Small diameter metal-on-metal total hip arthroplasty at 13 years – a follow-up study

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1. Introduction

Theoretically, second generation metal-on-metal (MoM) bearings provide interesting tribiological properties for wear, osteolysis and thus longevity of total hip arthroplasties (THA) [1–3]. An intermediate term study performed in our unit reported the results of 94 MoM THA using Metasul™ heads (Zimmer, Winthertur, Switzerland) associated with a press-fit Cedior™ cup (Zimmer, Winthertur, Switzerland) a cemented Acora™ or Exafit™ femoral stem (Zimmer, Winthertur, Switzerland) after a mean 6.4 years of follow-up [4]. The survival rate was 95.8% (91.8–99.8) for the cup and 94.8% (90.3–99.2) for the femoral stem. Based on these encouraging results, we decided to continue using the MoM bearing in young, active patients.

Although there are nine studies in the literature on survival of the 28-mm Metasul™ system after more than 10 years [5–13] follow-up, with a survival rate of between 90.9 and 100%, most of these used cementless femoral fixation with a titanium alloy. Thus, the results in cemented stainless steel stems with the Metasul™ bearings are not precisely known and we performed this follow-up study of our initial series with the following goals: (1) to analyze the rate of survival of 28-mm MoM THA with hybrid fixation, (2) to...
compare survival in this series to that after 6.4 years of follow-up (95.8% cup, 94.8% stem), (3) to evaluate the clinical and radiographic results and (4) to analyze the failures. Our hypothesis was that the number of revision THA would increase after 10 years.

2. Materials and methods

2.1. Patients

Between January 2012 and March 2014, clinical and radiological follow-up was performed a mean 12.8 years after primary THA in patients who underwent MoM THA and based on the same protocol as the intermediate term study [4]. From January 1999 to December 2002, 106 THA with high carbon concentration MoM (Metasul™) bearings were performed in 95 patients by two senior orthopedic surgeons (PO and PB). The patients’ mean age was 59.2 years old (range 37–69, median 56) at THA. There were 55 men and 40 women. The etiology of hip arthritis was: primary arthrosis in 82 cases (77%), necrosis of the femoral head in 11 cases (11%), arthrosis secondary to dysplasia in 10 cases (9%) and post-traumatic in 3 cases (3%).

2.2. Methods

An anterolateral approach was used in all cases (Hardinge approach). Components included a cemented stainless steel femoral stem with a 8/10-mm morse taper (Acora-Zimmer™ (n = 50) or ExaFit-Zimmer™ (n = 56)) with a 28-mm Metasul™ head and a press-fit Cedior-Zimmer™ cup including a Metasul™ liner. This titanium alloy cup had three unsealed screw holes in the polar zone and twelve 1.5-mm flanges in the equatorial section. No screws were used in our series. The cup contained a Metasul™ liner set in a polyethylene (PE) sandwich. The Metasul™ head was composed of a chromium-cobalt alloy with a high carbon content (0.2%) [1].

2.3. Clinical and radiological follow-up

The clinical follow-up was performed by an orthopedic surgeon who was not the operating surgeon. The Postel-Merle d’Aubigné (PMA) [14] score and the validated French Oxford score [15] were calculated for each patient.

A standard radiographic follow-up was performed at the final follow-up consultation including: a pelvic AP X-ray and AP and lateral X-rays of the prosthesis. Radiolucencies and periprosthetic osteolysis were identified according to the zones described by Gruen et al. [16] for the stem and DeLee and Charnley [17] for the cup. Osteolysis was defined according to the criteria identified by Zacit et al. [18] as a focal area of bone loss at least 2 mm wide. Loosening of the stem and the cup was defined according to criteria by Gruen et al. [16] and DeLee and Charnley [17] respectively. Additional CT images were only obtained in case of progressive periprosthetic radiolucencies or inguinal pain. A histological analysis of periprosthetic tissue and the synovial capsule was systematically obtained during revision THA. We did not perform ion blood measurements.

2.4. Statistical analysis and survival curves

THA survival was calculated at the final follow-up by the Kaplan-Meier [19] method with a confidence interval of 95% (CI 95%), using SPSS software 10.0 (SPSS, Chicago, Illinois, USA). The date of the last consultation or death was used to determine the length of follow-up in lost to follow-up patients and in patients who had died, respectively. The survival rate was calculated for the revision of one or both THA components whatever the cause (septic or aseptic), for aseptic revisions and aseptic loosenings (which do not include isolated femoral stem fractures). The types and causes of revision THA were determined.

3. Results

3.1. Survival analysis

After a mean 12.8 years of follow-up (10–16 years), overall survival of THA for revision for all causes and of the stem alone was 79.3% (CI 95% = 68.7 to 91.5%); 81.5% (CI 95% = 71.0 to 93.5%) for aseptic revision and 87.6% (CI 95% = 77.3 to 99.3%) for aseptic loosening (Fig. 1). Survival of the cup alone at 12.8 years was 83.4% (CI 95% = 72.8 to 95.4%) for revision for all causes and 87.6% (CI 95% = 77.3 to 99.3%) for aseptic loosening.

3.2. Clinical and radiological results

After exclusion of 13 revisions (2 septic and 11 aseptic), 48 (53 THA) out of 85 patients (94 THA) evaluated during the intermediate term follow-up study were available for clinical and radiological assessment after a mean 12.8 years (10–16 years) (Fig. 2). Clinical and radiographic scores were available for all 48 patients. Patients’ mean age at the final follow-up was 68 years old (47–78). None of the 12 deaths that occurred since the intermediate term study were related to THA. None of the patients complained about their hip at the moment of death.

The mean PMA score had not changed since the 6.4-year intermediate term follow-up study in the 48 patients seen at the final follow-up. It went from a preoperative score of 11 ± 2.3 (8–14) to 17.8 ± 0.5 (17–18) points at 6.4 years and 17.6 ± 0.8 (16–18) points at 12.8 years. The mean Oxford score was 16.5 ± 5.2 (12–38) points at the final follow-up for a maximum score of 12 points. It was not determined at the 6.4-year intermediate term study.

The radiological results in the 48 patients seen at 12.8 years of follow-up are presented in Fig. 3. Periprosthetic radiolucencies were mainly observed in the proximal metaphysis around the stem with 17 and 21% respectively in Gruen zones 1 and 7. Table 1 compares the radiological results of the studies at 6.4 and 12.8 years. Cup inclination had not significantly changed in the 48 patients between 6.4 and 12.8 years of follow-up (45.7° ± 4.5 and 47.4° ± 6 respectively).

3.3. Revisions

Thirteen out of 94 (12.5%) of the series of MoM THA had undergone revision THA at the final 12.8 year follow-up (Fig. 2): two patients (2%) for septic loosening and eleven patients (10.5%) for mechanical failure including 5 femoral stem fractures (5.3%) (Table 2).
Inclusion period
January 1999 to December 2002

1st STUDY
at a mean 6.4 years of follow-up

94 THA
in 85 patients

2 deaths/ 8 patients lost to follow-up

6 THA revised/excluded

88 THA available
in 81 patients

15 deaths/ 18 patients lost to follow-up

12 deaths/ 15 patients lost to follow-up

60 THA
in 54 patients

53 THA in 48 patients
available for clinical and radiological examination at last follow-up

Fig. 2. Flow diagram summarizing the MoM THA series (THA: total hip prosthesis; MM: metal-on-metal).

Six patients underwent revision THA before 6.4 years and had already been described in the intermediate term study [4].

Seven patients underwent revision THA between the 6.4 and 12.8-year follow-up:

- one bipolar revision for septic (peptostreptococcus) loosening at 9.4 years;
- two femoral revisions for breakage of the Exafit-Zimmer™ stem (metaphyseal-neck junction initiated at the extraction hole) at 7 and 7.2 years after primary THA. There were no macroscopic signs of metallosis;
- one emergency cup and femoral revision THA for a fracture of the Exafit™ femoral stem 11.3 years after primary THA (Table 2: patient n° 4). The patient also presented with periacetabular osteolysis facing an unsealed screw hole in DeLee and Charnley zones 1 and 2 (Fig. 4). Macroscopic metallosis was identified during revision as well as loosening of the PE sandwich liner in the cup;
- three cup and femoral revisions for aseptic acetabular loosening 11.5, 12.1 and 13.1 years after primary THA (Table 2: patients n° 5, 6 and 7 respectively). These three patients complained of recent inguinal pain. Plain X-ray showed acetabular loosening with tilting of the cup in two out of three cases (Fig. 5). Initial mean acetabular inclination was 42° (40 to 45°). Abundant synovial fluid was present at the three revisions without macroscopic metallosis. Bacteriological tests were negative. Histological analyses showed diffuse perivascular lymphocyte infiltrates.

4. Discussion

The results of the intermediate term follow-up study of THA with MoM bearings after a mean 6.4 years were encouraging with cup and femoral stem survival of 95.8% (CI 95% = 91.8 to 99.8%) and 94.8% (CI 95% = 90.3 to 99.2%), respectively. This longer-term study reports a mean survival rate after 12.8 years of follow-up of 81.5% (CI 95% = 71.0 to 93.5%) for aseptic revision and 87.6% (CI 95% = 77.3 to 99.3%) for aseptic loosening. This confirms our hypothesis that survival decreases after 10 years. However, most of the failures were not due to MoM bearing wear, which was only
Table 1
Distribution of radiolucencies and areas of osteolysis around the stem and the cup at 6.4 and 12.8 years of follow-up (values were expressed as a percentage of analyzed hips).

<table>
<thead>
<tr>
<th></th>
<th>Radiolucencies at 6.4 years (%)</th>
<th>Radiolucencies at 12.8 years (%)</th>
<th>Osteolysis at 6.4 years (%)</th>
<th>Osteolysis at 12.8 years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GRUEN Zone (stem)</strong></td>
<td></td>
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<td></td>
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<tr>
<td>1</td>
<td>3</td>
<td>17</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>2</td>
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<tr>
<td>4</td>
<td>2</td>
<td>11.5</td>
<td>3</td>
<td>2</td>
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<tr>
<td>5</td>
<td>7.5</td>
<td>21</td>
<td>12</td>
<td>10</td>
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<tr>
<td><strong>DeLee Zone (Cup)</strong></td>
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<td></td>
<td></td>
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<tr>
<td>I</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>0</td>
<td>4.5</td>
<td>1</td>
<td>2</td>
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<tr>
<td>III</td>
<td>0</td>
<td>2</td>
<td></td>
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</tbody>
</table>

Fig. 4. Patient no 4 presented with periacetabular osteolysis in a MoM THA in DeLee zones 1 and 2 after 11 years of follow-up. The area of osteolysis measuring 20 x 22 x 21 mm on CT scan is found across from an optional unsealed screw hole (A: AP X-ray; B: lateral view CT).

directly involved in one case of isolated osteolysis but which could not be absolutely confirmed. Two of the 13 revision THA were septic, 5 were due to stem breakage, 2 to impingement, 3 to loosening, as well as the case of unexplained osteolysis. The four latter cases were associated with osteolysis which did not seem to be directly due to the MoM bearing.

This study has certain limitations, in particular the absence of systematic dosing of metal levels in blood and metal analysis of explanted components, making it impossible to identify MoM wear as the cause of failure in this series. The retrospective design of this study and the large number of lost to follow-up, which must be taken into account in the analysis of survival rate, is another limitation.

There are nine studies in the literature reporting the outcome of the 28-mm MoM Metasul™ bearing after more than 10 years’ follow-up (Table 3). The components used and the method of fixation vary, although there was a majority (6/9) of cementless stems (Table 3). The clinical and radiological outcome and the survival rate should therefore be compared with caution. The long-term clinical results of the current series are satisfactory and comparable to those of other series (Table 3) if patients who underwent revision THA are excluded. The radiographic results at the final follow-up showed an increased rate of periprosthetic radiolucencies mainly in the proximal femur. (Gruen zones 1, 6 and 7). These radiographic findings, in particular calcar osteolysis, do not seem to affect the clinical outcome. They are similar to those in other long-term studies [6,7,9–12] (Table 3), in particular in cemented stems,
which result in more radiolucenties and osteolysis [9,10]. This progression of radiographic images over time could be due to metal or polyethylene debris [11], which could be confirmed by analyzing component interfaces during revision surgery and searching for polyethylene debris [10].

Survival in the current series is lower than that in other long-term ones using the 28-mm Metasul™ system which varies between 90.9 and 100% (Table 3) [5–12]. Several mechanisms, which are sometimes associated, can explain these failures.

The specific complications associated with the MoM bearings due to metal debris are defined by the generic term Adverse Reaction to Metal Debris (ARMD) (including metallosis, Aseptic lymphocyte-dominated vasculitis-associated lesions [ALVAL] and pseudotumors) [20]. While no pseudotumors were observed in our series, the absence of systematic complementary imaging could have resulted in an underestimation of asymptomatic pseudotumors. Only the revision THA of patient n° 3 due to unexplained osteolysis could be associated with an ALVAL, but this was not confirmed histologically. This rate of this specific complication is usually 0.3% in series of MoM THA [13].

Metallosis, due to metal wear is a result of debris infiltrating the tissue from several sources: the MoM bearing itself at the head-Metasul™ liner interface but also the head-femoral taper interface, due to femoral neck-liner impingement or a femoral stem fracture. Metallosis was identified in patients 1 and 2 (Table 2) during revision THA due to impingement between the Metasul™ liner and the stem. The low tolerance of the 28-mm hard-on-hard MoM bearing [21] with a low head-to-neck ratio could result in underestimation of impingement and cause metal debris [22–24] above and beyond the simple wear of the MoM bearing [25,26]. The incidence of impingement in series of THA explants with all types of bearings combined, is between 48 and 60% [21,27–30]. The estimated rate of these cases of liner-femoral neck notching was 13.5% of in the series of MoM THA by Simon and Bellemans [31]. This could result in weakening of the components; the femoral component with a risk of femoral neck fracture [31], and the acetabular component, with loosening, mobilization of the metal liner and/or of the PE sandwich.

The five stem fractures that occurred in our series are due to the design of the stem holder/extraction hole of the Exafit™ components that were manufactured until March 2003, causing femoral neck fracture from notching. A safety announcement published by the National Agency of Drug and Medical Product Safety (Agence nationale de sécurité du médicament et des produits de santé [ANSM]) was published on December 2, 2009 informing surgeons of this defective design and of the change in design of Exafit™ stems. In this publication, the rate of fractures reported for Exafit™ stems commercialized with the original design was 0.89% compared to 5.3% in our series.

The head-neck taper MoM interface can also be a point of corrosion creating an additional source of metal debris in the joint [32,33]. This phenomenon, called « trunnionosis » was identified in the 1980s with the commercialization of modular head-neck components [34,35]. There has been renewed interest in this head-neck interface due to ARMD from large-sized MoM bearings [36]. Corrosion at the head-neck interface associates crevice and fretting corrosion [32,36]. This phenomenon can be accentuated by a galvanized bearing when the interface materials are different, which is the case in this series with a chromium-cobalt head on a stainless steel taper. The geometry of the Morse taper and the female bore-trunnion contact surface also plays a role in head-neck interface corrosion [32,37]. Several authors have shown that [38,39] there was a greater risk of corrosion in 11/13 tapers than 12/14 tapers. In our series, the use of Metasul™ heads on 8/10 tapers, that were initially designed to be used on 12/14 tapers could have increased corrosion. Patients 5, 6 and 7 presented with acetalab loosening more than ten years after primary THA, which could be due to a defect in primary press-fit fixation and

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Patients who underwent revision THA for aseptic failure except for isolated fracture of the femoral stem.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study at 6.4 years of follow-up</td>
<td>Causes of revision</td>
</tr>
<tr>
<td>Patient 1</td>
<td>Chronic inguinal pain + abnormal noise</td>
</tr>
<tr>
<td>Patient 2</td>
<td>Abnormal noise + increased Cr/Cob blood levels</td>
</tr>
<tr>
<td>Patient 3</td>
<td>Bipolar osteolysis</td>
</tr>
</tbody>
</table>

| Study at 12.8 years of follow-up | Causes of revision | Follow-up (years) | Surgical observations | Revision |
| Patient 4 | Inguinal pain + periacetabular osteolysis (DeLee zones 1 and 2) + periprosthetic femoral stem fracture | 11.4 | Periprosthetic femoral stem fracture + diffuse metallosis + metaphyseal osteolysis of the proximal femur (zone 7, 25 mm × 20 mm) + loose PE sandwich in the cup | Bipolar revision: morselized allograft of the acetabular roof, cemented PE cup (Durasul™)/standard cemented stem + allograft of the proximal femur by impacted cortico-cancellous graft secured by cerclage wire |
| Patient 5 | Clicking and snapping of the hip for 6 months + aseptic cup loosening with tilting (verticalization) | 11.5 | Abundant synovial fluid + mobile cup and stem + minimal osteolysis in zone 7 of the femur (< 10 mm) | Bipolar revision: cemented DM cup in Kerboull cross-plate + morselized allograft of the back. Standard cemented femoral stem without graft |
| Patient 6 | Inguinal pain for 1 month + aseptic loosening of the cup with no tipping | 12.1 | Abundant synovial fluid + mobile cup + minimal osteolysis in zone of the femur (< 10 mm) | Bipolar revision: cemented DM cup without graft. Standard cemented femoral stem without graft |
| Patient 7 | Inguinal pain for 6 months + aseptic loosening of the cup with tipping (horizontalization) | 13.1 | Abundant synovial fluid + mobile cup + osteolysis of the proximal metaphysis of the femur (zone 7; 2.5 × 3 cm) with good stem stability | Bipolar revision: highly cross-linked PE cup (Durasul™) cemented in Kerboull cross-plate without a graft. Standard cemented stem + proximal femoral cortico-cancellous impaction allograft with cerclage wire |

PE: polyethylene; DM: dual-mobility; MoM: metal-on-metal; Cr: chrome; Co: cobalt.
### Table 3
Review of the literature in long-term series (>10 years) evaluating the MoM Metasul™ system with 28-mm heads.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Number of patients (THA)</th>
<th>Follow-up (years)</th>
<th>Implants</th>
<th>Mean age at THA (years)</th>
<th>Functional scores</th>
<th>Revisions</th>
<th>Survival rate</th>
<th>Radiological results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migaud et al. [5]</td>
<td>30 (39 THA)</td>
<td>12.6</td>
<td>Cup (1 to 2 screws systematically) and cementless stem</td>
<td>39.8 (23–49)</td>
<td>Harris score: 48.6 (28–80) preop 92.8 (70–98)</td>
<td>None (0%)</td>
<td>100% for all causes</td>
<td>Cup: 1 osteolysis (zone 1) Stem: 1 osteolysis of the Calcar, 3 radiolucencies zone 1</td>
</tr>
<tr>
<td>Randelli et al. [6]</td>
<td>111 (149 THA) – 100 patients followed-up (138 PTH)</td>
<td>13</td>
<td>Cementless cup and stem</td>
<td>50 years old (19–74)</td>
<td>Harris score: 91.4 points (31–100 points)</td>
<td>7 THA (6%): 1 septic loosening at 1 year, 2 recurrent dislocations at 1 and 6 years, 1 aseptic cup loosening at 8 years, 2 aseptic femoral loosening in 9 years, 1 broke cup at 13 years</td>
<td>Cup &amp; Stem: 94% (CI 95% 0.89–0.97) all causes, 97% (CI 95% 0.93–0.99) revisions for aseptic loosening Cup: 97% (CI 95% 0.92–0.99) all causes Stem: 98% (CI 95% 0.94–0.99) all causes</td>
<td>Cup no radiolucencies or osteolysis Stem: 8 THA (6%) with radiolucencies zones 1 and 7 19THA (14%) with minimal osteolysis zones 1 and 7, four severe osteolyses in zones 1 and 7</td>
</tr>
<tr>
<td>Hwang et al. [7]</td>
<td>74 (83 THA) – 70 patients followed-up (78 THA)</td>
<td>12.4</td>
<td>Cup (1 to 2 screws systematically) and cementless stem</td>
<td>39.8 (19–50)</td>
<td>Preoperative Harris score: 51 points (23–78) to 95 points (90–100) at final follow-up</td>
<td>1 revision (1%) for acetabular osteolysis</td>
<td>98.7% (CI 95% 98%–100%) all causes 97.5% (CI 95% 95%–99%) for revision for osteolysis</td>
<td>Cup: osteolysis/radiolucencies for 4 THA (5.1%) Stem: radiolucencies zone 4 (17 THA, 21.8%), zone 2 (2 THA, 2.6%). Focal osteolysis zones 1 and 7 for 7 THA (8.9%). 30 reconstruction of the Calcar (38.5%), 7 pedal (9%)</td>
</tr>
<tr>
<td>Hwang et al. [8]</td>
<td>149 patients (195 THA) – 141 patients followed-up (180 THA)</td>
<td>18.4</td>
<td>Wagner cup (1 to 2 screws in all systematically) cementless stem</td>
<td>43.3 years (19–55)</td>
<td>Preoperative Harris score: 50.5 points (46–67)91.9 points (62–100) at the final follow-up</td>
<td>6 THA revisions (3.3%): 4 for aseptic loosening or acetabular osteolysis 2 periprosthetic fractures</td>
<td>Cup: 97.8% (CI 95% 96.7% to 98.9%) and 96.7% (CI 95% 95.4% to 98%) for revisions for acetabular osteolysis</td>
<td>Cup: radiolucencies 13 THA (7.2%) Stem: radiolucencies in zone 4: 28 THA (16%) Osteolysis in zones 1 and 7 for 11 THA (6.1%)</td>
</tr>
<tr>
<td>Dastane et al. [9]</td>
<td>124 patients (127 THA) – 66 patients followed-up (69 PTH)</td>
<td>13 yrs (8–16.4)</td>
<td>28 cemented Weber cup 41 APR press-fit cups Cemented stems</td>
<td>62.5 years (27–85)</td>
<td>Harris score: 94 ± 7.2 points at the final follow-up</td>
<td>8 patients (8 PTH) (11.5%): 2 recurrent dislocations, 4 mobile Metasul™ liners, 2 loose cups 6 patients (6 ThA) (7.1%): 1 septic loosening, 1 suspected infection, 1 cup loosening, 1 metallosis, 2 ALVAL</td>
<td>Cup: 97.3% (CI 95% 88.7%–99.4%) for aseptic loosening and 92.2% (CI 95% 83.8%–96.3%) for mechanical failure Metasul™ Bearing: 94% all causes combined Cup &amp; Stem: 96% all causes</td>
<td>Cup: 2 osteolyses (1 in zones 1/2 and 1 in zone 3) Stem: six calcar resorptions</td>
</tr>
<tr>
<td>Eswaramoorthy et al. [10]</td>
<td>100 patients (104 THA) – 82 patients followed-up (85 THA)</td>
<td>10.8 years (10.2–12.2)</td>
<td>52 cemented PE cups (Stuehmer-Weber) 52 press-fit cups and cemented stems</td>
<td>61.6 years (44–84)</td>
<td>Oxford score: 20.7 (12–42) at final follow-up</td>
<td></td>
<td>Cup: 17 radiolucencies (13 in one zone and 4 in two zones) Stem: 47 radiolucencies (16 in one zone, 13 in two zones, 9 in three zones, 4 in four zones, 4 in five zones and 1 in six zones)</td>
<td></td>
</tr>
<tr>
<td>Number of patients (THA)</td>
<td>Follow-up</td>
<td>Implants</td>
<td>Mean age at THA</td>
<td>Functional scores</td>
<td>Revisions</td>
<td>Survival rate</td>
<td>Radiological results</td>
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<tr>
<td>Innmann et al. [11]</td>
<td>91 patients (100 THA) – 79 THA followed-up</td>
<td>12 years (10–15)</td>
<td>Cementless cup and stem</td>
<td>42 years (21–50)</td>
<td>Preoperative Harris score: 46 points (18–77) to 92 points (51–100) at the final follow-up</td>
<td>7 THA (7%): 2 septic loosenings, 1 periprosthetic fracture, 1 recurrent dislocation, 1 aseptic loosening in an undersized stem, 1 ALVAL, 1 acetabular failure 8 THA (7.5%): 1 septic loosening, 1 recurrent dislocation, 4 aseptic loosenings, 1 metallosis for impingment, 1 for periacetabular ossifications</td>
<td>Cup &amp; stem: 90.9% (CI 95% 80.9–95.8%) all causes combined, 98.8% (CI 95% 92.5–99.8%) for aseptic loosening</td>
<td>Cup: 5 radiolucenties (8%) Stem: 11 (18%) osteolyses of the proximal femur (Gruen zones 1 and 7) and 16 radiolucenties (25%) (Gruen zones 1 and 7)</td>
</tr>
<tr>
<td>Lass et al. [12]</td>
<td>98 patients (105 THA) – 49 patients (52 THA) followed-up</td>
<td>17.9 years</td>
<td>Cup with screws and cementless stem</td>
<td>56 years (22–69)</td>
<td>Harris score: 88.8 points (44–100) at the final follow-up</td>
<td>Cup &amp; stem: 93.0% (CI 89.5–96.5%) for aseptic revision Stem: 97.9% (95% CI 95.8–100%) for aseptic revision Cup: 95.0% (95% CI 92.1–97.9%) for aseptic revision</td>
<td>Cup: radiolucenties in zones 4 and 5 in 9.1%, zone 1 in 6.8%, zones 2 and 6 in 4.5%, and zone 3 in 2.2% Stem: radiolucenties in zones 1, 7, 8, and 14, with 25%, 22.7%, 20.4%, and 27.3% respectively, osteolysis in zones 7 and 14 for 4.5% and zones 1 and 8 in 2.2% Cup: 4 acetabular osteolyses Stem: no osteolysis</td>
<td></td>
</tr>
<tr>
<td>Triclot [13]</td>
<td>39 patients (41 THA) – 27 patients followed-up (29 THA)</td>
<td>16 years</td>
<td>Cementless cup and cemented steel anatomical stem</td>
<td>58 years</td>
<td>PMA: 78% ≥ 17 Harris: 88% ≥ 80; Oxford score: 85% ≤ 18</td>
<td>1 THA (2.5%) revision at one year for recurrent dislocation due to impingement 13 THA (12.5%)</td>
<td>100% for aseptic loosening</td>
<td>Cup: radiolucenties in zones 1 in 4.6%, zone 2 in 4.5% and zone 3 in 2%, Osteolysis: 2% in zones 1 and 2 Stem: radiolucenties: 17% in zone 1, 1.5% in zone 4, 6% in zone 6, 21% in zone 7, Osteolysis: 5% in zone 1, 2.5% in zone 6, 10% in zone 7</td>
</tr>
<tr>
<td>Our series</td>
<td>95 patients (106 THA) – 54 patients followed-up (60 THA)</td>
<td>12.8 years (10–16)</td>
<td>Press-fit titanium cementless cup and cemented stem</td>
<td>59.2 years (37–69)</td>
<td>PMA score: 17.6 ± 0.8 points Oxford score: 16.5 ± 5.2 points</td>
<td></td>
<td>Cup &amp; stem: 79.3% (CI 95% = 68.7%–91%) for revision all causes combined; 81.5% for aseptic revision (CI 95% = 71.0–93.5%) 87.6% (CI 95% = 77.3–99.3%) for aseptic loosening Cup alone: 83.4% (CI 95% = 72.8–95.4%) for revision all causes combined</td>
<td>Cup: radiolucenties in zones 1 in 4.6%, zone 2 in 4.5% and zone 3 in 2%, Osteolysis: 2% in zones 1 and 2 Stem: radiolucenties: 17% in zone 1, 1.5% in zone 4, 6% in zone 6, 21% in zone 7, Osteolysis: 5% in zone 1, 2.5% in zone 6, 10% in zone 7</td>
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THA: total hip arthroplasty; PMA: Postel Merle d’Aubigné score; CI 95%: confidence interval 95%.
initial fixation failure, aggravated by the lack of surface roughness of the CediaoTM cup. A symptom-free interval of more than 10 years does not support this hypothesis. Histological analyses showed perivascular lymphocyte infiltrate. Campbell et al. [40] described a 10-point histological score to diagnose ALVAL. Isolated lymphocyte infiltrate is only graded with 4 points, and is not enough to confirm the diagnosis of ALVAL. Another phenomenon called backside wear could explain this periacetabular osteolysis [41]. Tricotl [13,42] mentioned backside wear in his series of MoM THA as the cause of wear of the convex part of the PE sandwich due to micromovements of the PE sandwich in the cup. Debris from the PE that infiltrates around the cup through unsealed screw holes could result in osteolysis. The perioperative discovery of a mobile PE sandwich in the cup inpatient 4 during revision THA associated with periacetabular osteolysis supports this hypothesis (Fig. 4).

5. Conclusion

We have discontinued the use of MoM bearings in our unit due to survival rates that are considered to be unsatisfactory. However, the MoM bearing does not seem to be the main cause of these failures. The lack of series in the literature using the same implants with conventional bearings (CoCr-PE or Aluminum-PE) makes it impossible to specifically exclude the components as the source of these failures. Stem fractures, trunnionoses, impingement or backside wear can explain most of these failures.

Disclosure of interest

Nicolas Tardy, Ali Maqdes, Philippe Boisrenoult and Philippe Oger declare that they have no competing interest.

Philippe Beaufils declares the following conflicts of interest: occasional educational consultant for Zimmer and Smith & Nephew. He is editor in chief of Orthopaedics & Traumatology: Surgery & Research.

References