ORIGINAL ARTICLE

Durom hip resurfacing system: Retrospective study of 644 cases with an average follow-up of 34 months

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\textbf{KEYWORDS}
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Resurfacing;
Revision;
Biomechanical reconstruction;
Arthroplasty

\begin{abstract}
\textbf{Introduction:} The performance of second-generation metal-on-metal bearings has led to the reintroduction of hip resurfacing. The goal of this multicentre study was to evaluate the short-term radiological and clinical outcomes with the Durom hip resurfacing system.

\textbf{Hypothesis:} The Durom hip-resurfacing system will have similar results to other hip resurfacing systems and traditional hip arthroplasty implants.

\textbf{Materials and methods:} In the four participating centers, 580 patients (406 men, 174 women) and 644 hips were included. The average patient age was 48 years (range 16–77). A posterolateral surgical approach was used in 357 cases; a Hardinge-type approach was used in 182 cases and a Rottinger-type approach in 105.

\textbf{Results:} After an average follow-up of 34 months, 31 hips (4.8\%\%) had been revised. The reasons for revision were the following: 10 (1.6\%) neck fracture (seven with Rottinger operative approach, one with Hardinge approach and one with posterolateral approach); 12 (1.9\%) femoral loosening (four with lateral approach and eight with posterolateral approach); four (0.6\%) acetabular cup migration; three (0.5\%) unexplained pain; one (0.2\%) adverse reaction to metal debris; one (0.2\%) infection. Four hips (0.6\%) dislocated but without recurrence — all were operated using the Hardinge approach. The 613 hips that were not operated on again had satisfactory clinical results; the Merle d’Aubigné score was 17.2 (range 12–18) and the WOMAC score was 91 (range 20–100). The five-year survival rate was 91\% (95\% CI: 87–94\%). Based on radiographs, the average cup inclination was 44.4\degree\ (range 30 to 70\degree\). The femoral offset was reduced by an average of 2.4 mm (–31 to 23 mm) and the leg length had increased by an average of 0.8 mm (–15 to 19 mm) relative to the other side, which was prosthesis-free. None of the non-revised implants showed any signs of loosening.
\end{abstract}

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Introduction

Hip resurfacing with a metal-on-polyethylene bearing, used in the 1970s, only had a 75% survival rate after five years [1]. This was secondary to polyethylene wear and lead to this implant being abandoned in the 1980s [1]. The performance of second-generation, metal-on-metal bearings in traditional hip implants in the early 1990s led to a rebirth of the hip resurfacing concept. Hip resurfacing has many advantages relative to a traditional hip arthroplasty: bone stock is preserved [2], anatomical offset and leg length are reproduced [3], physiological joint range of motion is maintained [4], excellent functional results achieved that meet work and sports requirements [5–8], joint stability is better [9] and the infection rate is low [10]. But hip resurfacing also presented specific problems such as neck fracture [11], femoral component loosening with or without head collapse [11–14] and adverse reactions to metal debris produced by the bearing surfaces (inflammation, osteolysis, pseudotumour formation, tissue toxicity) [15–17].

The Durom hip resurfacing system (Zimmer, Warsaw, IN, USA) was introduced in Europe and Canada in 2003. The biggest advantages of this implant was that it had the same tribological features that made the Metasul™ (Zimmer, Warsaw, USA) metal-on-metal bearing surfaces successful: high carbon content, forged Chrome-Coal (Cr-Co) alloy with optimized clearance [18]. Its excellent tribological performance was confirmed by the low amount of chromium and cobalt ions released into the blood [19,20]. This implant has specific features that distinguish it from other available hip resurfacing systems: acetabular cup of consistent thickness having the shape of a flattened dome (165°), convex surface with titanium plasma sprayed coating and peripheral fins. The femoral component geometry allows for a 0.75- to 1-mm thick cement layer, which minimizes pressure and avoids excessive penetration of the cement into the femoral head. The smooth, short stem has no mechanical properties.

The goal of this study was to evaluate the radiological and clinical results, complication rate and short-term survival rate of the Durom hip resurfacing system based on a large, multicentre retrospective study comprising nine surgeons, one of whom was involved in the design of the system.

Material and methods

Patients

The population consisted of 580 patients who had undergone a Durom hip resurfacing procedure performed by nine surgeons. Four centres participated, with one centre having a single surgeon and three having multiple surgeons. This was a series of 644 hips that included the learning curves for all the surgeons (Tables 1 and 2). No selection criteria were applied and the cohort represented all the indications made by the various surgeons.

The Durom hip resurfacing system was implanted according to the instructions provided by the manufacturer. The Durom system has the following specific characteristics: high carbon content, forged alloy bearing with about 150 μm clearance. The acetabular cup has a consistent thickness, the shape of a flattened dome (165°) and a convex surface with titanium plasma sprayed coating. The femoral component is cemented (0.75–1 mm thick layer). Its internal surface has grooves that allow the cement to be extruded during insertion, which limits pressurization of the cement in the bone. The smooth femoral stem serves as an alignment guide. The femoral head is inserted about 3–4 minutes after the cement is prepared.

Assessment methods

The clinical evaluation was performed before the surgery and at the follow-up using the Merle d’Aubigné (PMA) functional score [21] and the Devane et al. activity score [5]. In addition, the WOMAC score was determined at the last follow-up [22].

Anterior/posterior X-rays of the pelvis at the follow-up were examined to determine the implant position in comparison with the anatomical features of the contralateral joint, if it did not have an implant (560 cases) (Fig. 1). The radiography analysis sought to determine if the cup orientation had changed by more than 3° and if more than 5 mm migration was present, as these were considered signs of loosening. The presence of radiolucent lines in the pelvis [23] and in the femur zones described by Amstutz et al. [24] was assessed. The presence of osteolysis, heterotopic ossification and femoral neck narrowing greater than 10% was also recorded. A Dunn view of the operated hip was used to determine the anterior femoral offset. The latter, given in millimetres, is the distance between the anterior cortex of the femoral neck and the most anterior part of the femoral component.

Statistical methods

The entire study dataset was compiled on clinical research software (Evamed-Etudes, Evamed, 7, rue Alfred-Kastler,
Table 1  Demographic data for the multicentre series.

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<thead>
<tr>
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<tbody>
<tr>
<td>Number of patients</td>
<td>580</td>
<td>406 men</td>
<td>174 women</td>
</tr>
<tr>
<td>Number of hips</td>
<td>644</td>
<td>448 men</td>
<td>196 women</td>
</tr>
<tr>
<td>Mean age (min−max)</td>
<td>48 (16−77)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnosis for hip resurfacing</td>
<td>Primary osteoarthritis</td>
<td>Osteonecrosis (6%)</td>
<td>Other (40 cases (7%))</td>
</tr>
<tr>
<td></td>
<td>505 cases (87%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass index</td>
<td>&lt; 25: 324 (50%)</td>
<td>25–30: 229 (36%)</td>
<td>&gt; 30: 91 (14%)</td>
</tr>
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Table 2  Overall series data on the revision rate, complication rate and surgical approach for each participating centre.

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<tbody>
<tr>
<td>Number of surgeons</td>
<td></td>
<td>Number of cases (644) (%)</td>
<td>Approach</td>
<td>Number of revisions (31) and % per centre</td>
<td>Number of dislocations (%)</td>
</tr>
<tr>
<td>Centre 1</td>
<td>3</td>
<td>265 (41.1)a</td>
<td>Posterolateral</td>
<td>11 (4.1)</td>
<td>0</td>
</tr>
<tr>
<td>Centre 2</td>
<td>1</td>
<td>92 (14.4)</td>
<td>Posterolateral</td>
<td>0 (0)a</td>
<td>0</td>
</tr>
<tr>
<td>Centre 3</td>
<td>2</td>
<td>182 (28.2)</td>
<td>Anterolateral (Hardinge)</td>
<td>12 (6.6)</td>
<td>4 (2.1)a</td>
</tr>
<tr>
<td>Centre 4</td>
<td>3</td>
<td>105 (16.3)</td>
<td>Anterolateral (Rottinger)</td>
<td>8 (7.6)</td>
<td>0</td>
</tr>
</tbody>
</table>

a Significance: $P < 0.05$.

14000 Caen, France). Statistical tests were performed with the statistical package, R (version 2.11.1). An alpha level of 0.05 was used to determine a significant $P$-value.

The differences between paired samples (PMA and WOMAC before surgery vs. at follow-up) were analysed with a paired Student’s $t$-test. The potential relationship between various factors and the occurrence of implant failure (revision) was evaluated by two methods:

- the Chi$^2$ test was used to evaluate the relationship between the distribution of failures and gender, preoperative diagnosis and surgical approach;
- Student’s $t$-test was used to evaluate the relationship between the distribution of failures and age, BMI, inclination of the acetabular cup and neck-shaft angle of the femoral component.

![Figure 1](https://example.com/figure1.png)

Figure 1  Implant positioning (positive values indicate limb lengthening or lateral offset of the joint). A. On the femoral side, the average lengthening was 0.8 mm (range −15 to 19 mm) and the average medialization was −2.4 mm (range −31 to 23 mm). The average neck-shaft angle was 139° (range 112 to 158°). B. On the acetabular side, the average upward migration was −1.3 mm (range −26 to 9 mm) and average medialization of −0.7 mm (−15 to 9 mm). The average cup inclination was 44.4° (range 30 to 70°). C. Method used to measure the anterior offset; the average measurement was 5 mm (range 0 to 15 mm).
Survival curves were generated based on the Kaplan-Meier method. The main failure criterion was implant removal. The survival analysis was also performed while specifically including the tilt of the acetabular cup, neck fracture, necrosis and all the re-operations. Differences in implant survival between the various participating centres were detected with a log-rank test. The impact of the learning curve was evaluated by comparing the survival of the first 50 cases from each surgeon with the survival in the following cases using the log-rank test.

Results

With an average follow-up of 34 months (range 12–102), 549 patients had not been operated on again (613 hips). All these patients had been reviewed in the two years leading up to the study, with a full clinical and radiological analysis. From the initial cohort, 31 patients (4.8%) were re-operated at an average of 36.3 months (range 0–72.5) after the initial procedure, for the following reasons (Table 2):

- 10 cases (1.6%) of femoral neck fractures, with five occurring during the first year and five occurring during the second year. Of these 10 femoral component fractures, seven had been implanted using a Rottinger-type anterolateral approach in the same centre;
- 12 cases (1.9%) of femoral loosening that had occurred an average of 15.3 months (range 1–40.9) after the initial procedure and had an undetermined cause (head collapse or deterioration of the bone-cement or implant-cement interface). Four of these had been implanted with a lateral approach and eight with a posterolateral approach. Loosening occurred during the first year in five cases, during the second year in two cases, third year in three cases, and during the fifth and sixth year in the other two cases;
- four cases (0.6%) of early tilting of the acetabular cup, which were revised at one month (range 0–1.6) on average;
- one case (0.2%) of an adverse reaction to metal debris, which occurred at 72.5 months;
- three cases (0.5%) of unexplained groin pain that required re-operation after an average follow-up of 6.3 months (range 1.4–13.2);
- one case (0.2%) of deep infection at two years post-surgery.

Dislocation occurred once in four patients (four hips) with no recurrence (0.6%). These four patients had all been operated on by the same surgeon using the Hardinge anterolateral approach. A systematic misalignment was found, with excessive acetabular anteversion visible.

In the 549 patients who were not re-operated, the average preoperative PMA score of 11 (range 6–16) improved to 17.2 (range 12–18) at the last follow-up and the WOMAC score was 91 (range 20–100). The average Devane activity score went from 2.2 (range 1–5) to 3.8 (range 2–5).

Radiographic analysis of these 549 patients revealed 28 cases (5.1%) of femoral neck narrowing, two cases (0.4%) of acetabular radiolucent lines and three cases (0.6%) of radiolucent lines around the femoral stem. There were no continuous radiolucent lines over all the areas, nor was a change in implant position observed.

The acetabular cup was medialized by an average of 0.7 mm (range −15 to 9 mm) when compared to the contralateral hip. The centre of rotation had moved upwards by an average of 1.3 mm (range −26 to 9 mm) (Fig. 1B). The average acetabular cup inclination was 44.4° (range 30–70°). The average femoral neck-shaft angle before the surgery was 134.4° (range 110–146°); the average angle between the stem of the femoral head and the shaft axis was 138.9° (range 112–158°) after the surgery (Fig. 1A). The femoral offset relative to the contralateral hip was reduced by an average of 2.4 mm (range −31 to 23) (Fig. 1C). The leg was longer by an average of 0.8 mm (range −15 to 19). The average anterior offset was 5 mm (range 0 to 15 mm). The average diameter of the implanted femoral head was 48 mm (range 38–58).

Gender, age and BMI had no effect on the risk of failure (P > 0.05). The type of surgical approach varied by centre, with the posterolateral approach being used most often (P = 0.001). The revision rate was higher in the centres using the anterolateral approach; use of this approach also resulted in a higher revision rate than use of the posterolateral approach (P = 0.002) (Table 2).

For the entire series, when the end point was surgical revision with the implant removed for any reason, the 5-year survival rate was 91.2% (95% confidence interval: 87–94%) (Fig. 2). The results ranged from 90 to 100%, depending on the centre. One centre (with a single surgeon) had a significantly greater implant survival rate (P = 0.001). The other centres (with multiple surgeons) had homogeneous results.

Discussion

The main advantages of hip resurfacing with second-generation metal-on-metal bearings are the ability to preserve the femoral bone (making future revision easier), good stability, preservation of joint biomechanics and minimal wear of the bearing surfaces. This design was reintroduced by the industry, with various implants having different features. The goal of this study was to evaluate...
the radiological and clinical results, complication rate and short-term survival of the Durom implant and to compare these aspects to historical results with traditional total hip arthroplasty (THA) and other commercially available resurfacing systems.

But the current study has a number of limitations. First, we described a retrospective case series without a control group. Thus comparisons with traditional THA and other resurfacing implants may be subject to bias. Multiple surgical approaches were used, thus it was difficult to draw any conclusions about implant positioning. The follow-up was relatively short, which limits the conclusions that can be drawn, especially since these implants were developed for young subjects with a long life expectancy. Excellent long-term performance will be needed to truly determine the value of this implant.

Our multicentre clinical evaluation of the Durom implant found functional results that were as good as those achieved with traditional total hip arthroplasty, as the average PMA score was very high [25]. However, the short-term (5-year) revision rate was higher than published and National Register data with a traditional THA or other resurfacing implants [26]. In addition, the functional score in the PMA is not sensitive enough to demonstrate a difference in young, active subjects [9,27]. New, more appropriate outcome measures seem to be needed.

The survival rate for traditional arthroplasty (no matter the age or aetiology) ranges from 96–98% at 10 years [26]. Hip resurfacing is used in a relatively young population — in our series, the average patient age was 50 years. The results of traditional arthroplasty in younger subjects are not the same as in older subjects. In patients below 50 years of age, the reported 10-year survival rate is between 85 and 95% [28,29]. For even younger subjects (under 30 years of age), the survival rate drops to below 60% at the 10-year follow-up [30—32]. For hip resurfacing, many groups have reported a 5-year survival rate around 95% [5,7,24]. In young patients (under 30 years of age), a 100% survival rate was reported but the follow-up was less than 5 years [33]. Thus it seems that for a young population, the survival rate for a resurfacing implant is very close to that of a traditional THA, which is consistent with data from our series (5-year rate between 90 and 100%, depending on the centre). But this rate was worse because of complications specific to the Durom implant, such as early implant tilting [27], which was observed in 1% of cases with the same implant [34]. This occurred more often than with the Birmingham hip resurfacing system because the bone ingrowth is not as good [27]. A Swiss group reported a survival rate of 88.2% in a series of 100 Durom resurfacing cases with an average follow-up of 60 months [34]. The Durom implant results were slightly worse than those reported with other commercially available resurfacing implants [35,36]. Although each implant has its own specific characteristics, each requires the same set of favourable conditions: well-trained surgeon, acetabular cup inclination less than 45° and consistent with anatomical anteversion, femoral head with 5° valgus relative to the neck-shaft angle, which covers the entire area of reamed bone, no notching in the neck and male patient having osteoarthritis and femoral head diameter greater than 48 mm [4,33].

In our series, the neck fracture rate was 1.6% (from 0 to 6.6%, depending on the centre) and was closely related to the anterolateral surgical approach. Half the neck fractures were caused by a high-energy trauma. Femoral neck fracture is a complication that is particular to resurfacing. It most often occurs during the first year. The frequency is rarely above 2% [37]. Small size, cup varus, superior neck notching and increase in femoral offset were identified as risk factors [38]. Surgeon experience is also an important factor since the fracture rate was 2.5% in the first 69 cases and then was 0.4% later on [39]. This was also supported by our findings in the single-surgeon centre.

The rate of femoral component loosening in our series was 1.9% (from 0 to 3%, depending on the centre), which compares to the 2% rate reported by others with this same implant [34]. Failure at the femoral interface can be secondary to necrosis of the residual femoral head bone or to a fracture of the cement mantle. Loosening secondary to necrosis typically occurs during the first few months after surgery and seems to be directly related to devascularization of the femoral head. Femoral head necrosis was found in 88% of revisions after hip resurfacing, with no effect of the surgical approach [40]. Resorption of the femoral neck over multiple areas seems to be indicative of head necrosis. Femoral loosening later on could be the result of cement failure due to repeated microscopic trauma. The ability of the cement to withstand fatigue depends on its quality (number of impurities such as air bubbles) and its thickness. The surgical technique for the Durom implant allows for a fairly thick (0.75 to 1 mm) layer of cement. The depth of the cement penetration into the bone must also be taken into consideration. The Durom implant has internal grooves that facilitate cement extravasation and reduce the pressure during insertion. Beaulé et al. have observed less penetration of the cement into the bone with the Durom implant than with the BHR system [41]. The possibility of implanting cementless femoral components could resolve this variability in cementing technique [42].

We observed a low risk of complications such infection, revision for groin pain and reaction to the metal-on-metal bearing. We found only one case of reaction to metal wear debris (0.15%), which can be attributed to the good tribological performance of the Durom implant and is consistent with the low levels of metal ions released [9]. Based on data in this study, we could not confirm the typically reported risk factors for metal-on-metal bearing reactions such as female gender, small implant size and wrong implant position [43]. Similarly, we found a very low rate of revision for groin pain (0.5%) [44]. Female gender, young age and activity level were identified as risk factors for groin pain [45]. A study comparing traditional THA, hip resurfacing and large-diameter femoral head THA found no significant differences in the rate of groin pain between the three groups after a 2-year follow-up [46]. We observed a 0.15% infection rate. Since no studies have been performed comparing THA and resurfacing, no conclusions can be drawn about differences in the infection rate between the two techniques. The infection rate following primary THA ranges from 0.5 to 2.2% [47,48]. A multicentre study reported an infection rate of 0.5% (3/653) after resurfacing [49], which has been confirmed in another study (0.6%) [50].
In the current study, the dislocation rate of 0.6% was correlated to the anterolateral surgical approach (from 0 to 2%, depending on the surgeon); none of these dislocations required a new procedure to be performed. The large friction diameter in theory helps to limit the risk of dislocation, even if the retaining ability of the acetabular cup is not as great as with a dual mobility implant. The dislocation risk is typically zero, although one study reported a rate of 2.2% [50].

Conclusion

Results with a second-generation hip resurfacing system seem to be encouraging. Our multicentre clinical evaluation of the Durom implant showed functional and activity-related results that are comparable to those achieved with traditional THA. However, the revision rate was higher than in published and National Register data using traditional THA or other resurfacing implants. These differences can be explained by the design and geometry of the cup, which make it difficult to insert and results in poor primary fixation, along with the high rate of femoral neck fracture and dislocation when an anterolateral surgical approach was used.

Disclosure of interest

S. Leclercq: co-investigator, non-principal researcher during clinical trials for Zimmer, Warsaw, IN, USA.

M. Lavigne: consultant for educational presentations (Canada and USA) for Zimmer, Warsaw, IN, USA. Consultant for Wright Medical Technology, Memphis, TN, USA.

PA. Vendittoli: principal investigator, coordinator or researcher during clinical trials for Zimmer, Warsaw, IN, USA. Consultant for Wright Medical Technology, Memphis, TN, USA.

J. Girard: consultant for educational presentations (France and Europe) and principal investigator during clinical trials for Zimmer, Warsaw, IN, USA. Consultant for Wright Medical Technology and Smith & Nephew, Memphis, TN, USA.

P. Chiron: consultant for educational presentations for Zimmer, Warsaw, IN, USA. Consultant for Smith & Nephew, Memphis, TN, USA.

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