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# Comparison of Outcomes and Complications Acetabular Reconstruction using an Antiprotrusio Cage and a Cemented Dual Mobility Cup or Simple Polyethylene Cup

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## I. Introduction

The demand for primary total hip arthroplasty (THA) is expected to increase over the next several decades, due to the increased life expectancy of THA patients and a trend towards surgical indication at younger ages [1]. Demand for THA revisions is projected to double by 2026, and case complexity is likely to increase dramatically [1]. Despite surgical technique and implant design improvements, instability remains the leading cause of mechanical failure of revision THAs accounting for up to 35% of these failures [3]. Different salvage procedures have been proposed in an attempt at stabilizing the hip. The most common option for treating recurrent dislocation in the United States is revision with a constrained acetabular component [14]. Constrained designs have reduced postoperative dislocation rates, but only to a limited extent and to the detriment of long-term acetabular fixation [2]. Dual mobility cups (DMCs) were introduced to prevent instability following THA, particularly in patients at high risk for dislocation, with fewer mechanical complications and lower loosening rates than with constrained acetabular components [1,3].

The advantages of acetabular revisions with antiprotrusio cages and the value of DMCs separately in terms of quality of fixation and prevention of instability were evaluated in our study. We did a retrospective series comparing functional and radiographic outcomes and complications of two groups, one with a simple polyethylene cup (SPEC) and other with a cemented DMC. We analyzed possible risk factors of dislocations, such as age, sex, number of previous surgeries, approach route, the size of the cages and cups and preoperative bone loss.

## II. Material and Methods

A retrospective single-center study was performed between January 2003 and December 2011. All patients undergoing acetabular revision using antiprotrusio cage and cemented DMCs and SPECs were included; unipolar femoral revisions or revisions THA for tumor were excluded.

This study included 37 patients: 25 females and 12 males, with an average age at revision of 67.8 years (range, 29 —90 years). 17 left and 20 were right hips. Osteoarthritis was the most common cause of THA (Fig.1).

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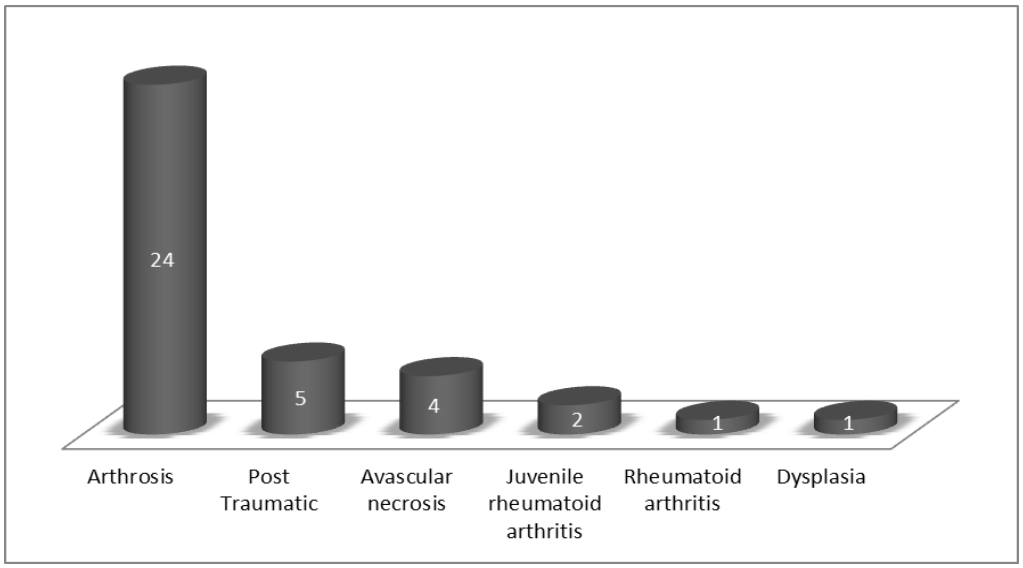



*Figure 1 :* Indications that led to primary hip arthroplasty

The average time from index arthroplasty to the acetabular revision was 13.4 years (range, 1- 27 years). We revised 25 hips for aseptic loosening, 3 for acetabular fracture and eight for recurrent dislocation associated to acetabular loosening. One hip had been previous infected although at the time of the index surgery the infection was controlled. The time from the last procedure to acetabular revision was 7.4 years (range, 0.2- 27 years). The number of previous surgeries on the hip in question averaged 1.9 and was: 1 (16), 2 (12), 3 (5), 4 (3), and 5 (1).

A postero-lateral approach was used in 32 cases (87%), in one case with femoral trochanteric osteotomy. A Hardinge transgluteal approach was used in 3 cases (8%), and Smith-Petersen anterior approach in two cases (5%). The hip joint was exposed and the acetabular component was removed and the femoral component was tested. Once the acetabulum had been cleaned, the severity of the acetabular defect was graded using the Paprosky classification system [4]: 2b (12), 2c (8), 3a (8) y 3b (9). Bone defects were filled with bone graft, using in two cases structural graft. Of the 37 cages used in this study, 15 performed initially were of the Protrusio cage [DePuyOrthopaedics, Inc, Warsaw, IN], and the latter 22 Contour types [Smith and Nephew Richards, Memphis, TN]. We used on average 6.6 screws (range, 3-9 screws) to secure the reconstruction cages. We cemented a SPEC into the cage in 23 hips. In 14 hips the device used was a DMC, Polar Cup [Smith and Nephew Richards, Memphis, TN]. The femoral component also was revised in 9 of the 37 cases. Postoperatively, patients were treated with protected weightbearing for 6 to 12 weeks and then were allowed to progress to full weightbearing as tolerated.

The Postel Merle d'Aubigné (PMA) score [5] was used to assess patient function. The radiological assessment was performed on an A/P view of the pelvis and A/P and lateral views of the hip. For the cups, radiolucency, osteolysis and cavities were identified and located by DeLee and Charnley zones [6]. The position of the centre of rotation was compared to the ''optimal'' centre of rotation defined by Ranawat et al [7]. The outcome of grafting was evaluated seeing incorporation, resorption or fracture of the bone graft [8]. Clinical failure of the acetabular reconstruction was defined as occurrence of instability and radiographic failure was defined as a failure of the antiprotrusio cage, like breakage of the material [3], and/or definite loosening of the cemented insert and/or resorption of the allograft.

We compare outcomes, complications and revision rates between the DMC-group and SPEC-group. We recorded all dislocation episodes, obtaining the incidence of implant dislocations at the end of follow-up (FU). We analyzed possible risk factors of dislocations, such as age, sex, number of previous surgeries, approach route, size of cages and cups and preoperative bone loss.

The statistical tests, carried out using STATA tm/SE v10, included univariate parametric tests with a critical p value less than 0.05.

## III. Results

FU averaged 5.4 years; the longest FU was 12.5 years. Preoperative PMA functional scores [5] averaged 5.48 ± 2.41. We observed an improvement ($p < 0.01$) in the postoperative score with an average PMA of 10.55 ± 3.82. Every component of the PMA changed significantly ($p < 0.001$). There were no significant differences between DMC-group and SPEC-group, with a mean PMA score 10.4±3.8 and 10.4±3.7 ($p>0.05$) (Fig.2).

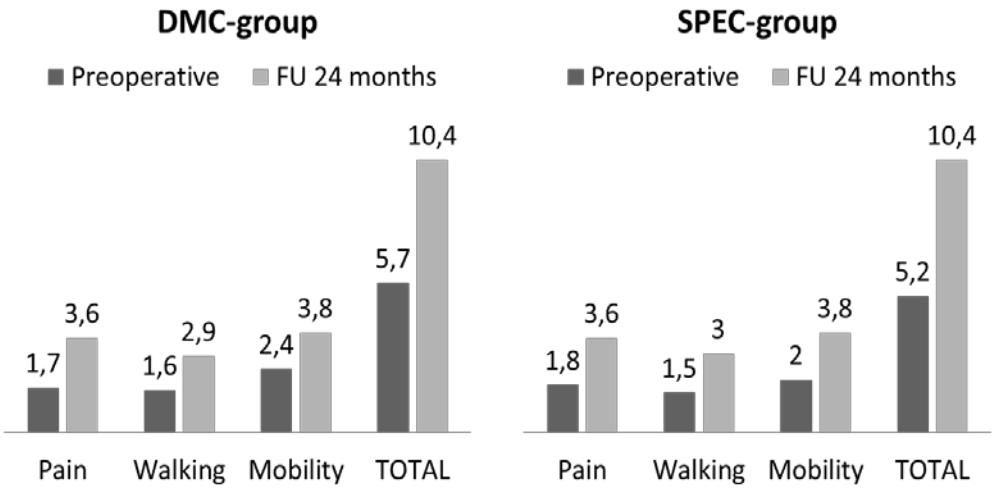



*Figure 2 :* Change in the Postel Merle dÁubigné from preoperative to follow-up in DMC-group compared with SPEC-group

Perioperative complications comprised: 1 greater trochanter fracture managed by plate fixation, 1 superficial infection resolved with antibiotic treatment and 5 inmediate postoperative sciatic nerve palsies with full functional recovery.

As postoperative complications we found (Table1): four deep infections (10.8%), one early infection requiring surgical lavage, which resolved the infetcion and three septic acetabular loosening (8.1%). One was associated to recurrent dislocations and a fracture of the superior flange of the cage, a revision was necessary at 44 months postoperatively using a constrained liner cemented into a new reconstruction cage. Another was revised at 36 months, and the last one refused to have surgery.

Three aseptic cage loosenings, of which only one was revised at 84 months. In this case a Protrusio cage lost fixation and impinged the sciatic nerve, so a revision to another cage and neurolysis of the sciatic nerve was necessary.

A cemented DMC lost fixation (7.1%) at 24 months, which was revised, leaving the cage intact, with no further complications.

We observed two material ruptures (screw or cage) (5.4%): the above-mentioned septic loosening with a Contour superior flange fracture and an ischial screw fracture that moved and impinged the sciatic nerve requiring the prompt removal of the screw, leaving the cage intact.

Three cases of late sciatic nerve palsies, which needed revision, explained aboved. There was a fracture of the ischium 12 months later with posterior fibrosis of the sciatic nerve that need neurolysis.

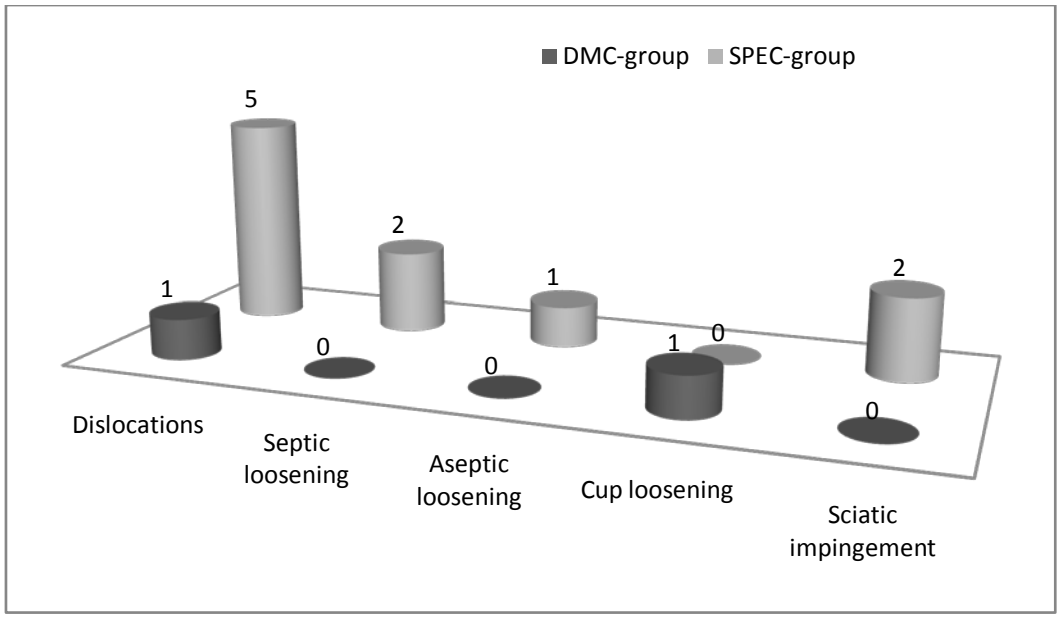
The overall postoperative dislocation rate at end of FU was 27% (10 dislocations). There were 3 cases of early dislocations that were reduced without additional surgery and remained recurrence-free. Seven hips (18.9%) needed further revision. One case was associated with septic loosening as explained above. Another two cases were revised to DMCs, without further complications. In two patients aged 89 and 90 respectively a resection arthroplasty was left. One of them died of causes unrelated to the process 24 months after the surgery. Another one was revised to a SPEC and dislocated two times again, Then another revision was needed to a DMC, without recurrence. The last patient was a dislocation of the femoral head from the mobile polyethylene (PE) component inside the metal shell, a so-called intraprosthetic dislocation, 3 months postoper-atively, being this the only case of DMC dislocation. After several attempts of closed reduction, an open reduction and revision to a constrained liner was necessary (Table 1). In summary, two constrained liners were used because of recurrent dislocations.

*Table 1 :* Complications occurred in DMC-group and SPEC-group

| Complications | SPEC-group (n=23) | DMC group (n=14) | Chi² test |
|---|---|---|---|
| Infection | 3 (3 septic loosening) | 1 | p>0.05 |
| Aseptic loosening | 2 | 1 | p>0.05 |
| Cup loosening | 0 | 1 | p>0.05 |
| Material ruptures | 2 | 0 | p>0.05 |
| Dislocations | 9 | 1 | p<0.05 |
| Clinical and radiographic failure | 10 | 3 | p<0.05 |
| Revision for any reason | 10 | 2 | p<0.05 |

We found an inverse association between the use of DMCs and both dislocation rate ($p<0.05$) and dislocation undergoing revision ($p<0.05$). We also found that a lower dislocation rate was found in patients with a lower age ($p < 0.005$). None of the other predefined risk factors significantly affected dislocation rates in the present series (Table 1). The need for reoperation for any reason was 32%, twelve hips (Table1) (Fig.3).

*Figure 3 :* Need for reoperation for any reason in SPEC-group and DMC-group




Thirty-four (92%) structural allografts and morselized cancellous grafts healed uneventfully without fracture or resorption. All acetabular reconstructions (100%) presented no radiolucent line around the cemented SPEC and 1 DMC (7%) presented radiolucent lines around the cemented insert that ended in a cup loosening and the need of revision. After the revision, a theoretically ''optimal'' centre of rotation (<10 mm) [7] was found in 20 cases (54%), 10-20mm in 14 cases (38%) and > 20 mm in 3 cases (8%). The mean vertical and lateral displacement of the centre of rotation was similar for DMC-group and SPEC-group. Reconstruction using an antiprotrusio cage associated with a DMC made it possible to obtain a mean cup inclination of 46◦ ±4.46◦, similar to the SPEC with a cup inclination of 49◦ ±5.80◦ ($p>0.05$).

## IV. Discussion

Combining technical difficulties related not only to the reconstruction of severe bone defects and the fixation of the acetabular component but also to a high risk of instability, revision THA remains a challenge particularly in the cases of Paprosky grade II and III [3].

The presence of severe bone loss is an indication for an acetabular reconstruction with the use of a metal reinforcement ring and bone graft. The use of a reinforcement device and bone grafting increases the success rate because it protects from excessive forces while providing support of the cup, approximation of the normal anatomy, restoration of lower-limb length, and better bone stock in case of future revision [9]. However, this technique is highly demanding and requires a wide exposure of the ischium and retraction of the soft tissue to place the inferior flange, which is associated with higher risk of sciatic nerve injury [10]. We reported 5 cases of sciatic nerve palsies that occurred in the perioperative period (14%), confirming the high risk of sciatic nerve palsy.

In addition, rates of instability as high as 25% have been reported, mainly due to the large dissection required to insert this implant [3], but also because of high number of previous surgeries and poor abductor function [10]. Constrained implants have been recommended by some authors where the risk of postoperative dislocation is high [1]. However, the success of the constrained design must be balanced against the theoretical possibility of increased transmission of stress to the implant-bone or implant-cement interface leading to loosening because of decreased ROM and early impingement [11]. It therefore seems logical to suggest caution in the use of these constraining devices [11].

In the recent days, DMCs have grown as an effective device in the treatment and prevention of instability following THA, particularly in patients at high risk for dislocation, with fewer mechanical complications

and lower loosening rates than with constrained acetabular components [1, 3, 11-15]. The overall survival rate of DMCs has been reported to be as high as 96% at 15-year follow-up with a restoration of hip stability in more than 95% of operated patients [2, 11-13]. This might be related to the fact that with a DMC, most of the motion occurs within the inner bearing patients [11] avoiding overstressing the cement-metal and the bone-cement interfaces.

The current series compared the use of an acetabular reconstruction technique using an antiprotrusio cage, on the one hand, with a DMC cemented into the cage and, on the other hand, a SPEC. At a mean FU of 5 years, no failure of the acetabular reconstruction was observed in 56.6% of the patients in the SPEC-group and in 78.6% of the patients in the DMC-group ($p<0.05$). Results that are similar to those obtained by Wegrzyn et al, with no failure of the acetabular reconstruction in 98% of the patients at mean FU of 7.5 years [3], or by Langlais et al, with no failure in 94.6% of 88 cemented DMCs [15].

A concern for long-term fixation of cemented DMCs is the poor results observed with cemented metal cups and with cemented metal-backed polyethylene cups [15].We reported one case (7.1%) of dissociation of cemented DMC and no cases of dissociation of SPECs. Recent studies demonstrated that cementation of DMCs provided even greater fixation strength than SPEC [1].

We reported a 39% dislocation rate (9/23) during the analysis of 23 reconstruction cages using a SPEC. Displaying the high rate of dislocations obtained using these devices, we began using a DMC cemented into the cage, improving our rates of 39% to 7.1% (1/14). We saw that using a cemented DMC into the cage, dislocation rate and dislocation undergoing revision dropped ($p=0.03$). Furthermore, the only case of DMC dislocation that we observed was a dislocation of the femoral head from the mobile polyethylene component inside the metal shell, a so-called intraprosthetic dislocation. Guyen et al reported two cases of intraprosthetic dislocation at the inner bearing [12]. They ensured that this was typically a medium- to long-term complication of DMC. Cold-flow failure and wear of the capturing area of the polyethylene component related to impingement of the prosthetic femoral neck against the chamfer are responsible for this complication [12]. The use of a femoral component with a thin Morse taper (10/12 Morse taper) and a highly polished neck to reduce abrasive wear is recommended to prevent this complication [12]. Our results are similar to those obtained By Schneider et al, at a mean FU of 41 months with 10.4% dislocation rate and without intraprosthetic dislocations of 96 cemented DMCs [16]. Wegrzyn et al reported no instability [1] and Langlais et al obtained a low dislocation rate of 1.1% of 88 cemented DMCs [15].

We analyzed possible risk factors of dislocations, obtaining that a lower dislocation rate was found in patients with a lower age ($p < 0.005$). None of the other predefined risk factors significantly affected dislocation rates in the present series. Therefore we could assign lower age at revision as a positive predictive value for postoperative dislocation. Langlais et al ensured that for patients older than 70 years of age, the risk of dislocation increases twofold [15].

We obtained a mean cup inclination of 46◦ ±4.46◦ (DMCs), similar to the SPECs with a cup inclination of 49◦ ±5.80◦ ($p>0.05$). The anatomical centre of rotation [7] was obtained in 8 cases in the DMC-group and in 12 cases in the other. Placing the acetabular component at the correct anatomical position decreases the risk of acetabular component loosening [1] and the risk of impingement and dislocation [1].

Our study had significant limitations. First, it was a retrospective study. Second, two reconstruction devices were used in the patients and may have confused the results. Third, midterm follow-up limited our ability to generate definitive conclusions with a power analysis, especially in relation to cup loosening. Finally, there were only 37, so larger studies with longer follow-up periods are needed.

Although a longer follow-up is required before reaching definitive conclusions, our preliminary results indicate that the treatment of severe acetabular defects by DMCs cemented into antiprotrusio cages is a viable option as they prevent instability. DMCs do not seem to have a negative impact on acetabular fixation.

## V. Acknowledgements

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## VI. Conflict of Interest

The authors declare that they have no conflicts of interest concerning this article.

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