing is eventually converted to a total hip replacement, will the long-term results of that procedure be altered in any way? There is no answer to these questions at the moment. What is of no doubt, however, is that MOM hip resurfacing arthroplasty has a part to play in modern orthopaedic surgery and that the change from a metal-on-polyethylene articulation was a clever and effective idea. The current models of hip resurfacing are a considerable improvement on previous versions. Whether they are better in the long term than a well established total hip replacement remains to be seen but it should also be said that the early results we have now are more than promising.

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