Hip resurfacing in patients under thirty years old: an attractive option for young and active patients

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Abstract

Purpose Metal-on-metal hip resurfacing is offered as an alternative to traditional hip arthroplasty for young, active adults with advanced osteoarthritis. The concept of hip resurfacing is considered very attractive for this specific population (hard-on-hard bearing component with a large femoral head limiting the risk of dislocation, and allowing femoral bone stock preservation).

Methods A prospective clinical trial was designed to investigate the outcome of hip resurfacing in young patients (under 30 years old). We studied 24 hips in 22 patients. Mean age at operation was 24.9 years (range 17.1–29.9). No patient was lost to follow-up.

Results There was no revision at average follow-up of 50.6 months (44–59). Mean UCLA activity score improved from 5.5 (1–9) pre-operatively to 7.6 (1–10) postoperatively ($p < 0.001$). Mean Harris hip score increased from 43.9 (19–67) to 89.3 (55–100) ($p < 0.001$). Radiological analysis discerned no osteolysis and no implant migration.

Conclusion The absence of short-term complications, such as mechanical failure or dislocation, is encouraging and leads us to think that mid-term results will be satisfactory. Moreover, the specific advantages of hip resurfacing (bone stock preservation, excellent stability, low risk of dislocation, large-diameter head) make the procedure a very attractive option for young subjects.

Introduction

For many years, hip arthrodesis and resection arthroplasty were considered as salvage procedures for painful, end-stage osteoarthritis in young patients [32]. In 2011, total hip arthroplasty seems to have become a suitable option for this specific population, but few studies in the orthopaedic literature have reported its use in young people under the age of 30 years, and no investigations of hip resurfacing have been published [6, 10–13, 17, 27, 28, 30, 31, 34, 38].

Total hip arthroplasty achieves fair results in such a young population (less than 30 years old), but literature reviews disclose significant revision rates (29 % on average) [6, 10–13, 17, 27, 28, 30, 31, 34, 38]. The outcomes of conventional total hip arthroplasty have been less predictable in young patients with great physical demands than in older, less active subjects [5]. Moreover, active, young patients are in the forefront of a high complication rate with aseptic loosening, short-term component durability, excessive conventional polyethylene wear, etc. [19]. On the other hand, patient expectations have also risen, with many young patients anticipating a return to demanding daily and/or sports activity [7, 21].

The concept of hip resurfacing is considered as very attractive for this specific population (hard-on-hard bearing component limiting wear, large femoral head reducing the

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risk of dislocation, femoral bone stock preservation, absence of thigh pain, restoration of normal hip joint biomechanics, anatomical hip loading [16]).

The purpose of this retrospective study was to evaluate the feasibility and the short-term clinical and radiological results of hip resurfacing in a young population.

Materials and methods

Patients

Between January 2007 and March 2008, a prospective clinical trial was designed to investigate the outcome of hip resurfacing in young patients (under 30 years old) and was undertaken after ethics approval was obtained. Patient inclusion was continuous, without randomisation, according to the following criteria: indication for primary hip arthroplasty, age over 18 years and less than 30 years old. During the inclusion period, 24 patients were not enrolled before surgery because of exclusion criteria (Table 1): avascular necrosis of the femoral head (14), chronic anti-inflammatory treatment (5), and inflammatory disease (5). The study was performed in 23 patients (25 hips). An additional patient (one hip) was excluded during surgery and was converted to total hip arthroplasty (developmental dysplasia of the right hip rated Crowe 3 with abnormal femoral anteversion and without neck available for hip resurfacing) [8]. The final group comprised 24 hips in 22 patients (seven women and 15 men; 13 right-sided and 11 left-sided subjects). No patient was lost to follow-up.

Mean age at operation and body mass index were respectively 24.9 years (17.1–29.9) and 24.2 kg/m² (18.8–36.2). The mean surface arthroplasty risk index was 3.16 (1–5). According to the University of California Los Angeles (UCLA) scoring system, patients were rated as grades 9 (one hip), 8 (four hips), 7 (one hip), 6 (nine hips), 4 (seven hips), 2 (one hip) and 1 (one hip).

Table 1 Details of exclusion criteria

Exclusion criteria
Femoral head osteonecrosis
Chronic anti-inflammatory treatment
Inflammatory disease
Hip arthrodesis
Renal insufficiency
Known or suspected metal allergy
One-stage bilateral total hip arthroplasty
Deep infection of the hip
Psychiatric illness
Pregnancy
Age (older than 30 years or younger than 18 years)

The diagnosis was primary osteoarthritis in three hips, with others being secondary to developmental dysplasia of the hip (eight hips, of which three hips were Crowe 1 [14], one hip was Crowe 3, and four hips were Crowe 4; Fig. 1), femoro-acetabular impingement (three hips), slipped capital femoral epiphysis (three hips), staphylococcus-related hip arthritis secondary to juvenile infection (three hips), post-traumatic (one hip), laminar coxitis (two hips), and epiphyseal osteonecrosis (one hip).

Fourteen hips had had previous surgery, before they were included in the study: one Chiari pelvic osteotomy, one shelf arthroplasty (Fig. 2), three femoral osteotomies, five hip reductions, two hip arthroscopies, one neck osteosynthesis, and one triple pelvic osteotomy.

Operative technique

All operations were performed by a single trained surgeon (JG). The components implanted were 14 Conserve Plus (Wright Medical) and ten Durom (Zimmer, Warsaw). All hip resurfacing was done through a postero-lateral approach under vertical laminar airflow with the patient in the lateral position. Except for developmental dysplasia of the hip, the gluteus maximus was never detached from its insertion at the linea aspera, and only supero-posterior capsulotomy was undertaken. In one case with excessive femoral anteversion, a subtrochanteric derotation femoral osteotomy was performed and secured with a dynamic compression plate (Fig. 2). Hip arthrolysis was carried out during the procedure in two cases of severe hip stiffness (flexion under 50°). Mean surgical procedure duration was 74.5 minutes (53–120).

All of them were administered non-steroidal anti-inflammatory medication (Celebrex 100 mg/day for ten days) to prevent heterotopic ossification.

Assessment methods

Hip function was assessed by Postel-Merle d'Aubigné score (PMA), the Harris hip score (HHS) and the Oxford hip score (OHS), and activity level by the Devane classification and the UCLA activity scale. All patients were evaluated yearly and reviewed by an independent observer who did not participate in the surgery.

Standardised antero-posterior and lateral radiographs were taken postoperatively, annually and at last follow-up and were analysed by an observer who did not participate in the surgery (NK).

Cup inclination was measured according to the teardrop line. Variation over 2 mm between follow-up radiographs was considered as migration [23]. Pre-operative cervical-diaphyseal angle, stem-shaft angle and anterior femoral head-neck offset ratio were quantified.

Fig. 1 Pre-operative radiograph of a 24-year-old man with bilateral Crowe 4 dysplasia (a). The left side was painful and the indication for hip resurfacing was retained. Femoral anteversion was considered as abnormal (48° , b). Hip resurfacing was performed with sub-

trochanteric derotation osteotomy and femoral shortening (c). At last follow-up, left hip function was satisfactory but the PMA score was 14 points because of contralateral hip pain. The patient is awaiting right hip resurfacing

Heterotopic bone formation was noted according to Brooker, as was the presence of femoral/acetabular radiolucencies and acetabular gaps.

Statistical analysis

Statistical analysis was conducted with SPSS version 13.0 for Windows (SPSS Inc., Chicago, IL, USA). Significance of the findings was evaluated by paired t-test. A value of $p < 0.05$ was considered statistically significant. Kaplan-

Meier survival including the entire cohort of 24 hips with 95 % confidence intervals (CI) were calculated.

Results

At an average follow-up of 50.6 months (44–59), no dislocation, infection or thromboembolic complications were encountered. One transitory postoperative sciatic nerve palsy was observed in a developmental dysplasia of the hip case and recovered spontaneously within eight weeks.

All functional scores and the UCLA activity scores showed statistically significant improvement ($p < 0.05$). Mean OHS pre-operatively was 35.5 (55–23) and at final postoperative review was 16.3 (35–12), a statistically significant change ($p < 0.001$). Mean UCLA activity score improved from a mean of 5.5 (1–9) pre-operatively to 7.6 (1–10) postoperatively ($p < 0.001$). Mean HHS increased from 43.9 (19–67) to 89.3 at last follow-up (55–100). Mean PMA score rose from 11.3 (7–14) to 17 (13–18) at the last follow-up ($p < 0.001$). Range of motion was also improved, whatever the angular section ($p < 0.01$) (Table 2). Eighteen hips (75 %) demonstrated flexion equal to or greater than 100° . At last follow-up, 21 hips were pain-free, three had infrequent and slight pain. Mean length of hospital stay was five days (three to ten). We didn't notice any adverse reactions to metal debris (ARMD) such as pseudotumor or metallosis.

Radiological analysis discerned no osteolysis and no implant migration. On the acetabular side, a postoperative gap was noted in ten cases, preferentially localised in zone II of DeLee and Charnley (42 %). All gaps filled up in less than one year.

Fig. 2 Radiographs of a 24-year-old woman with a right hip dysplasia treated by a previous shelf arthroplasty. Unfortunately, this side was painful with the development of a secondary osteoarthritis. Hip resurfacing was performed without plate or screw removal during the procedure. At last follow-up, the hip was rated with a PMA score of 18 points

Table 2 Improvement in range of motion between the pre-operative period and last follow-up

Measurement	Pre-operative	At last follow-up	<i>p</i>
Flexion (°)	86 (30–120)	102.3 (80–120)	<0.001
Extension (°)	1.45 (–20 to 20)	9.79 (0–15)	<0.01
Internal rotation (°)	5.4 (–10 to 30)	23.7 (20–40)	<0.001
External rotation (°)	15.9 (0–30)	27.5 (20–40)	<0.01
Abduction (°)	21.6 (5–30)	28.7 (20–40)	<0.02
Adduction (°)	21 (5–30)	28.1 (15–40)	<0.03
Global range of motion (°)	151.4 (45–230)	220.1 (160–280)	<0.01

Radiolucent lines were present around the femoral component in zones 1 and 2 in two hips (8.3 %). None was wider than 1 mm, and inclination angle was on average 46.9° (range 39–55°). Its orientation was between 40° and 50° in 17 hips (70 %). At last follow-up, one hip had developed heterotopic ossification limited to Brooker grade 1.

Pre-operative cervical-diaphyseal implant angle was 139.4° (124–159). At last follow up, an increase of valgus angle was seen (mean femoral stem-shaft angle of 5.04° (–12° to +17°) compared to the pre-operative cervical-diaphyseal angle. There was a little retroversion of the femoral stem (–1.17° [–15° to 5°]), and anterior head to neck offset was on average +5.4 mm (3–15).

With no surgical revision, at last follow-up (50.6 months), the survivorship rate, with revision for any reason as the endpoint, was 100 %.

Discussion

In the Swedish Registry, the 15-year follow-up total hip arthroplasty survival rate is quite different between patients less than 45 years of age and those older (77% and 92%,

respectively [2]). To date, 12 studies have analysed total hip arthroplasty in patients under 30 years old (Table 3). In all these studies, the mean revision rate was significant at 27.4 % (13–43) with a mean follow-up of 10.6 years (5.4–20). All authors highlighted the greater risk of revision compared to an older and/or less active population [3, 13, 27, 30, 31, 34, 38]. The main reason for revision was aseptic loosening secondary to polyethylene wear [5]. The use of hard-on-hard bearing can lower osteolysis risk and the revision rate in comparison to soft bearings [18, 25]. In these studies, the lower revision rate (13%) [27] was observed with a ceramic-on-ceramic bearing component. However, ceramic on ceramic bearing, although they limit osteolysis, seem penalised by long-term cup component fixation, squeaking and fracture risks [18]. To date, the impossibility of obtaining very large diameter heads with ceramic-on-ceramic bearing (more than 40 mm) and designing ceramic hip resurfacing represent two negative factors that contrast with metal-on-metal bearings.

The main advantages of hip resurfacing include preservation of femoral bone stock, reliable restoration of physiological biomechanics, and a low dislocation rate [14]. In patients under 30 years old, the dislocation rate varied from 0 to 18 % (5 % on average) and differed from our 0 % rate. This high rate explains the attitude of certain authors to ask patients to refrain from high physical and/or sports activity after hip arthroplasty [6, 13]. Such restrictions seem difficult for young patients, and therefore decreasing the dislocation risk with a large femoral head appears to be a crucial point in these subjects and allows the practice of sports [15]. The stability engendered by the large diameter of the prosthetic head, close to the native head diameter, is vastly superior to conventional implants with 22-, 28- or 32-mm diameter heads [16]. Moreover, the suction-fit effect of metal-on-metal bearing allows us to obtain high adhesivity of the head-cup interface and to reduce the risk of micro-separation or subluxation [20].

The absence of thigh pain is secondary to excellent loading transfer on the proximal femur and the absence of stem and medullary canal trepanning, establishing a real

Table 3 Acetabular and femoral osteolysis rates and revision rates in previous studies

Study	Number of cases	Follow-up (years)	Acetabular osteolysis rate	Femoral osteolysis rate	Revision rate
Ruddlesdin et al.	75	5.4	1.3%	1.3%	14%
Witt et al.	96	11.5	4%	4%	25%
Torchia et al.	63	12.6	67.3%	19.2%	43%
Sochart and Porter	83	20	34%	19%	41%
Dudkiewicz et al.	56	7.4	20%	0	21%
Nizard et al.	132	6.9			13%
Bonnomet and Glorion	941	7	16.6%	15.7%	25%
Present study	24	1.9	0%	0%	0%

advantage in comparison to certain cementless stems that evoke this complication [4].

Hip revision remains a challenging procedure, especially in young, active patients who are exposed to osseous and muscular operations [7]. In the case of hip resurfacing mechanical failure, surgical revision is relatively easy [35]. With the bone preservation allowed after hip resurfacing and with metal-on-metal bearings, many authors postulate that further revision will be easier with limited osseous lesions and greater femoral revision facility [36]. We thought that these attributes would be emphasised in a young, active population such as the one in our study.

To date, hip resurfacing in developmental dysplasia of the hip cases is a controversial procedure (soft-tissue contractures and muscle weakness [1, 24]). We recommend the investigation of femoral neck anteversion by pre-operative CT scan. In older patients, conventional total hip arthroplasty with correction of excess femoral neck anteversion is a better and safer procedure [24].

Some concerns still exist after implantation of metal-on-metal bearings [35]. Theoretically, there is potential risk of mutagenicity and hypersensitivity [33, 35]. In fact, the carcinogenic risk is not increased in subjects receiving metal-on-metal hip prostheses compared to those with metal-on-polyethylene hip prostheses [33, 37]. All metal implants release metal ions because of corrosion effects for instance after total knee arthroplasty which show metallic ion levels similar to those in metal-on-metal hip arthroplasty [22].

To date, no reports of mutagenic/teratogenic effects in patients with metal-on-metal total hip arthroplasty have been published [37]. The placenta could modulate the rate of metallic ion (cobalt and chromium) transfer and to date there has been no significant effect on the child [26].

Recently, the ASR metal on metal hip resurfacing device (DePuy) has been associated with a high rate of pseudotumour secondary to increased metal ion levels in the blood and led to an international recall [9]. Pseudotumour risk is estimated to be 1 % of patients who have metal-on-metal resurfacing within five years after implantation [29]. Pseudotumour may be the result of a toxic cell effect due to particulate wear debris. Some risk factors, e.g. female gender, age less than 40 years, smaller component size and edge loading with vertical cup, are now well known [29]. It seems interesting to note that in our high-risk population (very young patients, 33% of preoperative diagnosis of hip dysplasia, etc.) we found no ARMD. We assumed that it was directly correlated to correct cup position (especially for inclination) and to well-adapted metal alloy tribological properties.

This study has some limitations. The relatively short-term follow-up does not allow us to draw firm conclusions about the long-term success of hip resurfacing in such a very challenging young population. The absence of short-term complications, such as mechanical failure or dislocation, is

encouraging and motivates us to think that the mid-term results will be satisfactory. Two designs of hip resurfacing devices were used and could have led to a bias in data interpretation. However, no radiological or clinical results appear to be different between these components, and no revision was necessary.

Conclusion

Despite the challenge of performing hip resurfacing in young, active populations, the short-term clinical and radiological results in this series are encouraging and demonstrate data comparable to standard total hip arthroplasty at this early stage.

This study supports hip resurfacing as a suitable alternative to conventional total hip arthroplasty for such complex patients. Moreover, the specific advantages of hip resurfacing (bone stock preservation, excellent stability, low risk of dislocation, large-diameter head) make the procedure a very attractive option for young subjects.

Conflict of interest The authors declare that they have no conflict of interest.

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