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Belgium Experience with Metal-on-Metal Surface Arthroplasty

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Metal-on-metal resurfacing is increasingly becoming widely used. The history of failures with the Charnley teflon-on-teflon and the Wagner/Tharies metal-on-polyethylene prostheses makes resurfacing controversial [1–6]. Results achieved with the new metal-on-metal resurfacing are starting to be published [7–15].

With the introduction of a metal-on-metal resurfacing prosthesis and a refined instrumentation, high volumetric polyethylene wear and malpositioning of the head component on the femoral neck—problems encountered with earlier designs—should be avoided [16–18].

The short-term clinical results are excellent; none of the early problems associated with the metal-on-polyethylene resurfacing have been encountered [9,11,15].

Theoretic advantages are less bone destruction, less bone resection, normal femoral loading, avoidance of stress shielding, maximum proprioceptive feedback, and restoration of normal anatomy. In addition, reduced risk of dislocation, less leg inequality problems, and easier revision should convince surgeons to favor metal-on-metal resurfacing. When infection occurs, a one-stage revision and a smaller contamination is likely.

The purpose of this study is to review the early clinical results of a hybrid metal-on-metal surface arthroplasty and analyze the clinical outcome, level of activity, and radiologic findings. A first Belgian experience with a well-documented prospective series is presented.

Materials and methods

From September 1998 to April 2004, 1114 metal-on-metal resurfacings were performed by the author. Most implants were Birmingham Hip Resurfacings (BHR; Midland Medical Technologies, Birmingham UK; Smith and Nephew, Memphis, Tennessee); the Conserve Plus (Wright Medical, Arlington, Tennessee) was used in 20 cases and the Durom (Zimmer, Wintherthur, Switzerland) device was used in 6 cases. This article presents a consecutive series of the first 252 patients (all BHR) with a clinical follow-up from 2 to 5 years. Patients were clinically scored with the Harris Hip and Postel Merle d'Aubigné scores, hip range of movement, and activity. Follow-up was done at 6 weeks, 6 months, 1 year, and then at 1- or 2-year intervals. Data were collected intraoperatively and postoperatively in a prospective way. Data storage and processing was done using the Orthowave and Statwave software (ARIA-GreyStone, Bruay Labuissiere, France).

Age at surgery ranged from 16 to 75 years, with a mean of 49.7 years. The mean weight was 81.9 kg (range, 44–140 kg; SD, 16). Body mass index averaged 27.1 (range, 18.8–47.9; SD, 4.3). Left and right hip distribution was equal (52.9 and 47.1, respectively). More male patients (68.9%) were treated than female patients (31.1%) (Table 1). The percentage of patients in Charnley group A was 93.8%, the

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Table 1
Sex and age of patients

Patients	Number	Mean age (y)	Range
Total	252	49.7	16–75
Male	176	49.6	17–75
Female	76	50.1	16–69

percentage in group B was 3.1%, and in group C, 3.1% [19].

Sixteen cases were bilateral resurfacings. In 237 cases, a normal BHR was used; in 15 cases, a BHR with dysplasia cup was used (Fig. 1). The mean length of hospital stay was 7 days (range, 2–25 days; SD, 3.5).

Indications

The author's institution has almost no contraindications for hip resurfacing arthroplasty. No avascular necrosis (even with severe femoral bone loss) (Fig. 2) or rheumatoid arthritis was excluded. An age limit was set to 65 years for male patients and to 60 years for female patients. Patients older than this limit who had a high activity level (UCLA activity scale >7) and good bone quality on radiograph (fluted champagne glass–shaped femur, thick femoral cortex, and good trabecular structure in the femoral neck) were also included. Preoperative diagnoses are shown in Table 2.

The only exclusion criterion was a too-deformed femoral head, whereby offset and leg length could not be restored with a resurfacing procedure.

Preoperative scores were not collected because no patients received an arthroplasty when the Harris Hip Score was higher than 60.

Radiographic follow-up

All radiographs were evaluated immediately postoperatively and at 6 weeks, 1 year, 2 years, and at the latest follow-up. Osteolysis, reactive and radiolucent lines, heterotopic ossification, bone remodeling, development of cysts, migration of the components, bone resorption or narrowing at the femoral neck, and lines around screws (dysplasia cups) were noted [11,20,21]. In the first 115 prostheses, several angles were measured on the preoperative and postoperative radiographs and registered (measurement on digitalized radiographs, standing pelvis, Siemens Endomap). Five measurements were done to evaluate the reproducibility of placement of the BHR prosthesis. The preoperative angle of the femoral neck was measured (Fig. 3). The postoperative angle of the head of the prosthesis was measured in relation to the shaft of the femur. The obtained result and the difference with the preoperative neck-shaft angle were determined. The abduction angle of the acetabular component was measured, and parallelism with the femoral component was noted [9].

Operative technique

All surgeries were performed through an extended standard posterior approach. The maximus split extends about 10 to 15 cm into the muscle. The insertion of the gluteus maximus tendon is fully released to allow easy anterior displacement of the femur and femoral head to perform the acetabular procedure. The gluteus maximus tendon is released with cauterization close to the bone. The tendon is never reattached for risk of entrapment of the sciatic nerve in the suture. Exposure is never jeopardized by

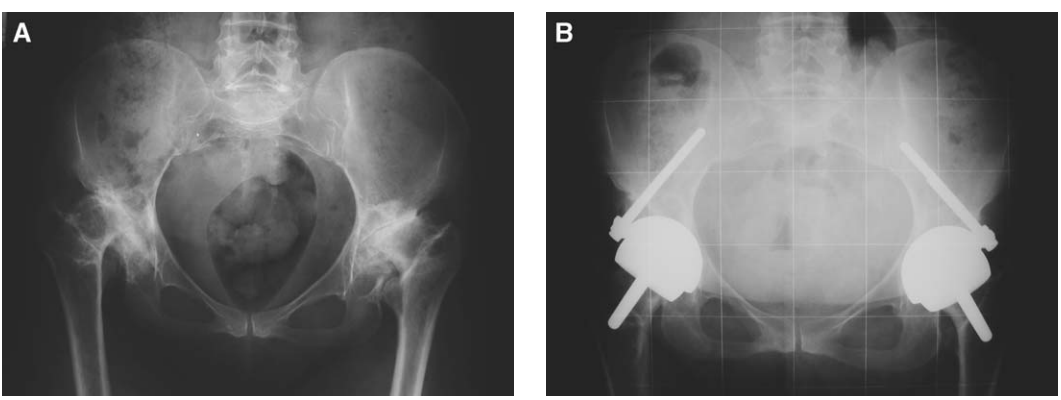

Fig. 1. Bilateral dysplasia BHR. (*A*) Preoperative x-ray. (*B*) Postoperative x-ray at 3 years.

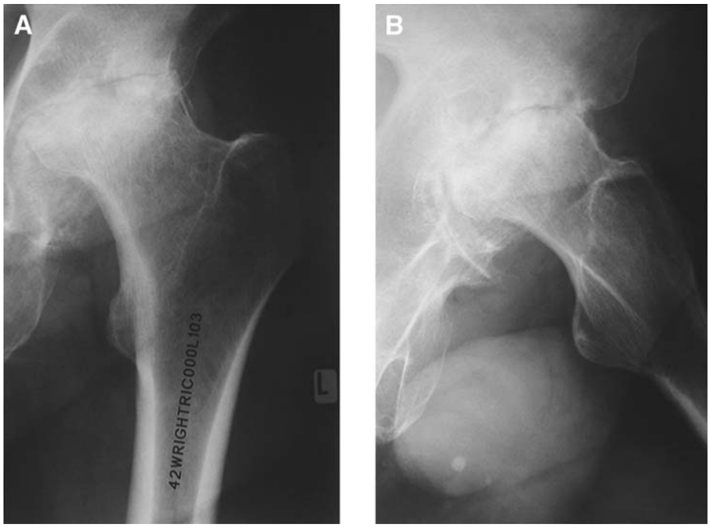

Fig. 2. Avascular necrosis (Ficat IV). (*A*) Anteroposterior view. (*B*) Lateral view.

a smaller or minimal incision. The capsule is divided circumferentially near the border of the acetabulum (1 cm). The posterior part of the capsule is incised as posterior as possible to not damage the soft tissue of the femoral neck. The circumflex vessels are always coagulated and divided. The soft tissues around the femoral neck are kept completely intact, and the capsule is not removed. Acetabular reaming is done as in a normal total hip procedure. A cup position of no more than 45° of abduction and an anatomic anteversion of 20° to 30° are aimed for.

Less anteversion can result in groin pain from local conflict with anterior structures and the psoas tendon. All resurfacing devices are chrome/cobalt alloys, which are stiffer implants than the more often used uncemented total hip titanium alloy cups. Therefore, a bigger force is needed to impact the cup. The absence of holes in the cup to see if it is fully seated explains the need for a hammer of at least 1 kg. In the BHR system, there is a possible additional screw fixation using a dysplasia device with two specially threaded screws. This cup only finds its application in congenital dislocation or severe developmental dysplasia in which a press-fit with a normal cup cannot be obtained. The superolateral aspect is grafted with autologous grafts from the reaming of the head and cup.

On the femoral side, meticulous placement of the central pin in the middle of the femoral neck is

Table 2
Etiology (N = 252)

	Indications	
Preoperative diagnosis	n	%
Osteoarthritis	203	80.56
Necrosis	22	7.26
Congenital dislocation of the hip	12	4.76
Rheumatoid	9	3.57
Traumatic	3	1.19
Neurometabolic	1	0.4
Other	2	0.79

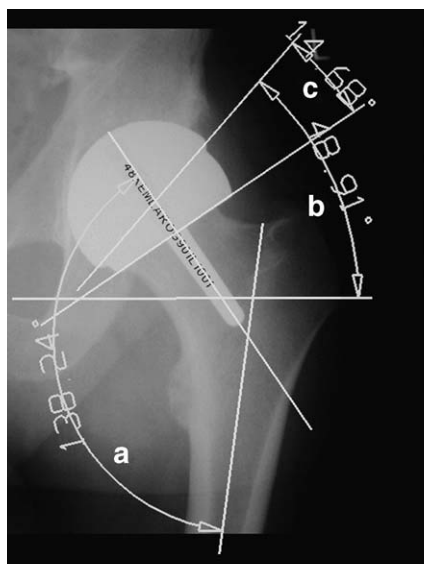

Fig. 3. Postoperative measurements. a, postoperative angle of the head of the prosthesis in relation to the shaft of the femur; b, abduction angle of the acetabular component; c, parallelism with the femoral component.

of capital importance. In addition, the varus-valgus angle and anteversion should be checked at the same time. A lateral femoral guide pin in the BHR system is helpful but can be forgotten at the end of surgery. In the other resurfacing systems, the varus-valgus angle and anteversion is assessed by eye. A goniometric device can help find a more correct varus-valgus angulation. In all cases, a 140° angle position is aimed for. Eight to 10 cement fixation holes of 4 to 5 mm are made before cementing the head component. When the bone is sclerotic, more and smaller holes (2 mm) are drilled (Fig. 4).

A femoral suction device is inserted into the lesser trochanter and keeps the femoral head dry and clean for cementing. It is inserted at the beginning of the femoral procedure. It also prevents general embolism and local thrombogenesis. Two-thirds of the head component is filled with tobramycin antibiotic cement (Surgical Simplex; Stryker, Mahwah, New Jersey) and impacted at 1 minute, 15 seconds. Before impaction, the femoral head is always pulse lavaged to clear the spongious bone. In large femoral defects (avascular necrosis), a longer time is waited (up to 2 minutes) to apply the head component. In avascular necrosis, all of the dead bone is removed and no bone grafts are used. Even in severe femoral bone deficiency in avascular necrosis, resurfacing is done. As long as there is a circumferential seal at the head-neck junction of the femur for the head component, cement pressurization can be obtained and resurfacing is not contraindicated.

Minimal bone resection is obtained with a size-to-size (line-to-line) placement of the femoral component on the bone. A line-to-line technique enhances a good primary fit, stability, and fixation. The impaction of the BHR femoral head sometimes requires a great deal of force because of a tight fit without cement extrusion. Marking the exact edge of the prosthesis on the femoral head-neck junction, before impaction, also helps to place the head implant at the ideal position and stop the impaction at the right time (Box 1). Proper preoperative templating is very important and the first indicator for the size of implant to be used.

Fig. 4. Big and smaller cement fixation holes.

Box 1. Risk factors for femoral neck fracture

- Notching the neck of the femur (cutting with cylindric reamer into the cortex of the femoral neck)
- Malpositioning of the central guide pin
- Varus placement of the head component
- Incomplete coverage of the reamed bone
- Removing soft tissues around the femoral neck (making the neck avascular)
- Impacting too hard and too long
  - Too much cement in the implant
  - Waiting too long before starting to impact
  - Not marking the end position of the implant before impaction
- Impacting in the wrong direction
- Removing too much bone of the femoral neck (head component too small)
- Severe osteoporosis

Thorough covering and draping of soft tissues and muscles before the preparation of the femoral head and the use of pulse lavage reduces heterotopic bone formation.

In the first 900 cases, a tight closure of all posterior structures, external rotators, and the trochanteric bursa was done. In the cases that followed, only the posterior capsule and piriformis tendon were reattached.

Postoperative protocol

Prophylactic cephazolin was administered for 18 hours (3 doses of 2 g). The patients were placed on low molecular weight subcutaneous heparins (nadroparine) for 3 weeks starting the day before surgery. In every patient, prophylactic indomethacin was given for 3 weeks (3 doses of 25 mg daily). In risk patients (ankylosing spondylitis, post-traumatic cases), a single irradiation dose of 7 Gy was given.

Patients were mobilized on the first postoperative day and allowed immediate full weight bearing. The average length of stay was 5 days, with discharge home on the third day post surgery. Patients were not given any further restrictions in activity. Patients

Table 3
Problems and risks encountered in sizing the resurfacing implant

Acetabular component	Femoral component
Too big	
Leg lengthening	Leg lengthening
Not covering implant and local conflict	Not covering implant and local conflict
Too much bone removal	
Malpositioning	
Loss of press-fit	
Too small	
No problems	Leg shortening
	Higher risk of notching and fracture
	Higher risk of avascular necrosis and stress fracture
	Risk of impingement
	Higher risk of dislocation

used two crutches for 10 to 14 days and then one crutch for another 2 weeks.

Component sizing

Choosing the right component size is often difficult. In resurfacing, there often is the choice of more bone removal from the acetabulum or from the femur. To adapt the cup to a big enough head size on the femur, a larger sized cup than might normally be selected is used. The choice is better range of motion with a bigger head size, bigger cup, and more acetabular bone removal or the possibility of impingement and less mobility in flexion with a smaller head size, smaller cup, and more acetabular bone preservation (Table 3).

Results

Clinical results

The duration of follow-up is from 2 to 5 years, with a mean for the group of 2.8 years. Of the 252 first patients, only 3 (four prostheses) were lost to further follow-up because they died. At the most recent follow-up, 97.8% had no pain. The total Harris Hip Score averaged 97.24 (range, 41–100; SD, 7.6). The mean Postel Merle d'Aubigné score was 17.68 (range, 12–18; SD, 0.9). Sixty-one percent of the patients performed strenuous activities (strenuous, 60.53%; activities of daily living, 38.60%; independent, 0.88%). Hip flexion averaged 123° (range, 50°–145°; SD, 13) (Table 4). There was no clear clinical evidence of leg lengthening (mean, 0.07 cm) in the overall group.

Forty-nine patients (19.4%) experienced a clicking, clocking, or clunking noise or feeling in the prosthesis that occurred in the first 6 months after surgery but was painless and disappeared progressively.

In 1.2% (3/252) of patients, squeaking noises appeared in the 2-year period after surgery. The duration of the noise was less than 24 hours and a one-time incidence. The noise started when the patient had an increase or change in activities. Stair climbing always generated or increased the noise. The sound was similar to a nonlubricated creaking door hinge.

Seven patients (2.8%) had a persistent slight groin pain. Four patients (1.6%) had no adverse effects with activity, but three patients could not do impact sports because of this problem and had to reduce their activity level (UCLA activity < 8).

Radiographic results

Preoperative and postoperative measurements were done on 115 resurfacings. A slight valgus placement of the head component is aimed for. A 140° positioning seems to be a good position for force transfer to the bone, femoral head, and neck. The mean preoperative angle of the femoral neck was 134.9° (range, 113°–148°; SD, 6.8). The obtained mean postoperative angle of the femoral head component was 137.6° degrees (range, 125°–156°; SD, 5.9).

In the full series (252 patients), osteolysis, reactive lines, migration of a component, or neck narrowing was seen in only two revision cases.

In the avascular necrosis case, a radiolucent line was seen in Amstutz et al's [11] "peg zone." The stem of the prosthesis moved progressively away from this line, indicating a loosening of the femoral component (Fig. 5). In the low-grade infection case, an osteolytic line in the three peg zones around the femoral stem and a progressive acetabular osteolysis were seen. There was also neck narrowing (Fig. 6).

Table 4
Harris Hip Score, Postel Merle d'Aubigné score, and flexion at follow-up

Measures	Median	Range	SD
HHS	97.24	41–100	7.6
PMA	17.68	12–18	0.9
Flexion	123°	50°–145°	13

Abbreviations: HHS, Harris Hip Score; PMA, Postel Merle d'Aubigné score.

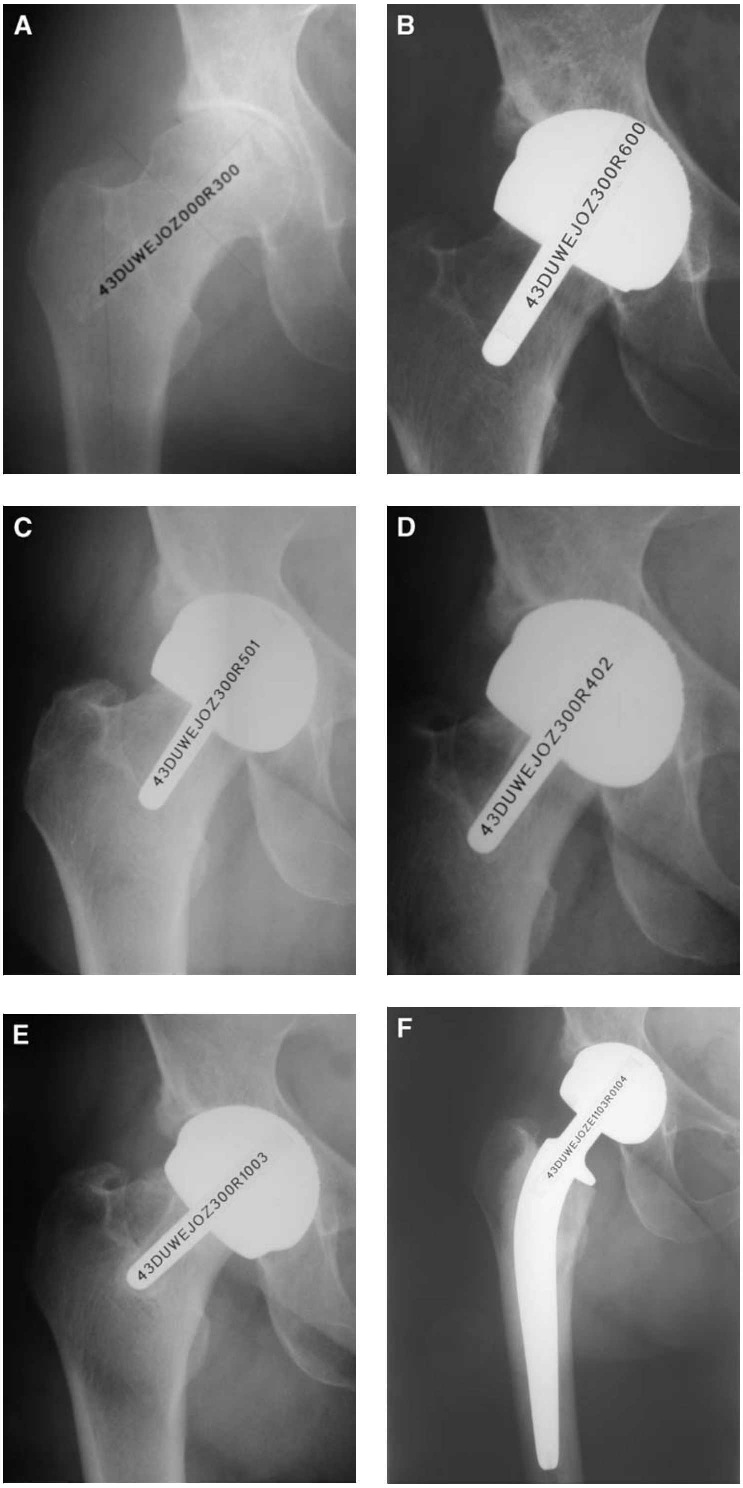

Fig. 5. Radiographs showing avascular necrosis of the head. (*A*) Preoperative. (*B*) Nine months postoperative. (*C*) One year postoperative. (*D*) Two years postoperative. (*E*) Three years postoperative. (*F*) Revision. Note the changing reactive line at the metaphyseal stem of the prosthesis (Amstutz et al's [11] peg zone 1).

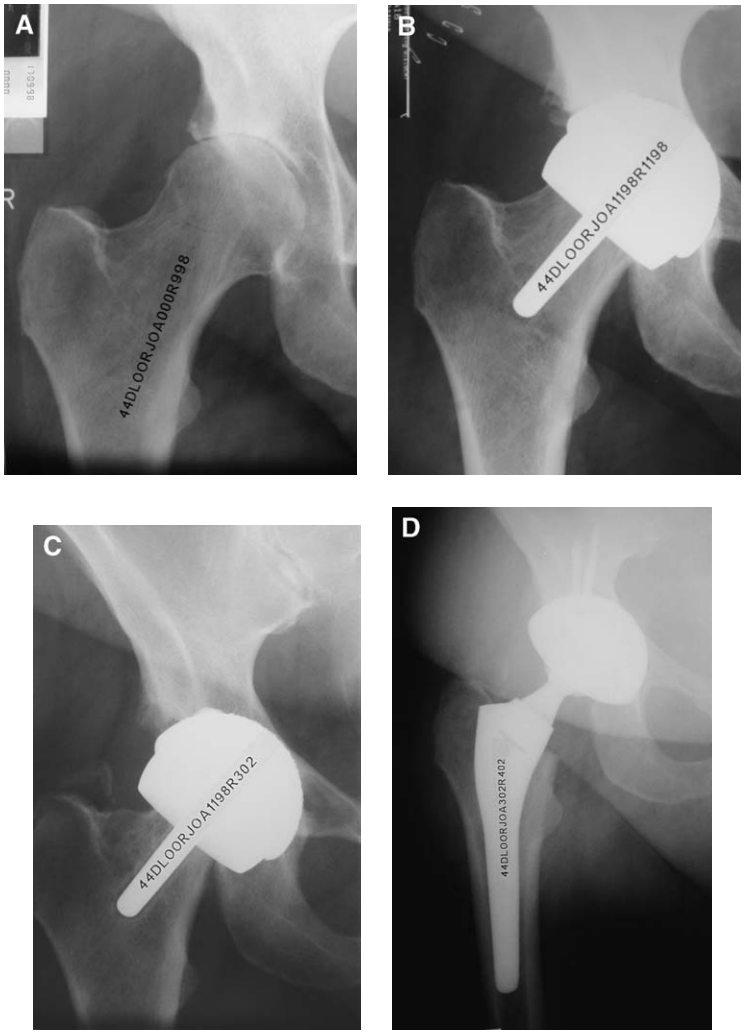

Fig. 6. Radiographs showing low-grade infection. In addition to osteolysis in all cup zones and the femoral neck, an osteolytic line is seen in the three zones around the stem. (*A*) Preoperative. (*B*) Immediate postoperative. (*C*) Four years postoperative. (*D*) Revision.

The diagnosis was made by anatomopathology and a possible *Staphyloccus aureus* specimen was identified on enriched cultures.

At the latest follow-up, all reviewed radiographs showed no bone resorption or osteolysis. No loosening of head or cup components was seen. Impingement of the neck can lead to remodeling the shape of the femoral neck (Fig. 7).

Complications

A summary of the complications is listed in Table 5. Both cases of sciatic nerve palsies with drop foot showed no evidence of recovery at the latest follow-up, which was more than 2 years postsurgery. In one case, a guide pin was inadvertently left in situ. The pin was not removed, and is still in place 4 years later. The postoperative deep venous thrombosis and pulmonary embolism cases were treated with anticoagulants with no further problems. Four cases of heterotopic ossification were seen: three Brooker grade 1 and one Brooker grade 2. There was no functional impairment in these cases. There were two dislocations in the same patient (4 months and 1 year post surgery). The dislocations were traumatic (fall) and occurred twice in an inebriated male patient; reduction was done without anesthesia.

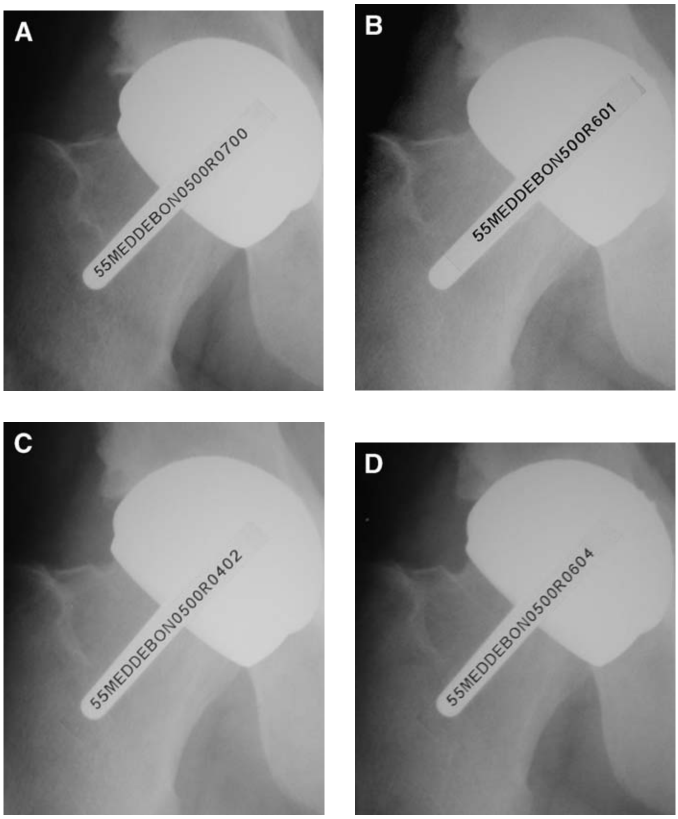

Fig. 7. Remodeling of the proximal lateral femoral neck at (*A*) 2 months, (*B*) 1 year, (*C*) 2 years, and (*D*) 4.5 years after surgery.

Failures

Three failures needed revision or reoperation (Table 6). The femoral neck fracture case occurred 3 weeks after surgery in a 42-year-old male patient with cerebral palsy and muscular spasticity. A difficult reduction in this developmental hip dysplasia case and osteoporosis could have led to an intra-operative stress fracture of the femoral neck. A reoperation was done with a modular head on a cemented stem.

Table 5
Complications in metal-on-metal resurfacing (11/252)

Complications	n	%
Sciatic nerve palsy with drop foot (no recovery >2 y)	2	0.8
Pin in femur	1	0.4
Deep venous thrombosis	1	0.4
Pulmonary embolism	1	0.4
Heterotopic ossification Brooker grade 1	3	1.2
Heterotopic ossification Brooker grade 2	1	0.4
Dislocation (not recurrent)	1	0.4
Infection	1	0.4

The avascular necrosis case was treated before fracture at 3 years, 7 months. Radiographic changes were noted at the 2-year follow-up period (but retrospectively, changes could be seen the 1-year follow-up; see Fig. 5). Diagnosis was done by bone scintigraphy (no vascularity of the femoral head in the blood pool phase). The patient had a post-operative stem-shaft angle of the head component of 139°, a UCLA activity level of 6, weight of 57 kg, no previous surgery, and no cyst bigger than 1 cm, which means that the patient had a Surface Arthroplasty Risk Index [12] of 2. For revision, a cemented stem with a modular head was used without changing the cup. The patient had a full recovery and increased satisfaction compared with the first surgery.

The low-grade infection case was first seen on radiograph after the 2-year follow-up. Diagnosis was done by bone scan, white blood cell scan, bone marrow scan, and was confirmed by anatomopathology.

Table 6
Failures, time to failure, and type of surgery

Failures	n	Time to failure	Type of surgery
Femoral neck fracture	1	3 wk	Cemented stem + modular head
Avascular necrosis of the femoral head	1	2 y	Cemented stem + modular head
Low-grade infection	1	2 y	Cleaning and exchange to primary uncemented total hip arthroplasty

The patient had a postoperative stem-shaft angle of 136°, a UCLA activity level of 4, weight of 97 kg, no previous surgery, and no cyst bigger than 1 cm (Surface Arthroplasty Risk Index = 0). Revision took place at 3 years, 4 months (see Fig. 3) and was treated as a one-stage procedure; a primary ceramic-on-ceramic uncemented total hip prosthesis was implanted. There was no femoral loosening.

Discussion

The early clinical and radiologic results in this group of metal-on-metal resurfacings are satisfactory, with Harris Hip and Postel Merle d'Aubigné scores indicating early clinical success. The high percentage of strenuous activity (61%) in this young patient group satisfies the expectations of the hip resurfacing procedure; notably, anatomic restoration with restoration of leg length and offset. The large diameter of the resurfacing is the reason for the low dislocation rate (0.4%).

Clinical perceptions in patients such as a squeaking noise or clicking or clunking noises and feelings in the prosthesis are new features in hip resurfacing. The clicking and clunking noises and feelings in the first 6 months after surgery are a possible temporary decoaptation of both components; they are painless and subside after the capsule and muscles around the hip are fully healed. The squeaking noises are possibly produced due to a temporary lack of lubrication—a dry running of the metal-on-metal prosthesis. It did not occur after 2 years, an interval that equals the running-in period of a metal-on-metal friction couple. The understanding of this benign incident can prevent misunderstanding and panic in patients and orthopedic surgeons.

Only further follow-up can tell whether these noises and feelings will result in a poor later outcome. Groin pain—the result of repetitive trauma to the femoral neck and soft tissues and structures around it or local conflict with tendons and muscles—can be explained by too little anteversion of the cup, the selection of an acetabular implant that is too big, or a femoral component that is malpositioned or too big. A femoral component that is too small or tighter to the femoral neck results in less flexion and possible impingement. Higher activity levels or participation in impact sports can be jeopardized because of this groin problem. Clinical examination gives the diagnosis of femoral neck conflict, with pain in the groin when the hip is flexed more than 90° in neutral abduction and with endorotation of the limb. When the leg is abducted with the same movements, the

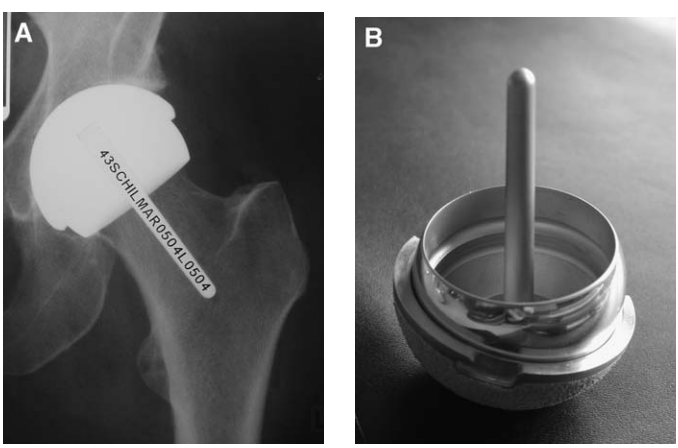

Fig. 8. (*A*) Conserve Plus Thin Shell x-ray, anteroposterior view. (*B*) Implant.

conflict with the femoral neck will be by-passed. A rubbing psoas or hip flexor tendon will give groin pain on active raising of the straight leg. A local anesthetic infiltration will also diagnose this problem.

The 4-mm implant-size increments with the BHR system lead to a higher risk in potentially oversizing the cup with the noted problems. With the polyethylene and cable impactor system, the BHR cup placement becomes technically demanding. An implant with 2-mm increments and a thin shell cup gives a lower risk for these problems. Two-millimeter implant-size increments also result in a smaller risk of oversizing or undersizing of the implant. For this reason, manufacturers today produce thinner acetabular implants. A lower-profile impactor, such as used with the Conserve Plus Thin Shell (Wright Medical) design (Fig. 8), gives a better control of the anteversion during insertion of the device. A better range of movement should be achieved with a larger head size, but it depends on the head-to-neck ratio, the existence of osteophytes, and the positioning of the implants.

Proper anteversion in the cup and meticulous removal of all osteophytes are important. The anterior femoral neck often needs reshaping. As stated earlier, the choice is better range of motion with a bigger head size, bigger cup, and more acetabular bone removal or the possibility of impingement and less mobility in flexion with a smaller head size, smaller cup, and more acetabular bone preservation. In the author's experience, line-to-line placement of the femoral head component (without cement mantle), multiple fixation holes, and a cementing technique with pressurization and pulse lavage are necessary to get an optimal fixation of the implant.

As of the latest follow-up in this series, no adverse effect was seen in the more varus placement of the head components as has been seen in other series [11].

Cementing of the stem is not advised by the author because stress distribution by the stem is not desirable, and the first signs on radiographs (femoral loosening, avascular necrosis, infection, wear), which are often seen around the stem of the resurfacing, may be masked. Long-term follow-up is needed to see whether varus placement has an adverse effect on the fixation and loosening of the head as was stated in the Amstutz et al series [11].

Using exclusively alternate bearings in patients under the age of 75 years, metal-on-metal resurfacing appears to be a good alternative in young active patients. The short-term results are promising. Meticulous surgical technique and planning are the key factors to an excellent postoperative result.

Reproducible placement of the prosthesis components should be possible and the wear properties of metal-on-metal should guarantee a good long-term follow-up. Time will tell whether this target can be achieved.

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