Cementless cups do not increase osteolysis risk in metal-on-metal total hip arthroplasty

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KEYWORDS
Total hip arthroplasty; Metal-on-metal bearings; Osteolysis

Summary
Background: Metal-on-metal bearings in total hip arthroplasty (THA) were introduced to reduce the production of wear debris and debris-induced periprosthetic osteolysis. Analysis of various series according to the type of selected acetabular fixation highlights different evolutions: favourable results with uncemented cups contrasting with loosening and radiolucent lines (RLL) evolution for cemented cups.

Hypothesis: Combining metal-on-metal bearings to uncemented cups does not increase the osteolysis risk at a minimum 5 years’ follow-up.

Materials and methods: From January 1999 to December 2002, 106 Metasul™ THAs were implanted in 95 patients using a Hardinge anterolateral approach (40 women and 55 men with an average age of 59.2 years). The cups were of cementless, hydroxyapatite-coated Cedior™ type (Zimmer) housing a Metasul™ insert in a polyethylene sandwich. The femoral stem used was the cemented Acora™, then the Exafit™ (Zimmer) type with Metasul™ 28-mm head mounted on a 8/10 Morse taper. Patients were evaluated clinically using the Postel-Merle-d’Aubigné (PMA) scoring system and radiologically using various markers: cup inclination angle, eventual RLL presence, appearance of osteolysis images, ectopic ossifications and finally, eventual implant migration. In the eventuality of suspected RLL evolution or osteolysis, advanced imaging was performed; joint aspiration liquid and cobalt serum level were studied.

Results: We reviewed 94 prostheses (85 patients) with an average follow-up of 6.4 years (4.3 to 9.3 years, median of 6.3 years). The rate of patient loss from follow-up and death was 12.1%. The PMA score of non-revised patients increased from 11.4 ± 1.5 to 17.6 ± 0.2 at follow-up. We numbered ten re-operations not attributable to the type of bearings used. Three revisions were directly related to the metal-on-metal bearing: two metallosis due to impingement and one case of hypersensitivity. Cup inclination angle was 45.7 ± 5.49°. No implant migration was noted during the follow-up duration. Only one cup undergoing revision presented a substantial osteolysis. On the femoral side, with non-revised implants, we observed 13 cement/bone RLL images around nine femoral stems and six calcar resorptions. The survival rate at more than 5 years of follow-up was 98.3%.

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Introduction

Total hip arthroplasty (THA) with metal-polyethylene coupling remains the standard despite osteolysis induced by polyethylene wear, the main cause of long-term failure [1]. Young, active patients undergoing THA are at high risk of aseptic loosening [2]. In 1988, with the objective of diminishing wear debris, Weber [3] re-introduced metal-on-metal coupling in the form of a cemented sandwich for the cup (Cr-Co Metasul™ insert set in a polyethylene cup covered with steel mesh on its peripheral face) paired with a Metasul™ femoral head (original forged chrome-cobalt Cr-6 Co-28 Mo-0.2C) (high carbon percentage). Simulation tests and analysis of the explants confirmed significantly decreased debris production compared to metal-polyethylene bearing [4]. Later, some authors reported their experience with Metasul™ cups directly-cemented on bone whereas others employed non-cemented implants in the form of metal-backed cups with press-fit or screws.

Analysis of series emanating from these different acetabular fixation techniques highlight different evolutions: favorable results with non-cemented cups reported by Long et al. [5], Migaud et al. [6], Kim et al. [7], Delaunay et al. [8,9] and Saito et al. [10] contrasted with the loosening and radiolucent line (RLL) evolution of cemented Metasul™ cups investigated by Levai et al. [11], Nich et al. [12] and Augereau et al. [13] or cemented “Weber type” cups studied by Weber [3], Dorr et al. [14] and Lazennec et al. [15]. Mixed series confirmed this hypothesis with higher rates of aseptic loosening with the cemented cups compared to the cementless ones [16].

Metasul™ metal-on-metal coupling has been used in the Versailles Hospital Centre since 1999 for hip arthroplasties in patients up to the age of 65 years. Fixation is hybrid, cemented at the femoral level, cementless at the acetabulum. We reviewed our series of 106 arthroplasties with more than 5 years of follow-up. Our working hypothesis was that metal-metal coupling does not increase the risk of osteolysis.

Materials and methods

Patients

From January 1999 to December 2002, 106 THAs with metal-on-metal bearing comprising a non-cemented cup were performed in 95 patients by 2 operators (PO and PB: 106 Metasul™ arthroplasties representing 15% of first-intention THAs in our institution at the same period). Metasul™ implants (instead of 22-mm metal-polyethylene bearing) were chosen according to criteria that took into account patient age below or equal to 65 years, or good physiological state and activity level of patients under 70 years of age. Etiology or body mass index was not a selection criterion. Included were 55 men and 40 women with an average age of 59.2 years (from 37 to 69 years, median 56 years).

The etiology was primary osteoarthritis in 82 cases (77%), arthroplasty secondary to hip dysplasia in ten cases (9%), and osteoarthrosis secondary to hip dysplasia in ten cases (9%), carporeal fracture in three cases (2.8%) and avascular necrosis in 11 cases (10%). All arthroplasties were performed through the Hardinge anterolateral approach (some with an osteoperiosteal anterior partial trochanteric osteotomy reinserted with metallic wires). The stem was of Acora™ stainless steel (51 cases) (Zimmer, Warsaw, IN, USA) or Exafit™ (55 cases) (Zimmer), cemented and modular (Morse taper 8/10), mounted by a 28-mm Metasul™ head (Zimmer) (Fig. 1). Femoral cementing after obturation of the femoral canal was undertaken, by the operators, in a retrograde or anterograde manner under pressure but always with low cement viscosity. The acetabular Cedior™ implant (Zimmer) was of the press-fit type in titanium, non-cemented, covered by hydroxyapatite with a 28-mm diameter Metasul™ insert and polyethylene sandwich. These cups could have additional three-screw fixation, which were not used in our series. Diameters of 50, 52 and 54 mm were the most represented but with 14% of diameters being below 50 mm (Fig. 2).

Evaluation methods

All patients were evaluated preoperatively with clinical and radiological follow-up. The clinical result was assessed by the Merle d’Aubigné functional score [17], and the presence of articular noise was investigated during questioning. Radiological follow-up was conducted by rantero-posterior (AP) pelvic standing view centered on the symphysis as well as hip AP and profile view. The stem fixation was analyzed on X-rays by researching, according to the zones of Gruen et al. [18], RLL, calcar resorption, periprosthetic osteolysis, and we looked for stem subsidence. Cup inclination angle was measured on the acetabular side and we looked for RLL and osteolyses according to the zones of DeLee and Charnley [19]. Implant migration was studied according to criteria.
Figure 1  Hybrid fixation of implants in this series. Modular and cemented Acora™ (left) or Exafit™ (right) femoral stems. Cementless™ Cedior™ cup (Zimmer).

Figure 2  Diameter of cups used in this series.

Figure 3  Evolution of Merle d’Aubigné score preoperatively (white column at left) and at follow-up (black column on right) for different parameters: pain, mobility and walking.

2.28 ± 1.28 to 5.78 ± 0.55, that of mobility from 5.28 ± 1.12 to 5.91 ± 0.44, and walking from 4.13 ± 0.91 to 5.92 ± 0.40. Only one patient presented intermittent squeaking, without any radiological or clinical anomalies (PMA score of 18) at 6 years of follow-up. The survival rate (with re-operation for implant change) over more than 6 years was 95.8% (91.8–99.8) for the cups and 94.8% (90.3–99.2) for the femoral stems (95% confidence interval).

Complications

Nine early or semi-early revisions were required:
- one hematoma drainage at 1 month with a PMA score of 18 at last follow-up;
- two ablations of trochanteric metal wires;
- two lavages in emergency for late infection (at 6 and 7 years of follow-up respectively), their evolution was favorable and PMA score was 18;
- one late infection necessitated two stage revisions at 1 year postoperatively (PMA score of 15 at 6 years);
- two femoral implant fractures at the level of the metaphyseal neck junction related to laser marks;
- one recurrent early luxation at 3 months postoperatively required revision with a double mobility cup.

Radiological results

Average cup inclination angle was 45.7 ± 5.49° (range 38° to 61°). At the latest follow-up, no migration or change of cup inclination angle was noted; all cups were integrated and none presented RLL. Only one cup manifested osteolysis in zones 1 and 2, justifying revision at 7 years. On the femoral side, 13 cement/bone RLL on nine non-revised prostheses were distributed in zone 1 (3), zone 2 (1), zone 6 (2) and zone 7 (7). At the longest follow-up, the RLL present at 3 months postoperatively were non-evolving. The only femoral osteolyses present were located in zone 7 in six patients and were more like calcar atrophies. One hundred arthroplasties showed no periprosthetic ossifications. We noted one hip with stage I, three hips with stage II and two hips with stage III Brooker ossifications. A 38-year-old patient whose PMA score was 18 at 4 years incurred posterior hip pain associated with calcar resorption. Scintigraphy
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6 months. Radiographic analysis highlighted a 60°-cup inclination and excessive anteversion. Femoral osteolysis was observed in zone 7. Bilateral hip puncture disclosed an articular cobalt level of 5,242 µg/L on the left with 143 µg/L on the right (right metal-metal THA with no recent problem). Fluid bacteriology was negative. Surgical revision disclosed metaposition due to posterior impingement between the prosthesis neck and the Metasul™ inlay. All parts were normally stable. Acetabular revision was undertaken by implantation of a cemented polyethylene cup with replacement of the ball. Histological synovial analysis showed macrophagic predominance with the cytoplasm containing blackish metallosis pigments. Bacteriological analysis of tissues was negative. At 5 months after acetabular revision and after an early luxation episode at 6 weeks postoperatively, the cobalt serum level decreased to 7.77 µg/L and the PMA score was 18.

A simple change of insert and ball was undertaken 18 months after implantation in a 36-year-old patient who had benefited earlier from total metal-on-polyethylene type arthroplasty of the other hip for juvenile coxarthrosis. Revision was motivated by the association of episodes of squeaking with cobalt serum elevation (37.22 µg/L). There were no radiological anomalies on the implants which, in addition, were oriented normally. Fluid sampled during hip puncture was sterile. Surgical revision disclosed metaposition in relation to neck-rim Metasul™ insert impingement visible only on explant examination. The insert and ball (going from 0 mm to +4 mm) were simply changed, keeping the same Metasul™ coupling on perfectly stable parts. Histological analysis detected a macrophagic granuloma containing metallic inclusions evoking metallosis. Tissue cultures were negative. The clinical evolution was marked by two episodes of luxation (2nd day and 2nd postoperative month). The cobalt serum level was divided by two as early as the 8th month, then stabilized with values above normal (23.1 µg/L at 2 years, to 19.7 µg/L at more than 3 years). At more than 5 years after surgical revision, the PMA score was 17.

Significant and evolving femoral osteolysis in zones 1 and 7 appearing as of 18 months led to revision at 5 years (Fig. 4). The cobalt serum level was subnormal at 1.66 µg/L (normal <1 µg/L serum), and scintigraphy showed hyperfixation on zones of femoral osteolysis as well as on the posterior wall of the acetabulum. Articular puncture detected abnormal fluid whose bacteriological analysis was negative. During surgical revision, no signs of intraprosthetic conflict were apparent: the capsule was abnormally thick and hardened, without clinical metallosis. The two prosthetic parts were in place without mobility at the cement/bone or bone/prosthesis interfaces. We noted complete calcar lysis and, to a lesser degree, of the greater trochanter and the posterior wall of the acetabulum. Bipolar revision was undertaken by cemented metal-on-polyethylene coupling with a 28-mm head. Bacteriological analysis of articular tissues remained negative, and "fibrous tissue presenting many vessels, including small inflammatory lymphocytic areas,..., whose aspect could be compatible with an hypersensitivity reaction to metal" was noted on anatomopathology (Fig. 5). The only foreign bodies visible on microscopic examination were polymethacrylate particles circumscribed by a row of macrophagic cells; there were no foreign metallic bodies or cellular reactions evoking granulomas to polyethylene.

Acetabular osteolysis in zones 1 and 2 associated with femoral osteolysis in zones 1 and 7 was revised at 7 years by bipolar change (Fig. 6). These radiological anomalies appeared in the 5th year. Hip puncture disclosed neither fluid evoking metallosis nor germs at culture. CT scans presented voluminous osteolysis on a normally oriented cup. Cobalt serum level was subnormal at 1.47 µg/L. Surgical revision disclosed bipolar loosening, without metallosis, with tissue interposition at the bone/cup interface. Histological analysis of interposing tissues highlighted aspecific granuloma whereas bacteriology remained negative.

Late revisions

One cup revision was performed at 4 years because of secondary hip pains associated with cobalt serum level elevation to 167.8 µg/L (normal: <1 µg/L of serum) at 6 months. Radiographic analysis highlighted a 60°-cup inclination and excessive anteversion. Femoral osteolysis was observed in zone 7. Bilateral hip puncture disclosed an articular cobalt level of 5,242 µg/L on the left with 143 µg/L on the right (right metal-metal THA with no recent problem). Fluid bacteriology was negative. Surgical revision disclosed metaposition due to posterior impingement between the prosthesis neck and the Metasul™ inlay. All parts were normally stable. Acetabular revision was undertaken by implantation of a cemented polyethylene cup with replacement of the ball. Histological synovial analysis showed macrophagic predominance with the cytoplasm containing blackish metallosis pigments. Bacteriological analysis of tissues was negative. At 5 months after acetabular revision and after an early luxation episode at 6 weeks postoperatively, the cobalt serum level decreased to 7.77 µg/L and the PMA score was 18.

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Figure 5  Hypersensitivity. Top: ''Punctuated fibrous tissue of vessels dissociated by small hemorrhagic suffusions. It includes small areas of inflammatory lymphocytic elements'' and metallosis (bottom): ''Dense, conjunctive, not very cellular tissue containing histiocytes whose cytoplasm is filled with a blackish pigment''.

Of the 94 hips reviewed in our series, and with more than 6 years of follow-up, we thus counted nine stable and non-revised hips with femoral cement/bone RLL. Two femoral osteolyses were revised. There were no RLL at the acetabular level, but two acetabular osteolyses were revised.

Discussion

Our series (number, average age and lost-to-follow-up rate) is similar to other metal-on-metal bearing series, and our clinical results are superposable on those of other authors using the functional score of Merle-d'Aubigné (Tables 1–3): 17 for Augereau et al. [13] and Nich et al. [12], 17.1 for Levai et al. [11], and 17 for Delaunay et al. [8,9]. Our series, with 6.4 years of average follow-up, are part of monocentric, non-cemented metal-metal bearing series with longer follow-up. Grubl et al. [22], Delaunay et al. [9] and Vassan et al. [23] had the longest follow-up: 10, 7.4 and 7 years, respectively. Metal-on-metal coupling thus confirmed its very good functional results in a young population with more than 6 years of follow-up of its non-cemented cup form.

Our revision rate (13 out of 106 [12%]) was among the highest: nine out of 97 for Lazennec et al. [15], ten out of 112 for Vassan et al. [23], eight out of 104 for Eswaramoorthy et al. [24], and five out of 98 for Delaunay [8]. However, the number of surgical revisions directly attributable to metal-on-metal coupling was not more than three: two metalloses due to impingement and one hypersensitivity reaction out of 94. The ten other revisions were not related to the bearing used.

Our rate of aseptic loosening and serious osteolysis was low if we relate it to the results of metal-on-metal series with cups cemented in bone: five revisions out of 143 for Augereau et al. [13] and five out of 122 for Levai et al. [11] in connection with cup diameter less than 50 mm (14% of our cups), similar to the series of Weber type cups: seven revisions out of 97 for Lazennec et al. [15] and five out of 105 for Weber [3]. Our series thus resembled those of metal-on-metal bearing prosthesis using cementless cups of Delaunay (one out of 98 and none out of 87) [8], (four out of 105) Grubl et al. [22], (one out of 68) Kim et al. [7], (none out of 106) Saito et al. [10].

Radiological analysis of RLL and osteolysis not revised surgically is close to the best non-cemented metal-on-metal series of Delaunay [8] (one non-revised femoral osteolysis out of 98, 4.1% RLL in zone 1, and seven femoral osteolyses) and Delaunay et al. [9] (ten RLL in zone 1, no osteolysis), and Kim et al. [7] (one osteolysis out of 68 hips; in zones 1 and 7 on one stem at 8 years and one acetabular osteolysis in two zones at 7 years). Calcar atrophy in our series was not as frequent as for Delaunay [8] (94%) or Migaud et al. [6] (31 out of 39). This atrophy does not appear to be pejorative for the future.

Thus, the future of acetabular fixation, the weak point of metal-on-metal coupling, seems to be much less worrisome.

Figure 6  Surgical revision of defective osteointegration with acetabular osteolysis in zones 1 and 2.
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<table>
<thead>
<tr>
<th>Series</th>
<th>Implant fixation mode</th>
<th>Number</th>
<th>Average age</th>
<th>Functional score</th>
<th>Follow-up</th>
<th>Number of revisions</th>
<th>Revision of aseptic loosening</th>
<th>Osteolysis and radiolucent lines (RLL)</th>
<th>Brooker ossifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weber [3]</td>
<td>Cemented Weber cup/cemented femoral stem</td>
<td>110 hips/105 reviewed</td>
<td>59 years</td>
<td>Harris score</td>
<td>3.5 years</td>
<td>5 revisions (3 stems, 1 cup postoperative and 1 stem after 6 years because of varus)</td>
<td>5 revisions (3 stems, 1 cup postoperative and 1 stem after 6 years because of varus)</td>
<td>Stems: 1 on 4 to 6 zones, 4 on 2 or 3 zones, 20 on 1 or 2 zones Cups: 18 RLL (15 on 1 zone, 3 on 2 zones)</td>
<td>1 stage III 3 stage II 13 stage I</td>
</tr>
<tr>
<td>Levai et al. [11]</td>
<td>Cemented stem and cup</td>
<td>134 hips/122 reviewed</td>
<td>61 years and 10 months</td>
<td>PMA score 11 to 17.1 at follow-up</td>
<td>3 years and 8 months</td>
<td>5 revisions of acetabular unsealing (1 to 2 years, 2 to 4 years, 2 to 5 years)</td>
<td>5 revisions of acetabular loosening (1 to 2 years, 2 to 4 years, 2 to 5 years)</td>
<td>No femoral cup RLL: 18 without RLL, 81 with 1 non-evolving RLL in zone 1, 18 evolving RLL (11 complete RLL)</td>
<td>None</td>
</tr>
<tr>
<td>Nich et al. [12]</td>
<td>Cemented polyethylene cup/27 cemented stems, 1 without cement</td>
<td>28 hips/27 reviewed</td>
<td>44 ± 8.3 years</td>
<td>PMA score 12 to 17 at follow-up</td>
<td>31 months (± 2.58 years) 1 sepsis at 5 months/1 trochanteric hook ablation</td>
<td>None</td>
<td>Cups: 13 with partial RLL in 1 zone, 8 with RLL in 2 zones. 3 with complete RLL 7 evolving RLL, of which 3 were complete Femur: no RLL, no Merkel resorption, no osteolysis</td>
<td>2 stage I</td>
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<tr>
<td>Augereau et al. [13]</td>
<td>Cemented polyethylene cup/cemented femoral stem with 1 non-cemented</td>
<td>166 hips/143 reviewed</td>
<td>59 years</td>
<td>PMA score 17 at follow-up</td>
<td>42 months (± 3.5 years)</td>
<td>5 cup revisions because of loosening</td>
<td>5 cup revisions related to loosening</td>
<td>Femur: no RLL, no osteolysis Cups: 114 RLL, 100 partial, 14 complete, 25 evolving</td>
<td>None</td>
</tr>
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<td>Series</td>
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<tr>
<td>Dorr et al. [14]</td>
<td>Cemented Weber cup/31 non-cemented stems, 25 cemented stems</td>
<td>70 hips/56 reviewed</td>
<td>Harris score 41 preoperative to 89.6 at follow-up</td>
<td>5.2 years</td>
<td>1 cup revision of aseptic loosening, 2 cup revisions of luxation, no femoral revision</td>
<td>1 cup revision of aseptic unsealing</td>
<td>11 cup RLL: 7 in 1 zone, 3 in 2 zones and 1 in 3 zones, none evolving Femur: 1 hip with RLL in 8 zones, 1 in 5 zones, 1 in 4 zones, 2 in 2 zones, 1 in 1 zone, none evolving. 2 calcaneal resorptions</td>
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<tr>
<td>Lazennec et al. [15]</td>
<td>Cemented Weber cup/cemented femoral stem</td>
<td>97 hips</td>
<td>Devane score</td>
<td>8 years</td>
<td>9 revisions (2 of recurrent dislocation due to impingement, 7 of acetabular osteolysis)</td>
<td>7 revisions (5 undertaken and 2 scheduled)</td>
<td>30 cups (25 RLL in zone 1, 11 worrisome, 5 rapidly evolving osteolyses in zone 1) among these 30 cases 8 femoral osteolyses (3 in zone 1, 5 in zone 7)</td>
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Table 2  
Literature review of clinical metal-on-metal THA series with cementless cups.

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<tr>
<td>Long et al. [5]</td>
<td>Cementless cups/132 non-cemented stems, 29 cemented</td>
<td>161 hips</td>
<td>55.5 ± 11.6 years</td>
<td>Harris score</td>
<td>6.5 years</td>
<td>6 revisions: 5 cups (1 for recurrent luxation, 2 inexplicable pains from hypersensitivity, 1 infection, 1 disassembly on conflict) 1 stem for aseptic loosening</td>
<td>None</td>
<td>None</td>
<td></td>
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<tr>
<td>Migaud et al. [6]</td>
<td>Cementless stem and cups</td>
<td>39 hips</td>
<td>&lt; 50 years</td>
<td>Harris score</td>
<td>69 months (≈ 5.75 years)</td>
<td>None</td>
<td>None</td>
<td>Calcar atrophy in 31 cases/RLL on 7 cups: 5 in zone 1, 2 in zone 3 3 cups with complete RLL (1 mm) without migration/9 stems with RLL on 3 zones (1 mm) without migration</td>
<td>13 ossifications: 9 stage I 4 stage II</td>
</tr>
<tr>
<td>Saito et al. [10]</td>
<td>Cementless stems and cups</td>
<td>106 hips</td>
<td>57.8 years</td>
<td>Harris score</td>
<td>6.4 years</td>
<td>1 revision for polyethylene ring luxation</td>
<td>None</td>
<td>None</td>
<td></td>
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<tr>
<td>Kim et al. [7]</td>
<td>Cementless cups and stems</td>
<td>103 hips/68 reviewed</td>
<td>&lt; 50 years</td>
<td>Harris score</td>
<td>7 years</td>
<td>2 infections with material ablation at 4 years</td>
<td>1 cup osteolysis in zones 2 and 3 in 1 patient (at 7 years) revised by grafting (lymphocytic tissue or fluid) 2 osteolyses in zone 1 and 7 femoral in 1 patient (at 8 years)/1 cup osteolysis in zones 2 and 3 in 1 patient (at 7 years) revised by grafting (lymphocytic tissues or fluid)</td>
<td>10 ossifications: 8 stage I 2 stage II</td>
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<td>Delaunay et al. [9]</td>
<td>Cementless stems and cups/22 heads with skirt, 78 without skirt</td>
<td>100 hips/98 reviewed</td>
<td>59.5 years</td>
<td>PMA score 11 preoperative to 17.3 at follow-up</td>
<td>6 years</td>
<td>5 revisions: 2 luxations, 1 inexplicable pain of the head without skirt (hypersensitivity), 1 aseptic hip loosening with osteolysis on conflict (skirt), 1 hip skirt in conflict</td>
<td>1 stem revision of aseptic loosening</td>
<td>1 proximal femoral osteolysis non-revised because of non-evolution, 4.1% of RLL in zones 1 and 7, calcar atrophy in 94%</td>
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</tr>
<tr>
<td>Delaunay [8]</td>
<td>Cementless stems and cups</td>
<td>83 hips/82 reviewed</td>
<td>40.7 years</td>
<td>PMA score 11.1 preoperative to 17.4 at follow-up</td>
<td>7.3 years</td>
<td>All parts in place/2 re-interventions (psoas tendinitis, trochanteric bursitis)</td>
<td>None</td>
<td>53 calcar atrophies/no osteolysis/10 non-evolving acetabular RLL in 1 zone</td>
<td></td>
</tr>
<tr>
<td>Grubl et al. [22]</td>
<td>Cementless stems and cups</td>
<td>105 hips/73 reviewed</td>
<td>56 years</td>
<td>Harris score = 92 UCLA score = 6</td>
<td>&gt; 10 years</td>
<td>4 revisions: 1 infection, 1 luxation, 1 ossification, 1 fracture of greater trochanter</td>
<td>1 radiological acetabular failure and 1 revision after 10 years</td>
<td>RLL: stems: I: 9.2%, zone 1 = 17%, zone 2 = 6.6%, zone 3 = 7.9%, zone 4 = 2.6% Osteolyses: stems: zone 1 = 3.9%, zone 7 = zone 6 = zone 8 = 1.3%/Cups: zone 1 = zone 2 = 2.6%, zone 4 = 1.3%</td>
<td></td>
</tr>
</tbody>
</table>
Cementless cups do not increase osteolysis risk in metal-on-metal total hip arthroplasty

Table 2 (Continued)

<table>
<thead>
<tr>
<th>Series</th>
<th>Implant fixation mode</th>
<th>Number</th>
<th>Average age</th>
<th>Functional score</th>
<th>Follow-up</th>
<th>Number of revisions</th>
<th>Revision of aseptic loosening</th>
<th>Osteolysis and radiolucent lines (RLL)</th>
<th>Brooker ossifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vassan et al. [23]</td>
<td>Cementless cup/66 cemented and 35 non-cemented stems</td>
<td>119 hips/112 reviewed</td>
<td>56 years</td>
<td>Harris score 38 pre-op to 91 at follow-up</td>
<td>7 years</td>
<td>1 revision for pain without infection, 1 revision for recurrent luxation, 4 periprosthetic fractures, 3 sepsis, 1 insert disassembly/metal-back</td>
<td>3 stem mobilizations (without cement), 1 acetabular failure at 1 year</td>
<td>Non-evolving RLL (in 1 or 2 zones) for 5 cups 13 calcar atrophies</td>
<td>5% patients</td>
</tr>
</tbody>
</table>
| Our series        | Cemented stems and cementless cups     | 106 hips/94 reviewed | 59.2 years | PMA score 11.4 preoperative to 17.6 at follow-up | 6.4 years | 13 re-interventions | 2 metalloses on intraprosthetic conflict and 1 hypersensitivity | Femur: 13 cement/bone RLL on 9 prostheses non-revised, distributed in zone 1 (3), zone 2 (1), zone 6 (2) and zone 7 (7) Cups: No RLL, no osteolysis | Stage I = 1  
Stage II = 3  
Stage III = 2 |
Table 3  Literature review of clinical metal-on-metal THA series with hybrid fixation (cemented and cementless).

<table>
<thead>
<tr>
<th>Series</th>
<th>Implant fixation mode</th>
<th>Number</th>
<th>Average age</th>
<th>Functional score</th>
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<th>Revision of aseptic unsealing</th>
<th>Osteolysis and radiolucent lines (RLL)</th>
<th>Brooker ossifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharma et al. [16]</td>
<td>139 cemented Weber cups and 76 metal-backed/cemented stems</td>
<td>209 hips</td>
<td>70 years</td>
<td>Harris score 39.8 preoperative to 85.8 at follow-up</td>
<td>7.3 years</td>
<td>1 revision for recurrent dislocation, 8 periprosthetic fractures (thus, 3 with revision of implants for retentive cup)</td>
<td>2 acetabular failures (3 and 6 years) uniquely on cemented cups</td>
<td>Non-evolving RLL in 17.7% of cups and 17.2% of stems Calcar atrophies in 24% (without specifying fixation sub-classes)</td>
<td>Stage I = 3, Stage II = 4, Stage III = 2</td>
</tr>
<tr>
<td>Eswaramoorthy et al. [24]</td>
<td>52 Weber type cemented cups and 52 cementless cups/cemented stems</td>
<td>104 hips/ 85 reviewed</td>
<td>61.6 years</td>
<td>Oxford score 20 at follow-up</td>
<td>10.8 years</td>
<td>8 revisions, i.e. 2 ectopic ossifications and 2 sepses</td>
<td>2 acetabular failures on 1 cemented Weber cup and 1 non-cemented (suspected hypersensitivity)</td>
<td>Cups: RLL in 14 cemented cups (1 on 1 zone and 3 on 2 zones) and in 3 cups without cement Stems: 16 RLL on 1 zone, 13 on 2 zones, 9 on 3 zones, 4 on 4 zones, 4 on 5 zones and 1 on 6 zones</td>
<td>Stage I = 16, Stage II = 4, Stage III = 2</td>
</tr>
</tbody>
</table>
Cementless cups do not increase osteolysis risk in metal-on-metal total hip arthroplasty

Cementless cups do not increase osteolysis risk in metal-on-metal total hip arthroplasty, especially if the diameter was the same. Aseptic loosening appeared most frequently in the series of Lazennec et al. [15] (11 “worrisome” acetabular RLL and eight femoral osteolyses on 97), Weber [3] (five stems with RLL in more than two zones, and RLL in two zones for three cups out of 105) and Dorr et al. [14] (four cups with RLL in two zones, five stems with RLL in more than four zones out of 56).

Our rate of ectopic ossification is among the lowest in series comprising non-cemented cups with metal-on-metal bearing, despite the absence of medical prevention: 9% stage I and 4% stage II for Migaud et al. [6], and 9% stage I, 6% stage II, 1% stage III, 1% stage IV for Grubl et al. [22]. However, these two series investigated cementless stems.

The survival rates as well as the clinical results of our series resemble those employing ceramic-on-ceramic coupling: survival rate of 93.2% at 6 years with a PMA score of 17 for Hamadouche et al. [25] in a comparable population (62 patients with an average age of 49.6 years), with 94.3% of 82 patients at 10 years averaging 54 years of age for Gabbar et al. [26]. There also, acetabular fixation seemed to follow the same rules. Aseptic loosening appeared most frequently with cemented cup fixation, especially if the diameter was less than 50 mm [27]. Thus, the rate of cup survival was 88% to 10 years for Nizard et al. [27] using cemented cups versus 94.3% to 10 years for Gabbar et al. [26], or 93.7% to 9 years for Bizot et al. [28] with acetabular metal-back fixation. In the same series, the survival rate can thus vary from 61.2 to 85.6%, according to the acetabular fixation mode [29].

Femoral osteolysis evolution, which appeared as of 18 months with a normal cobalt level having led to bipolar change, seemed to be perfectly specific to metal-on-metal coupling. The clinical evolution with early appearance of hip pains and evolving radiological osteolysis combined with a subnormal cobalt level seems to indicate type IV hypersensitivity. This hypothesis correlates with histological cup analysis finding significant perivascular lymphocytic infiltration, as described by Willert et al. [30].

Early acetabular loosening in zones 1 and 2 rather seemed to evoke a primary cup fixation defect leading to retrograde osteolysis by “fluid pressure”. In fact, there were no macroscopic lesions due to polyethylene insert convexity. On the other hand, osteolysis developed opposite to metal-backed orifices for the placement of screws. Our peroperative observations, radiological evolution and histological findings, excluding hypersensitivity or metallosis, seemed to be similar to the results already reported by Beaule et al. in 2001 [31]. In our experience, we have no reason whatsoever to implicate some osteolysis with the polyethylene sandwich.

Cobalt serum level, measured only in the event of radiological and/or clinical anomalies, implied the absence of investigation in asymptomatic patients, unlike the follow-ups carried out by Delaunay [8] (11 inexplicable elevations on 98 hips). The abnormal blood levels in our series were thus always correlated with radiological and clinical anomalies and were explained by the surgical observations: one cup change and one insert/ball change on metallosis due to impingement, hypersensitivity and aseptic loosening on defective osteointegration.

Conclusion

Our study confirms the good mid-term clinical and radiological results of hip prostheses series with metal-on-metal Metasul™ type bearings and non-cemented cups, in young patients, despite two femoral implant ruptures and a high infection rate (2.8%). The rates of aseptic loosening, RLL or acetabular osteolysis are low and stable in time, contrary to Metasul™ series with polyethylene directly cemented in bone or ceramic-on-ceramic coupling series with cemented cups. Our survival rate is also comparable to those of hard-hard coupling with non-cemented cups.

Certain complications, such as metallosis due to impingement and hypersensitivity, are specific to this bearing coupling; the incidence of impingement could decrease with diameter of the head going from 28 to 32 mm (clearance of 7° more on 8/10 cones, going from 131° to 138°). These complications led to aseptic unsealing and osteolysis evolution, which must be quickly detected for early surgical revision on yet limited bone lesions.

Implant malpositioning can have major deleterious effects on hard-hard bearings, with particular risks of bone anchorage failure. Our results encourage us to continue using metal-metal bearings with non-cemented cups in active patients.

Conflicts of interest

The authors declare that they have no conflicts of interest with respect to Zimmer Laboratory.

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References


